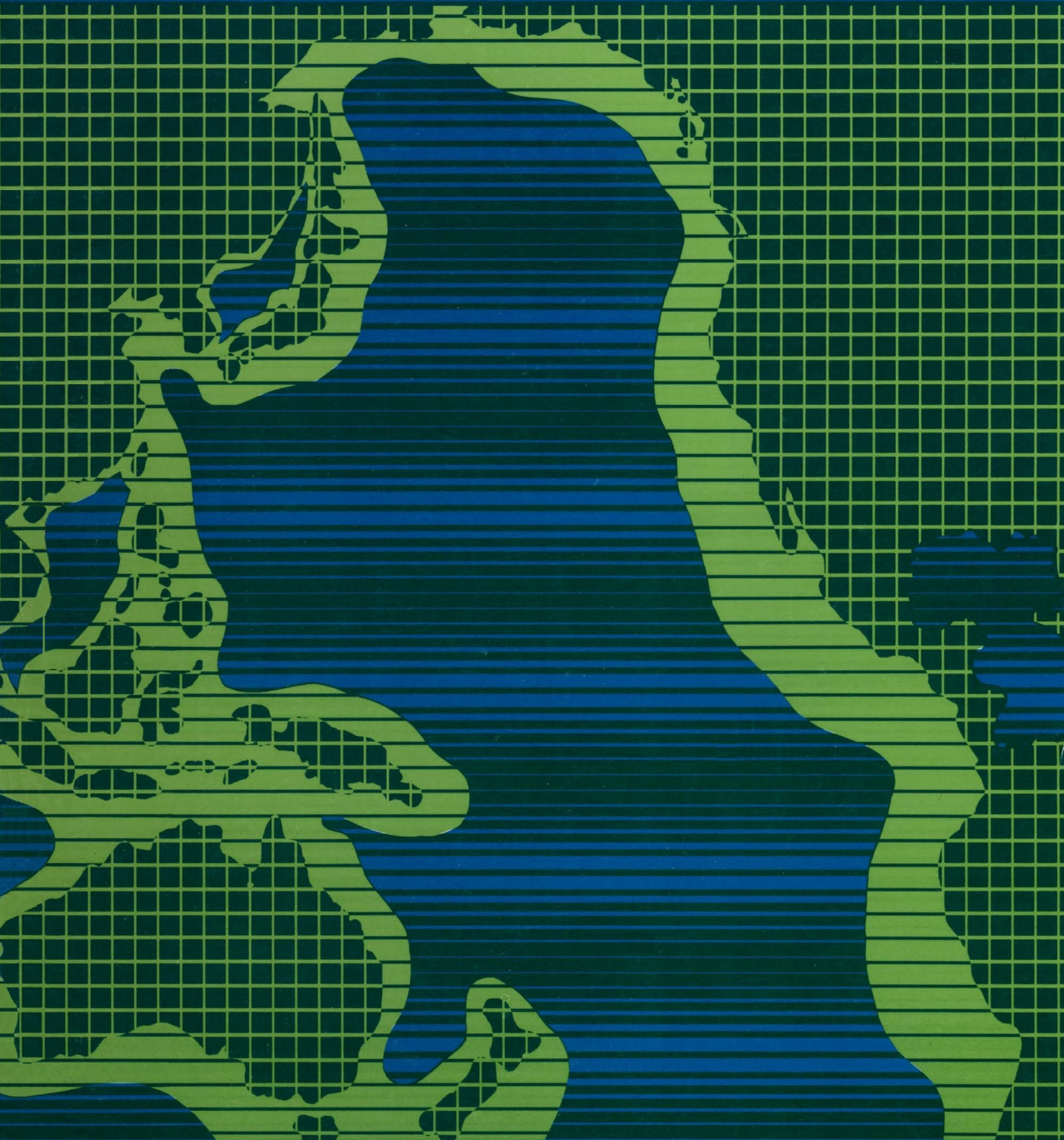


Renewable Resources in the Pacific

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Proceedings of the 12th Pacific Trade and Development
Conference, held in Vancouver, Canada, 7-11 September 1981



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Renewable Resources in the Pacific

**Proceedings of the 12th Pacific Trade and
Development Conference, held in Vancouver, Canada,
7–11 September 1981**

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Contents

Foreword 5

Preface 6

Introduction 7

General Studies

Intensive, Extensive, and Optimal Development of Forestlands

Anthony Scott 13

Optimizing the Use of Ocean Fish Resources in the Context of Extended
National Jurisdictions **Parzival Copes** 33

Discussion Peter Drysdale, Narongchai Akrasanee, John Bene, Wontack
Hong, Francis T. Christy Jr 48

Trade and Investment in Fish Products among Pacific-Area Countries

Biing-Hwan Lin, Rebecca J. Lent, and Richard S. Johnston 57

Discussion Hak Yong Rhee, Yoshiaki Matsuda 71

Pacific Trade and Investment in Forest Products **K.L. Aird and**

W.A.J. Calow 73

Discussion Kenji Takeuchi 81

The Northeast-Asian Market Economies' Response to Tighter Controls on
Fish and Forest Resources **Sueo Sekiguchi** 83

Discussion Helen Hughes 89

Resources of the Eastern USSR **Jan J. Solecki** 91

Forestry Case Studies

Forest Plantations, Production, and Trade in the Pacific Basin

Roger A. Sedjo 97

Discussion K. Hemmi 102

Pacific Northwest Timberlands **David R. Darr** 103

Discussion Wontack Hong 115

Development Prospects for Forestry in Indonesia **A.T. Birowo** 117

Discussion R.N. Byron 120

Tree Crops in Malaysia **Francis K. Chan** 123

Discussion Mohamed Ariff 133

Fisheries Case Studies

The Economic Future of Alaska Groundfish under Extended Jurisdiction

R.L. Stokes 137

4 RENEWABLE RESOURCES

- Discussion* Yoshiaki Matsuda 142
Canadian Regulation of Pacific Fisheries **David G. Moloney** 144
Discussion Yoshiaki Matsuda 154
The Developing Skipjack Tuna Fishery of the Central and Western Pacific
Ocean **David J. Doulman** 156
Discussion Theodore Panayotou 163
Fisheries Development in the South China Sea **Teruji Sakiyama** 165
Discussion Aida R. Librero, Norman J. Wilimovsky,
Theodore Panayotou 171
The Squid Fishery in New Zealand: the Role of Joint Ventures and Foreign
Fleets **C.C. Wallace** 178
Export Potential of Coastal Shrimp Cultured in Thailand **Kamphol
Adulavidhaya and Thanwa Jitsanguan** 188
Discussion Hugh Patrick 193

Renewable Substitutes for Fossil Fuels

- Substitution of Nonexhaustible Resources for Fossil Fuel Energy and
Industrial Raw Material Resources **Ben Smith and Hugh Saddler** 197
Discussion Miguel S. Wionczek 207
Prospects for Renewable Energy Resources in South Korea **Hoesung Lee
and Jee Dong Kim** 209
Discussion Romeo M. Bautista 219
Energy Constraints and the Open Economic Strategy in China's
Modernization **Li Guong-on and Luo Yuanzheng** 221
Discussion Jan J. Solecki, Lawrence B. Krause 227

Policy Issues

- Location of Mechanical Processing of Tropical Hardwood
K. Takeuchi 233
Discussion Alhambra Rachman 245
Cooperative Fisheries Arrangements between Pacific Coastal States and
Distant-Water Nations **Gordon R. Munro** 247
Discussion K. Hemmi 254
Fiscal Policies and Resource Rents in the Extraterritorial Oceans
Ross Garnaut 256
Discussion T.K. Shoyama, Hugh Patrick 267

Summary Keith A.J. Hay 271

References 279

Participants 291

Official Hosts and Observers 293

Foreword

Since 1968 there has been a series of 12 conferences for applied economists interested in trans-Pacific trade, investment, and other aspects of cooperation and development. The series, known as the Pacific Trade and Development Conference, staged its most recent meeting at the Bayshore Inn in Vancouver, 7-11 September 1981. Previous conferences have been held in Japan (1968, 1973), the United States (1969, 1977), Australia (1970, 1979), Canada (1971), Mexico (1974), New Zealand (1975), Thailand (1976), and South Korea (1980). These meetings dealt with a wide range of topics relating to trade, international investment, transfer of technology, employment, and adjustment problems.

The Pacific Trade and Development Conference series has had an impact in political as well as academic circles. Senior Japanese and Australian economists associated with the conference played a major role in organizing the Pacific Co-operation Seminar held in Canberra, Australia, in September 1980, at which for the first time government officials, business executives, and academics met to consider the means for fostering regular consultation on Pacific economic cooperation issues. That meeting proposed the establishment of a tripartite committee to study and make informed recommendations to government about areas of concern where unilateral and even bilateral approaches have generated problems for Pacific economic relationships in the past.

The theme of the Vancouver conference was renewable resources in the Pacific area. There were 48 participants from 13 countries in the Pacific and from three international organizations. Financial support for the meeting came mainly from the International Development Research Centre, the Max Bell Foundation, the Canadian Department of Industry, Trade and Commerce, and the Asia Foundation. Local arrangements and hospitality were supported by the Canadian Department of External Affairs, the British Columbia government, the B.C. forest industry, and four banks, the Bank of Tokyo, the Royal Bank of Canada, the Bank of Montreal, and the Bank of British Columbia.

We wish to express appreciation to these groups and other members of the host committee: Gordon Munro of the University of British Columbia and Parzival Copes of Simon Fraser University. Also to Susan McLintock who coordinated the preparation and distribution of papers and the staff support during the conference.

The conference organizers are very grateful to the International Development Research Centre for all the publication's arrangements and for input into the conference by Jeffrey Fine of the Social Sciences Division.

H.E. English and Anthony Scott

Preface

Canada's vast store of natural resources and its role as a major trading nation made it a particularly appropriate venue for the 12th Pacific Trade and Development Conference, which focused on renewable resources. Growing support by the International Development Research Centre for research into trade, natural resources, and renewable sources of energy complements the conference's focus.

As IDRC President Ivan L. Head said in his introduction, international trade has a profound effect on the economic welfare of the developing countries of the Pacific rim. Over the past decade, it has provided the foundation for rapid growth in a number of the countries in the region. Now, however, because of prolonged economic recession and growing protectionist sentiments in the industrialized countries, it is in danger of being curtailed — a possibility that would seriously impede the opportunities for development in the area. This economic concern is typical of the kinds of issues that PACTAD meetings have been addressing for the past 12 years, bringing together an informal, but closely knit, group of scholars from the Pacific rim.

The Social Sciences Division of IDRC recognizes the value of such exchanges, and it is encouraging research into economic issues, by supporting projects to examine the relationship between trade policies and changing comparative advantage in the developing countries of East and Southeast Asia. Projects dealing with various aspects of renewable energy, fisheries, and forestry are also foreseen in the next few years.

The Centre is grateful to Professor Ted English of Carleton University, the convener of the conference, for his contribution to a stimulating meeting and to the preparation of this volume.

David W. Steedman
Director
Social Sciences Division
IDRC

Introduction

Ivan L. Head

International Development Research Centre, Ottawa, Canada

The themes — and the benefits — of trade and development are closely linked. The contribution of trade to the economies of the vibrant Pacific basin nations is striking. For example, foreign trade measured as a percentage of gross national product (GNP) is 33% in the Philippines, 38% in Indonesia, 39% in Thailand, 79% in Malaysia, and 189% in Singapore. The record of these five countries and their geographic neighbours offers demonstrative evidence that participation in the markets of the world contributes to the economic buoyancy of all and to the development, particularly, of the industrializing countries.

Canada has long understood that phenomenon. It is one of the world's major trading nations and has been for many years. Some \$0.25 of every dollar circulating in this country derives from the sale abroad of goods and services. The standard of living is dependent upon the economic performance of the country's trading partners. If they are in trouble, so is Canada. If their economic outlook is bleak, so is ours. There is not, therefore, the slightest question in my mind that it is in the sound business interest of this country — indeed of all industrialized countries — to contribute to the development of the Third World.

In many respects, development of the South will enhance trading opportunities for those in the North; in other respects, a failure to develop will lead to unexpected complications everywhere. Food production and consumption are at once an example of both phenomena. As living standards rise worldwide, demand for more and better food rises as well. The opportunity is created, through adequate incentives, for increases in agricultural and fisheries production and in sales for the producers from North and South. If planning is not wise, however, those

demand increases can create major difficulties worldwide.

Evidence abounds that economic affluence contributes to changes in eating preferences. As per-person incomes rise, diets change to include larger percentages of meat. Because meat, compared with cereal grains, is an inefficient vehicle for transformation of solar energy into calories, pressures mount on the land available for cultivation. The amount of arable land is finite; if not employed efficiently, through both the employment of science-based agricultural techniques and the dedication of areas to balanced cropping, the supply-demand gap will widen and inflationary pressures will continue to mount.

The effects of rising prices will be felt everywhere. Because poultry, cattle, and swine consume feed grains that are often not grown in developing countries, the South turns to countries such as Canada and the United States to obtain them. This demand pushes up the price of feed in these countries, and thus the price of meat. Tragically, those who suffer the most are the poorest persons in the developing countries, as resources in those countries are dedicated to the production of feed for animals that will grace the tables of the well-to-do instead of being employed to deliver more food at affordable prices to those in greatest need.

The problem is not a small one. According to the World Bank, one-third of all wheat and one-half of all grains imported by developing countries are used as animal feed rather than food for humans. More and more fish, too, are being converted into animal feed. As Canadians learn from every trip to the food markets, food prices are escalating. They may well rise even more dramatically in the decade ahead because of demand from the Third World.

In the longer term, the problem could become much more serious. The caloric efficiency of food intake drops dramatically as grain and fish are passed through an animal rather than eaten directly by humans. In rough terms, 2.5 cal of grain are required to produce 1 cal of chicken meat, 4 cal for 1 of pork, and 8 cal for 1 of beef. As those suffering from cholesterol problems know, it does not follow that eating more meat leads to better health. It does follow, however, that in a world facing a shortage of arable land, an immense increase in the consumption of meat will lead to an unsustainable demand on land. If, added to that type of demand, there continues the trend to fuel cropping (the cultivation of land with crops dedicated not to food but to the production of liquid fuels), the world will face a crisis of alarming proportions.

Food is only one of the essential elements in development, important components of international trade, and major factors contributing to North-South interdependence.

Another such is energy. As with food, energy demands may soon exceed this planet's capability to fulfill them. Innovative research, wise planning, effective implementation, and honest international cooperation will all be necessary to avoid catastrophe. Eight years ago, E.F. Schumacher extrapolated population growth and energy consumption. His findings have been challenged but not disproved. He assumed that populations in North and South would grow at annual rates of 1.25% and 2.25% respectively until the year 2000 and that, in the same period, per-person fuel consumption would increase by 2.25% annually in the North and 4.5% annually in the South. That being so, world fuel consumption would reach, in the year 2000, 2300 Mt coal equivalent — some four times the figure consumed in 1966. Schumacher argued that such a consumption pattern was simply not plausible and that alternative life-styles would be required, with all the social trauma that such a change demands.

Whether or not one accepts Schumacher's figures or his conclusions, the energy issue already is one of critical importance to all nations — industrialized, newly industrialized, and developing. Most critically affected are the last group for they must bear the burden of high imported-oil prices, paid for in foreign exchange, as well as respond to the noncommercial fuel requirements of the 80% of their population living in rural areas. It is an awesome double requirement and one that was in part addressed by the recently concluded United

Nations conference on nonrenewable sources of energy held in Nairobi, Kenya.

It is estimated that as many as 2.5 billion people now depend for almost all their energy needs on wood, agricultural residues, and dung. The Food and Agriculture Organization of the United Nations (FAO) calculates that a billion persons are able to meet their minimum fuel requirements only by cutting wood in excess of sustainable supply. This means that each day forests are being cut, soil is drifting, rivers are silting, and deserts are advancing. The Brandt Commission forecast, at present rates of depletion, the loss of fully one-half of the world's forests by 2000, with horrendous environmental and climatic consequences. FAO estimates that, to arrest this trend at present population growth, fuelwood demands, and forest depletion, more than 2.3 billion people will have to use alternative fuels by the year 2000.

At Nairobi, Canada's Prime Minister Trudeau announced new elements in the country's response to the energy requirements of the developing countries. One of those elements was an increase of funds available to the International Development Research Centre in the amount of \$10 million over the next 5 years. These funds will permit IDRC to intensify and broaden the support it now offers to developing countries for research into energy and energy-related problems. Many techniques using renewable energy are relatively recent and are still emerging, as are questions about them. Indeed, the energy needs of the developing countries are more readily described than are programs of research designed to meet those needs.

Quite clearly, the "energy problem" is only partly technical. It cannot be segmented from the social, economic, and political context in which it occurs. Solutions made without reference to all these environments are unlikely to succeed. An immense amount of investigative work is required into rural energy demands and consumption, into noncommercial energy practices, and into small-scale technologies appropriate for application in developing countries.

Some examples of what one needs to know are:

- Whether a particular energy problem is supply- or demand-related (the difficulties faced by rural dwellers are as much a problem of poverty as they are of new energy sourcing);
- How energy policies in developing countries can be motivated by factors other than urban requirements and foreign exchange deficits, which are currently the primary motivating factors;

- How the technical knowledge that is now available can be adapted to developing country requirements; and

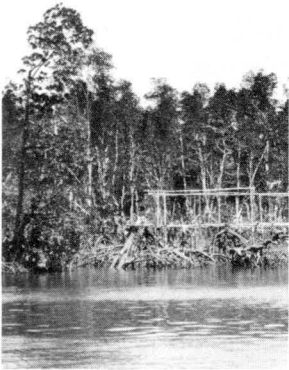
- How different societies can be reoriented toward conservation, a key factor in increasing energy — particularly liquid fuel — supply.

IDRC is proud to have been asked by the Government of Canada to undertake this task. The Centre was created by Parliament in 1970 as a means of enhancing indigenous research competence in developing countries and of contributing to solutions to Third World problems. Research supported by the Centre must be practical and dedicated toward those who live in the rural areas. The Centre's task is to assist in the identification of research issues, in the choice and refinement of methodology, in the monitoring of progress, and in the evaluation of results.

IDRC was pleased to have been given an opportunity to contribute to the staging of this

conference on renewable resources. The major subjects discussed — fisheries, forests, and energy — figure prominently in the Centre's work, and contributions to the meeting by developing-country scientists, development-agency personnel, and developed-country economists are an essential component of the dialogue IDRC seeks to encourage.

Specific issues addressed by participants have strong implications for developing countries. The diversity of these issues — ranging from protectionism in trade, through the effects of the introduction of a 200-mile extended fisheries jurisdiction for coastal states, to new approaches to energy production — is matched by the diversity in perspectives of the contributors. The message that no country or group can act in isolation is abundantly clear. That many nevertheless attempt to do so is a reflection of the shortsightedness that must be overcome.



General studies



Intensive, Extensive, and Optimal Development of Forestlands

Anthony Scott

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What are the major economic considerations for a country with vast undeveloped forestlands? The economics literature on forest development has few answers to this question, because authors generally have focused solely on either the clearing and use of the forest in support of other sectors of the economy or the regeneration and preservation of the trees. Both focuses are incomplete; they do not deal with issues that are basic to development of a forest economy. This paper attempts to single out the policy options available and to spell out their effects.

Quelles sont les perspectives économiques majeures d'un pays qui possède de vastes surfaces forestières inexploitées? On trouve peu de réponses à cette question dans la littérature sur l'économie forestière, les auteurs préconisant généralement soit le défrichement et l'aménagement des zones déboisées au profit d'autres secteurs, soit la régénération et la conservation des arbres. Ces deux approches sont incomplètes et ne rendent pas compte de nombreux points essentiels au développement de l'économie forestière. La présente communication tente de dégager d'autres alternatives possibles, et les incidences éventuelles de leur mise en pratique.

Forest industries and forest trade have played an important role in the economic history of many countries. Because the trees stand in the way of land use for settlement, the industry is often regarded as a by-product of economic growth and not as interesting to economists as the rise and decline of mineral, fishing, or manufacturing industries.

The purpose of this paper is to draw attention to the special characteristics of the forest and to the way that these characteristics have (or ought to have) shaped forest-sector development.

The Economist's View

The Forest Frontier

To the researcher considering the role of the forest sector in trade and development, a most striking characteristic is the neglect of the forest's role by the authors of handbooks and monographs. General economists have been blind to both the trees and the forests in their analyses of development of today's emerging economies, a blindness that contrasts sharply with their full descriptions of agriculture; coal, iron, copper,

and other minerals; water resources; oil and gas; and even fisheries.

Of course, there are good specialists writing about forestry. Some of them are present at this conference. Furthermore, there are statistical organizations, especially at the Food and Agriculture Organization of the United Nations (FAO), that keep track of wood growth, production, and trade. But too many of these specialists have seen the world's forests as the forum for the procurement of wood, cellulose, or timber for the markets and industries of other economies. A typical subtitle of such a work would be "Patterns and trends in resource supplies" — supplies to the purchasing country. "Policies" may also be mentioned, but they are the restrictive policies about cutting, or exporting, that may impede supply to users and processors elsewhere. Many of the works do not provide the reader with an answer to the question of how the see-sawing of logging and shipping affects those who gain employment, materials, or revenue from the activity on the forest frontier. Perhaps the World Bank studies of country development prospects are the only important exceptions.

Within economics, the other class of writer should be identified. Forest economics is an old subject, the most distinguished, probably, of all the resource-economics fields. Since the 18th century, formal theory has been coupled with practical writing by those in need of timber, charcoal, or household fuel to create a long tradition of study of the best conditions for forest protection and renewal as well as the best cutting age. But this literature, which would turn forestry into a branch of agriculture, deals with a minor aspect of the headlong progress of Western procurement through the mature forests of Europe, South Asia, North America, and now the Pacific rim.

Development: Demand and Supply

From a nonspecialist's point of view, wood is not difficult to find and exploit. Trees and forests are ubiquitous, visible, and self-reproducing. Almost any tree or limb will do for weapons, fence building, and rough structures. Furthermore, fastidious cabinetmakers, joiners, carpenters, boat-builders, farmers, and papermakers have learned to adapt their procedures and products to the supplies available. Thus, although there is some need for exploration for new forest-material sources, the forest-product industries are not so completely preoccupied with the process of exhaustion as are the mining industries. Indeed, the general progress of the world forest industry can be traced with the tools of analysis developed by Adam Smith, Malthus, and Ricardo for world agriculture, particularly the concepts of intensive, and extensive, margins. The agricultural parallel is surprisingly close.

At one time, before the "agricultural revolution," wood, clay, and stone were the universal materials. As the world's population, incomes, tastes, and technologies built up the demand for wood and paper products, and as a growing demand for farm products led to the conversion of forests to farm land, adjustments and adaptation became necessary. Although consumers substituted other materials for wood, especially as fuel, harvesters could afford to turn to more remote locations, driven by the depletion of old stands and drawn by the clearing of newly settled regions: this was and is the extensive margin. To a certain degree (but less than in agriculture), they could also afford to progress along an intensive margin in the direction of plantations and orchards. But the return on the required silvicultural and protection systems was low so long as the background technology on the extensive margin was available. Before investing in forest regeneration, it paid to find new materials to

replace wooden articles, fuels, and fibres. By the mid-20th century, it is possible to imagine a technology freed from dependence on cellulose in any form. Technological requirements for every wood product are nowadays rarely absolute: manufacturers and consumers can be guided by price in their choices of inputs. This easy consumer substitution weakened any incentives to invest in planting and growing new forests or plantations. Better to investigate technologies for harvesting on rough terrain. Powerful harvesting methods and alternative transportation systems have broadened the number of sources from which wood can be obtained. The conversion of rare species into veneers and of large timbers into plywoods and laminates has increased the yield per tree.

This stylized history suggests two important forest-industry-supply characteristics that are not encountered so overwhelmingly in agriculture (or, indeed, in mineral production). The first is a characteristic of intensive forestry. Because the harvest is rotational instead of annual, the producer must incur heavy financial (or implicit) carrying costs while waiting for the trees to mature. There is a crippling capital intensity endurable only when the rotational period is very short, interest and other opportunity costs very low, or forest benefits extremely high (examples: naval supplies of oak, teak, and pine; forests grown for the hunt or shelter of other plants or animals; aesthetic and hobby-tree growing; production for bark, cascara, nuts, leaves, rubber, and syrup; and soil-, water-, or wind-control tree belts). Most mature forests have grown naturally on lands that have not been needed or on which development for other uses would be costly. Land preparation, planting, fire control, thinning, and spacing have rarely (and in most places never) been practiced. Forest communities either are dependent on other products that flourish in the forest (such as game) or are temporary, being concerned only with the harvesting of wood. Of course, in some regions there is farming-forestry in which the people move between harvesting and farming and land improvement with the seasons. But such equilibria are rare. Even in the most primitive areas, industrial wood production is not labour-intensive but depends on off-peak employment of equipment or animal power; farmers treat their wood production as a by-product, or spare-time, activity. A minor aspect of this is that, in political and national social life generally, intensive forest-growing interests are rarely as important as the social movements and groups that speak for farmers. Those who speak

for the "forestry industry" are usually connected with extraction: cutting, moving, and processing both cultivated and "volunteer" stands.

If one moves from the intensive to the extensive margin, one finds a second special characteristic: "bulk" or great mass per unit of final value. Many of the world's mature forests consist of trees that are so large or heavy as to be both costly to sever and extremely difficult to transport overland. This "inaccessibility" accounts for their survival. To the extent that they escape the hazards of flood, disease, and fire and the local demand for firewood or farmland, they await envelopment within the extensive margin.

Inaccessibility and bulk yield to technology when the commercial rewards become adequate. No tree appears to have been too big to resist the patient cutting methods combining hacking, stripping, firing, blasting, and uprooting developed by even the most undeveloped societies.

Until this century, logs that were not too large were transported whole over long distances by draft animals or flotations in rivers and inlets. They were processed into lumber or fuel at or near the final market. Otherwise, sawmills and other plants eliminated the bulk, beginning the manufacture of specific products near the forest where loads and rafts converged for shipping to distant markets. Although some local manufacture has always been one feature of wood export, it has not been the prevailing pattern. At the logging site, bulk reduction has usually been limited to debarking, delimiting, shortening, or squaring. One reason is that logging operations continually move but mills do not have the capacity to follow. Once loaded or floated, timber may as well be carried all the way to the final market, as innovations overcome the costly transportation problems produced by bulk. Rivers are cleared and flumes, railways, canals, and roads constructed. Thus, the forest frontier, which at one time might have been at or near the seacoast, gradually pushes into the hinterland and up the mountainsides. The extractive industry renews and transforms itself more easily than it renews the forest. Increasing values challenge the ingenuity of local industry and investors to find ways to bring out logs previously thought to be beyond reach. The mechanical technology on which they can draw is all-powerful. Nothing but cost prevents the removal of every stick of wood, no matter how difficult the location. Heavy-duty trucks, tractors, overhead cable systems, helicopters, and balloons have brought every stand within reach, bringing both the labour to the tree and the tree to market. Only costs matter. In

Harold Innis' language, forestry looks outward, to the sea and to foreign markets. It is not a society-building industry.

On the one hand, users have economized on the utilization of rare and costly woods, turning to more accessible or ubiquitous materials, including lower quality woods, but also steel, aluminum, cement, and plastics. In the forested regions, rising populations and higher standards of living have increased local demand for wood for fuel and for construction materials. This local demand may yield to export demand but more often has reduced the amounts offered for export, perhaps because local suppliers are not able to protect their stands from local and rural "poaching."

On the other hand, the slow growth of trees has forced suppliers to turn to increasingly costly sources, moving from region to region and species to species. Some investment in regeneration has also been undertaken.

The outcome has been increased prices for wood. Locally, wood as fuel and building material has become harder to get. Worldwide, the price of timber and pulp has increased steadily since the 1870s, suggesting that the response of substitute products and new harvesting methods has been inadequate to keep wood from becoming a scarce material.

Although the evidence of increasing wood costs is limited for the most part to the United States, the USA is a major importer and exporter of various forest products. The evidence is striking because investigators have found that the increasing price trend for forestry is different from that of other materials and is considered to be indicative of both absolute and relative increasing scarcity in that the prices, costs, and rents of wood products have all been rising relative to those of consumer goods, the GNP price index, and the indices for farm, mineral, and fish products respectively. Evidently, although U.S. consumers have found many replacements for wooden materials, the rate of substitution has been slow and reluctant. They have been willing to pay higher prices, thus justifying the producing industry's turning to higher cost sites, salvaging lower quality trees, and investing in replacement, thinning, and protection (Potter and Christy 1962; Barnett and Morse 1963; Smith 1979). If U.S. trends are similar to those of the rest of the world, it is not surprising that the forest frontier has moved from Asia and North America and is now to be found around the Pacific rim, from Alaska and Siberia to New Zealand and Southeast Asia.

Instability

The pace of development is far from steady. To see why, it is useful to consider how the world forest-product industry might make unrealistically smooth adjustment to expanding demand. Growing markets reflect a continually increasing consumption of all dimensions and species of timber. Producers respond by increased cutting from accessible stands and by opening untouched mature forests elsewhere. If costs and prices rise, old plans are revised, and the industry penetrates to more inaccessible stands and invests more in the salvage of lower quality trees; in the newly opened regions, the industry initially invests more in harvesting, transportation, and infrastructure than it had in the older, cut, regions. Old and new regions can be producing simultaneously, and the transition from one region to another can be drawn out, even though the harvesters' philosophy is similar to that in mining: cut and get out. Users are comparatively uninterested in the geographical origin of the lumber they buy, relying on their importing merchants' and mills' searching and arbitration among a succession of exporting regions.

This model of smooth adjustment to depletion and development is quite unrealistic. One reason is that the various dimensions and species of trees are not perfect substitutes. For example, final users do exhibit quality preferences and may choose new materials rather than accepting (or paying for) the best replacements offered by dealers. Thus, in some supplying regions, the trade may persist in its search for exportable timber for many years; in other regions, it may depart after only a small percentage of the stands have been removed. Cabinet hardwoods provide good examples of this selective and jerky progress.

A second reason is that demand for timber is closely associated with cyclical capital-goods production of, for example, railway ties; housing; falsework; scaffolding; and ships. Consequently, worldwide demand may be cyclical. Thus, the timber trade does not exert a steady demand but, instead, imposes uncertainty and discontinuity, forcing harvesters to delay or to accelerate their moves to new regions.

A third reason is that harvesting for export may suddenly be reduced to satisfy a new local intermediate demand for a reliable flow of wood and chips from investors in processing plants. This requires the process of cut-and-get-out harvesting to be replaced by the longer term commitment of existing mature stands. The new industries may even motivate regeneration for a further cutting cycle.

A fourth reason is similar to the third: exports may be interrupted by new local consumer and final demand. In North America for example, urban building competed with a marginal foreign demand for the same lumber. Elsewhere the demand for woods like teak, eucalyptus, and mahogany has declined and increased again, in response to changes in local business conditions and tastes. Some exporters have also to contend with intensified local demands for wood as fuel, especially by rural consumers turning to wood from kerosine, fuel oil, and even gasoline.¹

A final reason is that tropical regions may not be environmentally stable sources of supply. Perhaps one-third of the world's forestland is in "open woodland," in grassy and savanna environments. Important sources of leaves, poles, grazing, and fuel, sometimes burned for pasture or cultivation, open woodlands are now disappearing permanently under population pressure for food and fuel.

This leaves the temperate mixed forests and the tropical moist forests as the main sources around the Pacific rim. They are now under assault by the wood-products industry, and their clearing is having structural effects on the quality of the forest-growing stock, soils, and habitat and on the stability of water runoff. The old forest is not simply being modified by cutting or distributed trees and stands; the environment is in many places being transformed. Modification, a result of selective logging and shifting agriculture, results in a resumption of forest successional changes and localized land-structure adjustments. Transformation is a characteristic of widespread and unselective total removal of cover followed by the appearance of agricultural settlement, urbanization, or a wasteland-like rebuilding of the forest community at an early stage of soil building and vegetal succession. This distinction is emphasized by Barney (1980: 131-132) who presents a disturbing picture of its effects:

Nutrient depletion will be increased as greater volumes of wood will be removed. Ecological diversity will be lowered, and consequent popu-

¹In this essay I do not dwell on other energy uses of biomass. Two of these may become more important: the use of wood wastes and chips for electricity generation (Helliwell and Cox 1975) and the use of charcoal for industrial processes (Nef 1964). Forest depletion in Britain was caused by the search for charcoal, and it has been argued that the coal-using elements of the industrial revolution arose because of charcoal shortage. It may be that local industries will again revert to this very hot, pure fuel.

lation explosions of pest plants and animals are likely to occur. Water yield and quality are likely to suffer if large areas are intensively cutover, as very little is known about how to forestall water problems in the tropics. The few techniques for water conservation that have been developed are seldom implemented, as the institutional structure is lacking. Effects of intensive forest use on soil structure and soil micro-organisms in the tropics are virtually unknown, but are almost certain to be negative. The commercial and environmental quality of the second-growth forest that will follow intensive forest use is another unknown. It will be lower than the quality of second growth that now follows selective logging, unless improved silvicultural techniques are developed and implemented.

The disturbances are not confined to the cutover areas but can spread out to cause river siltation, loss of groundwater supplies, and damage to or loss of fish, botanic species, and birds and animals.

The smooth adjustment of the world forest industry to the movement of the extensive margin from region to region would require that, in the tropics, the rapid rates of stand growth would permit its continuing reentry into export markets. A combination of selective logging and protection of young stands to maturity would ensure this natural rotation. But today's clear-cutting promises a more dangerous discontinuity. The tropical zone evidently cannot stand the surges of demand emerging as temperate forests play out, and either by planning or by neglect, its possible sustained output (per century) may turn out to be as low as the temperate zone's.

Thus, although forests may have an almost agricultural capacity to provide steady flows of wood and cellulose to world markets, they are likely to do so in ratchet-like fashion. The consuming countries may, by widespread purchases from numerous regions, succeed in smoothing out the lurching supplies. But a producing nation would not be well advised to rely on this industry as a source of steady employment or public revenue.

Forestry Development

The generalizations in the preceding sections have emerged from a historical and developmental examination of the economies within which forestry activity has been or is important. Here, I narrow the point of view to compare two developmental patterns between which the countries of Southeast Asia must choose if their future

forestry activities are to be more than autumnal gleanings among the gullies and stumps.

Extensive Margin

The extensive margin in forestry may be examined on two broad levels: the extension of the timber-producing area within a geographical region and the movement of timber production within particular countries as traditional forests are cleared.

Immediately after World War II, all countries of Southeast Asia were characterized by underdevelopment in timber production. Small volumes of logs and sawn wood were exported from the Philippines and Malaysia, but production was generally limited to supplying the needs of the indigenous population. Slow but steady increases in harvesting ensued during the 1950s and 1960s, with total exports continuing to be dominated by Malaysia and the Philippines.

In the late 1960s and 1970s, despite increasing prices for all wood products, Philippine timber production failed to increase, and its total volume for export actually decreased. Malaysia had substantially increased both production and export volume. However, it was Indonesia that markedly shifted its production frontier. With a vast inventory of old-growth forests, it increased total production fourfold, between 1967 and 1973, and now dominates the export trade around the Pacific rim (Table 1).

A continuing reliance upon Indonesia has been forecast, with further expansion within the forests of the Philippines and Thailand limited by past harvests. The Malaysian province of Sabah has also already been extensively harvested, although it still has some unexploited areas that are under present prices and conditions commercially inaccessible. Sarawak and Peninsular Malaysia, although exploited, have fairly large remaining stands of merchantable forest. Other future suppliers include Papua New Guinea and the Solomons. Both have been only lightly exploited, owing, for the most part, to the high costs of harvest. As the real price of wood continues to rise, these regions should contribute substantially to world exports, especially of logs. Their harvesting costs are primarily the costs of transporting the timber — a symptom of extensive forestry and, hence, of forest depletion.

A new constraint on the extensive margin in Southeast Asia is the assignment of land to forestry. Hitherto, regardless of the standards of harvesting, it could be presumed that the area available would remain unchanged. Now food and fuel production challenges the claims of wood

Table 1. Trends in forest production, imports, and exports for selected countries in the Pacific.

Year	Total production (10 ⁶ m ³)			Exports (U.S. \$million)		Total value of forest products exports (U.S. \$million)	Total value of forest products imports (U.S. \$million)
	Fuelwood and charcoal	Industrial roundwood	Sawlogs and veneer logs	Industrial roundwood	Sawlogs and veneer logs		
Philippines	1968 17.8	13.1	11.6	219.6	219.6	270.4	26.3
	1973 20.8	12.6	10.2	303.6	303.6	426.7	27.2
	1978 24.5	9.9	7.2	144.9	144.9	309.1	43.8
Indonesia	1968 92.0	7.3	5.6	15.6	15.4	16.2	19.3
	1973 103.3	28.3	26.3	562.0	561.3	578.7	47.3
	1978 117.7	30.1	27.8	933.8	909.3	1022.9	150.7
Papua New Guinea	1968 4.1	0.4	0.4	1.8	1.8	5.6	1.5
	1973 4.5	0.8	0.8	8.0	8.0	15.7	0.5
	1978 5.1	1.1	0.9	23.1	na ^a	33.0	na ^a
Thailand	1968 13.9	4.8	3.3	3.9	3.9	10.5	26.6
	1973 15.2	5.3	3.5	12.1	12.1	42.5	54.1
	1978 17.1	4.7	2.6	2.9	2.9	33.8	130.3
Malaysia	1968 4.9	16.6	16.2	179.7	179.3	241.9	19.6
	1973 5.3	24.8	23.6	409.5	396.6	721.0	65.8
	1978 5.8	32.6	31.5	728.8	719.9	1178.3	129.5

^a na = not available.

Source: FAO yearbooks on forestry statistics.

exportation. Indeed, the short-run incentives for rapid replacement of trees by food crops have become overwhelming. The high expectations of the Green Revolution have proved illusory, as only one-half the last 20 years' increase in food supply can be attributed to more intensive agriculture. The other half has come as a result of agricultural expansion, virtually all at the expense of productive and commercially accessible forestlands (Barney 1980).

In the Philippines, of the 14 Mha of original productive forest, 3 Mha had, by 1971, been lost through "legal" allocation to agriculture, with an additional 1 Mha deforested by shifting cultivators. Since that time, the losses to shifting cultivation have accelerated significantly. Conservative projections for the 1970s suggested that, of the annual loss into agriculture of 200 000 ha of forestland, 180 000 went into shifting cultivation (FAO 1976). Estimates indicate denudation of a total 5 Mha by 1978 (FAO 1979).

Thailand is experiencing even more drastic forest clearing. Despite efforts to reduce deforestation through reforestation and conservation programs, the total stocked area suitable for commercial logging decreased by more than 8 Mha between 1973 and 1977, an annual decrease of 10%. The remaining forestland, 13 Mha, is no more than was projected in 1970 for total commercial forest in 1990 (FAO 1979). Shifting agriculture — estimated at 500 000 ha each year (Persson 1974) — and legal reallocation can be expected to deplete Thailand's productive capacity in the future. Indeed, Barney (1980) projected total forestland to fall below 9 Mha in 1981 and to be effectively cleared as early as 1987.

In Peninsular Malaysia, despite the absence of large-scale shifting agriculture, the productive commercial forest (3.3 Mha in 1979) is being harvested at a rate of 450 000 ha/year. About 80 000 ha/year are reallocated directly to agriculture. Total commercially accessible timber area in Sabah and Sarawak amounts to 5.2 Mha, of which at least 400 000 ha are designated for legal conversion to agriculture. Shifting agriculture affects 350 000 ha annually (FAO 1979). Such figures suggest that Malaysia will also face a severe drop in wood supply in the near future.

Indonesia, with its vast expanse of commercial timber, is least affected by high levels of production. Total operable forests are estimated at 42 Mha, of which 18 Mha are slated for legal conversion to agriculture. Slash-and-burn cultivation, having already depleted 30 Mha of former forestland, now affects an additional 150 000 ha/year. The permanent forestlands, however,

should allow Indonesia, over the next 20 years, to maintain or increase its total production (FAO 1979).

The past trends in forestland conversion for the entire region are astonishing; extrapolated into the future, they are ominous. The projected foodstuff requirements for this region will increase annually to the end of this century at between 3% and 4%, reflecting in part the expanding population levels, with a correspondingly greater proportion of young people and higher real incomes (Barney 1980). The physical, economic, and social constraints blocking Southeast Asian societies from applying Green Revolution technology suggest that gains in food yields will be marginal and smaller than in the previous 20 years. Thus, an even greater percentage of food requirements must come from the extensive margin, or be imported.

A final factor inducing countries to speed their deforestation is government concern for the balance of payments and for foreign-exchange earnings. It is obvious that the temptation to realize the implicit capital gains represented by old-growth forests may be irresistible, similar in kind to the windfalls of new oil discoveries. The allocation of forestland contains elements that complicate exchange-balance choices — for example, the problems of satisfying increasing domestic demands for food, fuel, and paper products. As has already been shown, the forests must pay for most of the increased food consumption, if not by yielding land to farms then by providing logs to pay for foreign food. Similar foreign-exchange alternatives arise for fuel and paper: either the forest provides fuelwood and chips for paper to domestic markets or it is stripped to pay for foreign oil and paper. For paper, the choice may be even more unfavourable to forest conservation, for domestic paper production involves both heavy capital imports for new plant and equipment and reduced wood-export earnings.

In brief, the extensive margin in Southeast Asia is cramped not only by problems of access and cost but also by new alternative uses of the land for food, fuel, and foreign exchange. So far, the most significant of these has been the conversion from forests to fields, and this process is substantially outside the market. It is probable that the process will be completed in the next 20 years: all suitable arable land will then have been denuded. After that, the progress of forestry will be governed by its own relative costs.

These costs, as one would expect in the mining phase of harvesting old natural forests, will be largely those incurred in new areas (both in pres-

ent producing regions and in new regions such as Papua New Guinea). In the next paragraphs, I turn to the determinants of the *full* costs of producing new wood at the intensive margin. There is in fact a wide range of choices. Harvesting itself can be made more thorough and less selective; it can also be conducted in a fashion to encourage faster natural germination and growth. Beyond this are variants of plantation forestry, involving soil preparation, planting, spacing, thinning, protection, and log selection. These offer excellent possibilities for growing immensely greater volumes of wood per unit of land. But the time-lag is long. Thus, the producing region's problem at the extensive margin today is to decide how much land to keep in good growing condition to profit from the eventual depletion of other old forests and from the switch to the intensive margin.

Intensive Margin

The extensive margin cannot maintain or increase supplies of industrial and household wood. Materials for an ever-expanding wood products demand will be found on the intensive margin. By intensive margin, I mean not only a recourse to techniques similar to those in growing annual crops but also a less ambitious and more discretionary use of increased inputs in regions where most of the forest is young or is made up of stands rejected earlier.

Many of the established silvicultural techniques were first conceived in an agriculture-forestry setting — artificial planting; thinning; weeding; and the introduction of fertilizers, pesticides, and irrigation. The application of these techniques will eventually lead to a fully determined or controlled forestry sector. Timber exploitation will become forest husbandry where humans using science and technology master nature (Scott 1962). Yet, if the objective, as the forester suggests, is to forestall the deforestation of the countryside by maximizing total production of commercially valuable timber from each unit of land, then emphasis must also be placed on the efficiency and intensity of the harvest. Thus, two aspects of intensive production must be examined: the application of silvicultural techniques and the focus on efficient harvests.

The intent of silviculture is to increase the commercial stock per hectare or, perhaps more specifically, to increase the mean annual increment (MAI) to usable stock. The techniques can be divided into two approaches: polycyclic (selection) and monocyclic (plantation) systems.

Polycyclic systems generally entail repeated harvesting of a mixed-aged forest where technol-

ogy is aimed at increasing the survival and growth rates of desired commercial species by reducing the competition for space and nutrients through the elimination of noncommercial stands. Inducing the natural regeneration of specific species has proved disappointing in trials so far, although enrichment planting (the seeding of commercially valuable species on spots devoid of usable timber) and group planting (regional seeding with the allowance for natural regrowth) have shown some success.

In contrast, monocyclic systems eliminate the age mix as well as unwanted species. Land is usually cleared, then planted with pine, teak, eucalyptus, etc. The crop (or stock) is then intensively managed until harvest.

Recent literature has contained much debate about the relative efficiencies of these two systems and natural regrowth, and concerning criteria for choosing between them. Here, I will briefly survey the arguments, which are focused more on the physical, than on the economic, attributes of each system.

The production objective is to supply sufficient raw materials to maintain the timber industry as a permanent feature of national economic development and diversification. Low annual yields per hectare are considered to reduce employment opportunities, retard the creation of necessary infrastructure, and reduce the wood-processing sector. Higher yield than is possible with natural regeneration is therefore thought imperative.

A polycyclic system can produce yields three to four times those of natural regrowth. Thus, for many foresters, the rather low establishment costs together with relatively high yields per hectare clearly indicate that the polycyclic system "... shows a promising future" (Chai Domingo 1975).

The MAI for insular Southeast Asia in 1970 was 1.2 m³/ha (an average 5 m³/ha for second growth forests and 0.1 m³/ha for virgin timberland). FAO projections of this increment rise to 2.8 m³/ha in 1980 and to 4.5 m³/ha by 1990, reflecting increased use of silvicultural techniques.

The development of polycyclical forests has encountered greater problems than expected. The large rise in energy costs in the 1970s meant fertilizers and pesticides increased substantially in cost. Furthermore, many of the technical aspects of planting, thinning, weeding, and the like were developed in and for temperate climates. These techniques may not suit tropical areas and the tropic-specific technology now

being developed may not provide substantial increases in harvestable wood. Perhaps the overriding difficulty with polycyclic systems, however, is that the harvesting techniques entail the destruction of relatively large areas surrounding the stands of trees. Thus, the advantage of mixed-age forests — the fact that the harvesting of potentially valuable but as yet immature timber may be postponed until growth is complete — may be nullified.

Monocyclic systems in general have management practices of much greater intensity, magnifying both the advantages and the difficulties. The incentives for forestry to follow in the footsteps of monocultural agriculture, to become eventually a totally managed crop, are indeed inviting. Given an industrial yield, averaging annually, 20 m³/ha (pine plantations yield more and fast-growing hardwoods such as eucalyptus may yield 25 m³/ha), the entire industrial demand projected for roundwood in the year 2000 could be met by 100 Mha of plantation land, or less than 4% of the world's forested area. And this, state the optimists, without any of the technical innovations that have characterized the development of intensive agriculture (Sedjo 1981).

The technical disadvantages of highly intensive plantations, however, are great. Although the effects of a monoculture on soil and water conditions are not understood, preliminary evidence suggests breakdowns in land productivity, loss of humus, desertification after cutting, and destabilization of water flows by the disturbance to moisture-absorbing watersheds. In addition, the plantations' lack of biologic diversity, both in timber crop and flora-fauna mix, can threaten the fragile tropical ecosystem. Considerable risk to the crop arises from the intense infestations of insects and from disease.

No conclusion has been reached by foresters in this debate. Yet, to the economist, the arguments (particularly those emphasizing the monocyclic systems' superiority in MAI) are peculiar in that they tacitly assume that volume increment equals value increment. Yet, in forestry, as in other enterprises, national prosperity calls for a plan to maximize the *net* returns to inputs, for a focusing upon the systems' benefits and costs not merely on their incremental physical capabilities.

The benefits associated with each system are simply the sum of the total value of wood products produced, measured by their future market prices, and the total value of the social benefits accruing to the system (these may include environmental effects, the value of employment as a

social good, and the like) measured by their relevant social shadow prices.

The costs are the total value of all inputs — wages, capital, managerial expenses, etc. These have been most neglected in the forestry-systems debate. Two are particularly important. The first, often the bulk of capital investment, is not the establishment cost or the maintenance cost of a particular system but the opportunity cost of retaining the growing stock as standing timber. Faustman clearly recognized as far back as 1849 that even if its opportunity cost for some other productive activity (say agriculture) is zero, forestland still has an opportunity cost; one can harvest early to cultivate a faster-growing stock. This cost of holding capital is rarely included. The second is a cost more recognized in forest husbandry: the act of waiting or, more succinctly, time, measured through the device of compound interest. Total input costs are compounded forward to the day of harvesting, or, equivalently, future benefits are discounted back to the present. This is not the place to discuss the difficulties associated with measuring future wood values, social shadow prices, or even the discount rate to be applied. Given the long rotation periods of nonplantation systems (50–70 years), virtually any positive interest rate will result in a drastic cost.

Suffice it to say that including the capital costs of holding forests and of waiting for the returns on inputs is believed to cause any benefit–cost comparison of the two systems to favour the monocyclic system with its relatively shorter period of investment (10–20 years) over the nonplantation alternative (50–70 years).

Yet, this outcome is far from certain. Even a long rotation forest with low yield per hectare may prove the best in economic terms if future log prices are expected to be high and rising or establishment costs are sufficiently low. Likewise, fast-growing, high-yielding plantations, if characterized by high cultivation costs or low per-unit future prices, may be poor financial investments. The World Bank policy of extending long-term, low-interest loans for forest development implicitly alters this discounting factor and so increases the benefit–cost ratio of long-period systems.

However, many forest planners have tended to ignore the cost of time as an input. For example, enrichment planting has been considered economically viable because initial investment costs of M\$610/ha are lower than plantation management costs (M\$943/ha). Yet, if rotations of 60 years and 20 years respectively are assumed with an historically low real interest rate of 3%, then the compounded cost of enrichment planting is

more than M\$3700/ha compared with M\$1730/ha for the plantation. This comparison, based on extreme assumptions, suggests how disastrous may be the neglect of capital costs and how great may be the political and managerial incentives to neglect the well-meant advice of those who want to save the forests in the most costly way.

As for consideration of social costs (and benefits), forest planners rightly give weight to non-commercial goals when comparing the two systems. But they do so in a nonquantitative manner. Thus, they tend to favour a regimen that adds to economic and social stability rather than to cut-and-run forest harvesting, which is said to be both socially disturbing and unjust from a distributional point of view. Economists are rightly critical of these all-or-nothing justifications of systems, but so far they have contributed less than their science is capable of.

The real payoff from benefit–cost studies of alternative systems comes from optimization: modifying or combining rival systems to increase their net benefits. For example, some attempts have been made to offset the waiting costs of the monocyclic system by cultivating farm crops between trees (*taungya*). A farmer is given an area to clear and sow. The forest department plants trees on the same plot. Weeding and fertilizing are by-products of farming, which is continued about 3 years. By then, the tree should be well enough established to withstand the elements. Not yet sufficiently studied, this type of project may well represent a better use of land and other resources than does farming or intensive forestry alone.

Indeed it is not yet clear that intensification of tree culture will ever require the plantation approach. Roger Sedjo (1981) is optimistic, recently writing that plantations are "... the most profound phenomenon being experienced in the forest resource area." But will they be a significant source of wood? Even if the proposed world plantation area of 21 Mha for the year 2000 is achieved, this can supply only 10–20% of projected annual demand. Actual conversions to plantations have, in general, fallen far short of proposals. In Peninsular Malaysia, total conversions between 1976 and 1979 were only about 50% of proposed plantings. In Sabah in late 1976, some 240 000 ha were set aside for fast-growing plantations; yet by 1979 only 550 ha had been seeded (FAO 1979). Even FAO projections for insular Southeast Asia indicate that total cultivated forests, including enrichment planting, will increase by fewer than 100 000 ha between 1980 and 1990 (FAO 1970) — and this in a region that

in 1978 produced more than $75 \times 10^6 \text{ m}^3$ of industrial roundwood. Thus, the application of silvicultural and agrisilvicultural techniques and the introduction of industrial plantations can only be viewed as long-term remedies for shortages.

The opposite end of the producing spectrum, that is, the harvesting of timber, may give greater reason for optimism about intensification as a means to profitable increased supply. Part of the incentive for silvicultural use and plantation development is the prospect of greater homogeneity of commercially merchantable timber. Tropical forests are notorious for their great variety of timber species; Sarawak forests, for example, comprise 600 major species and Papua New Guinea at least 200. In addition, an undesirable age mix is often present in tropical forests, particularly those of virgin timber. At present, much of the timber of uncommercial diameter is simply left to be destroyed by the slash-and-burn operations of prospective farmers or is lost during felling of larger, more desirable trees. Selectivity in species and age mix have resulted in what may be considered, from a forester's point of view, a serious underutilization of forestland in much of Southeast Asia. In Peninsular Malaysia, for example, only 35–40% of the standing timber is harvested as a wood product and, in areas slated for agriculture, quick clearing results in a loss, for commercial purposes, of 80% of the timber (FAO 1970).

This waste has perhaps the greatest potential for increased wood production from presently harvested forests. The recovery of secondary species and small-diameter woods is not a dramatic intensification. It involves evolutionary, not revolutionary, changes in the practices of loggers and consumers, and research on the possibilities inherent in exploitation rather than in silviculture. Parallels with agriculture recur, this time with the study of the Green Revolution. What is needed is economic research on the profitability of more thorough recovery. The focus on the logging enterprise would supplement that on a hypothetical, perhaps mythical, tree-growing enterprise.

Benefits from Forest-Sector Development

If an island were suddenly faced with offers to clear its forests and export the products, the government — whether it had the power to reject the demand or not — would like to know whether to use its policy instruments to encourage or discourage a logging and clearing industry. What benefits, or costs, would be perceived and what

other conditions must be satisfied to achieve net benefits? I have found little economic literature on this question. I have, therefore, drawn from works on other industries in developing countries: mining, agriculture, and manufacturing.

Social Effects

By “social benefits or costs,” I refer to the net gains from the different sorts of society that come with different policy “packages.” At one extreme is the forest society, characterized by hunting, slash-and-burn farming, and a nomadic way of life for a small, scattered population. Intermediate is the forest-husbandry society, engaged in planting, protecting, thinning, harvesting, transporting, and milling trees — a small but settled rural population. At the other extreme is the cleared-forest society, typical of much of the Americas, where land use involves farming, industry, with a forest fringe waiting to reinvade any areas abandoned by the industrial-residential economy.

Thus, to reap social benefits from forestry, a society must choose where to place itself within this spectrum. The choice is unfamiliar and rarely debated; yet decisions are made, explicitly or implicitly. For example, when a public forest is felled or when conservationists keep forests free from farming and urban development a choice is being made about the intermediate case. Whereas the selected policies seem usually to be part of a quest for a better natural environment, there is good evidence that they are also elements in building a better regional social system. In British Columbia, for example, successive Royal Commission reports to the provincial government on a public-lands policy of perpetual-uniform-sustained-yield emphasized contribution to social stability more than profitability.

The cleared-forest extreme is more familiar, involving abandoning the forested way of life but retaining a small forest industry and some lands in parks and reserves for recreation and observation. The recreational and economic benefits of setting aside forested areas are plentiful and relatively sophisticated.

What my island community needs is a body of expertise to discuss these society-type consequences of forest decisions. Present literature, valuable as it is, may not help. An essentially urban, Western society debating how much of its remaining wild lands to preserve from intense industrial or residential development is not providing the necessary analysis for a developing society that may yet choose to eschew agriculture and urbanization (Burch 1977).

Environmental Effects

The forest produces not only wood of various dimensions and qualities but also water flows, animal pasture, recreation, and an environment for flora and fauna. Any help or hindrance given by forestry operations to these multiple uses is usually thought of as forest externality. It often makes just as much sense to think of wood production as an externality of watershed protection, soil erosion, avalanche prevention, farming, range management, or wildlife conservation.

Although some of these joint products of the forest are strictly commercial, others are environmental services of forestry outside the marketplace worthy of special political consideration in decisions on forest policy. They are usually considered because they are important to local people. But, because of their possible effects on carbon dioxide, air circulation, humidity, particles and chemicals in the atmosphere, the policies may be important to neighbouring countries and, indeed, to the whole world (D'Arge 1976).

Most forest environmental effects are the result of the rate of logging, burning, and clearing. At some logging rate, no adverse environmental effects will result, and a good way of dealing with much environmental damage in frontiers is to slow down production not to give up or postpone it altogether. The important thing is that a country should consider alternative rates of forest depletion and regrowth.

Stability

Among the problems of a forest economy is that its chief exports, timber products, are prey to extreme fluctuations in demand and price. Logging communities are not only nomadic but also prone to intense booms and depressions. Demand for timber below that expected translates into reduced employment and increased average capital costs — costs that are partially offset in the harvesting sector by the accumulating volumes (and presumably values) of commercial timber from the uncut areas but that are unmitigated in the processing sector.

In a world of unstable timber markets, then, part of the price for developing a forest-based economy may be instability, although some products of the forest, notably fuelwood, pulp and paper, and recreational facilities, are less affected by external cycles and may indeed be less depression-prone than mining, manufacturing, or service industries. Furthermore, forest husbandry and protection, by offering some employment even when markets are poor, may tend to stabilize the larger economy. Of course, a

forest-products exporter does not have to accept market instability passively. It may join with other producers to form a cartel and thus help make the price. The newsprint industry is frequently alleged already to indulge in international price-fixing, and it is conceivable that a cartel could force industrial buyers to take fixed quantities annually, thus stabilizing employment. It is more likely, however, that price-fixing would make employment and output fluctuate even more widely. On balance, a country that chooses to rely on forests must expect to be dependent and unstable. It cannot even choose — as with a farm economy — to be self-sufficient unless it wishes only to eat game and fish, berries and bark, burn twigs, read paper, and take shelter in wooden buildings. Furthermore, the forest industry is typically vertically integrated, with developing economies supplying raw materials and developed economies supplying the capital and know-how. Hence, the markets will be far from perfect. Raw material may be transferred outside the country in exchange for bookkeeping entries in the accounts of multinational firms. Within the country, too, forests will be allocated by administrators and politicians to loggers in return for investment, bribes, or political favours. The forest may seem to melt into world markets with little public return. These dangers provide good reason for a nation to move slowly into trade while forest-alienation pricing and taxing are developed. Whereas the slow but repeated discovery of minerals often gives a host nation many decades over which to learn how to dispose of mining rights profitably, the visibility of forests may mean that they are sold and under the axe before a good public sale or-lease policy can emerge.

Employment

In Canada, 54 000 wage earners and another 20 000 small contractors, woodlot owners, and reforestation workers produce 1.57×10^8 m³ roundwood annually or about 20 000 m³ per worker. (Half of this production comes from the industrially organized British Columbia region. In 1950, half came from Ontario and Quebec, where part-time and farm workers brought in much of the harvest.) These workers amount to about one-quarter of the total labour force directly involved in wood products, there being about three workers in sawmills, plywood mills, and various pulp and paper mills for every one in the woods, and perhaps as many more involved in related transportation, materials handling, and supplying industries.

Operations in the woods were once labour intensive, although further processing and finishing has always required equipment and structures. In North America, today, much of the harvesting is done mechanically. Softwoods yield easily to machines, and many new machines have been invented to replace the former teams of humans and beasts who worked for days to fell, buck, and remove a large tree. Sawmills and plywood plants now tend to use more workers per unit of wood than does logging. In pulp and paper, however, capital is heavily utilized. In pulp mills, the atmosphere is like a hydroelectric generating station; the workers are separated sometimes by hundreds of metres of mostly automatic machinery.

Because labour intensity is not inherent in the material or the market, it varies from country to country. Trees are cut, on smallholdings or by contract in large forests, by labour-intensive methods in areas where real wages are low and capital is scarce. The observant economist would guess that a logging function has a smoothly changing rate of substitution between inputs.

Opportunities for Local Capital and Enterprise

Although much of the forest industry is vertically integrated, the forestry sector offers considerable opportunities for local participation. Operations in the woods are everywhere being subcontracted to local cutters and transporters, and plantations provide an opening for local capital and unskilled labour. A country that does not have the managerial skill and the ability to accept the serious risks inherent in running plantations could consider joint ventures for the purpose. Pulp and paper plants are another possibility and are particularly attractive because their profitability is not as closely linked to on-the-spot managerial skill as is that of sawmills. The skill, care, and frugality in the use of raw material determine the competitiveness of a sawmill, and experienced hands are abundant at the final market.

These considerations will suggest to the decision-makers in the island economy that one option is to combine a forest-harvesting economy with a policy of compulsory local processing in milling timber and also in making pulp and paper and furniture. Many governments use their forests as an instrument for encouraging industrial development. But a local-processing policy is like a protective quota. The round logs are sold for what they can get from local millers. Thus, the rent from the trees is diverted to mill profits (and wages) while the forest owner (usually the general taxpayer) gets a smaller royalty or tax revenue.

The milling industry dies if the forest is cleared, and if the government shortens its life by accelerating the permitted rate of logging. However, a local-processing policy may actually discourage the annual rate of logging — for example, if local processors offer too low a price for the raw material or if investors demand a guaranteed flow of wood for a stated number of years (Pearse 1976).

The absence of open log markets in new logging communities combines with the declared risk aversion of investors to persuade the government to give the required guarantee. In my opinion, forest investors extravagantly exaggerate their need for certainty in this respect. Experience in Europe, eastern Canada, and southern United States, and elsewhere shows that sawmills and pulp and paper mills can, if they must, survive by bidding for wood in an open market. Naturally, they prefer not to have to do so and take great pains to persuade host governments to assign them large blocks of public forestland in return for large-scale investment. Their demands are sometimes said to be a response to political risk, but collectively they entrench government power and so add to political risk. The foreign investors are putting their trust in the political dedication of a forest to their investment, rather than in a traditional property right or in an open market. Their insistence on dedication, like all vertical integration, tends to narrow the market and thus becomes the justification for a non-market wood allocation. Sometimes the fault lies with local governments, however, their enthusiasm for development leading them to agree to more than is required. The alternative methods of log disposal from public lands have been discussed by McKillop and Mead (1976) and by Pearse (1980).

Backward Links

Like those of other natural-resource industries, such as fishing and mining, the basic operations in forestry generate a demand for relatively simple products. Because both husbandry and harvesting are scattered over marginal areas, the greatest demand is for trucks and the routes to drive them on: roads, bridges, and other works of the civil engineer. These must be built and maintained. Although local enterprises may be forced to import the needed equipment and systems, they can sell and stock them; offer repairs, tires, and parts; and build special assemblies such as trailers, cranes, cradles, wharves, chutes, and so on. Furthermore, if the woods operations are remote, buildings or whole villages or camps may be needed with the catering, merchandising, and maintenance trades that constitute infrastructure.

Typically these have been boom towns, lasting only as long as the logging operation. The backward links, like a large bubble, create both incomes and skills but not for long. The burden of this instability may be passed backward through the forest-product industry to a variety of mushrooming industries.

Considerations such as these are often used to support politically imposed, sustained-yield policies that would ameliorate the economic impact of cut-and-get-out industry practices. The economist's judgment on these policies should depend on his or her estimation of the mobility and versatility of the labour force. Boom towns often become ghost towns with stranded secondary industries. But this outcome, distressing as it appears, matters less than what happens to the skills of those who acquired them during the active period. The question should be whether these skills can easily be put to work elsewhere.

If, on this criterion, the industry's boom-and-bust behaviour is likely to be serious, a government can force the industry to bear the burden of construction and displacement of "company towns." This approach, of course, limits not only the disturbance to the host economy but also the benefits to its local enterprises.

Regional Development

Each nation has problem regions in which growth lags behind the national average. Forestry investment can play a major role in economic and social development of such regions if demand has caught up with the high costs or low quality of the local forest product. In British Columbia and Quebec, the forest industry has been a major employer and basic activity in otherwise inactive areas. Indeed, because it is a renewable resource, the forest promises continued direct and indirect demand in isolated regions far from large markets or sources of supply; it may be said to be an excellent instrument for regional development. It can meet the usual tests: it can employ a fair number of local people or attract outsiders who can become permanent residents; it can gradually expand its purchases from local firms; and it can offer infrastructure in the form of roads, bridges, and communities that may be of use to other industries entering the region (Gillis and Beals 1980). In their contracts for timber rights, governments can insist on these conditions without utterly destroying the profitability of logging and milling.

Logging alone, however, cannot exercise much developmental force. Manufacturing of plywood, cut lumber, pulp and paper, and specialty wood products is required for development to

have any magnitude. The demands of these processing industries for prolonged supplies may tend to slow a region's rate of cutting so that the developmental boom matures into a permanent increase in regional output, instead of a hectic construction-and-clearing episode.

Economists should remember that using the forest industry as an instrument of development has its own drawbacks and costs. Slow cutting, while permitting the local establishment of large, processing industries, deprives other regions of raw materials or industries that might bring a greater development. The principle of comparative advantage suggests that exporting round timber is, at times, better for the whole economy than propping up an isolated region by compulsory full exploitation of its forest resource. In particular, the main national gain from the forest industry may often take the same forms as in oil and gas: revenue receipts from royalties, land payments, and taxes. These will be largest when the forest is sold at its highest price. A good test is whether a nation, exporting roundwood for a good price, would choose to siphon the proceeds into its most backward regions to assist their development. If it preferred to help the retarded regions' people in some other way, a logging-export ban should be avoided.

Transfer of Technology

Backward links to suppliers and forward links to processors are intimately related to issues in the transfer of technology. Because such activities as timber harvesting, milling, and advanced processing require adaptation of standard international techniques to regional species, terrain, climate, labour, and market, a policy to encourage local processing may not only diffuse technology along the forest frontier but also mean that the techniques are ingeniously adapted.

Little systematic information is available about the global transmission of new knowledge. Multinational corporations transfer and licence their new sales and processes to their own subsidiaries and associates, and sales of modern equipment are often accompanied by training. Users learn about new processes from their customers, employees, and moneylenders, or read trade magazines. Both appropriate technology and induced local innovation become diffused through complex knowledge networks that, with the exception of the multinational-firm channel, require considerable investigation.

It is not enough for new ideas to promise more than existing methods, someone must convince capitalists and moneylenders that they are worth investing in and that they will fit into the tradi-

tional rhythms of the local society. Techniques that change family life, status, hours of work, or skills may be unacceptable.

These considerations largely determine the rate of modernization in forestry, as in other sectors. The logging and transporting stages probably become modernized fairly rapidly. In the first place, the migration of logging from stand to stand and forest to forest provides numerous opportunities for reconsidering methods. Second, new workers may be undertaking logging in each new region, uncommitted to and perhaps unfamiliar with traditional methods. Third, the costs of energy and machinery are substantial enough to encourage technical change in the various substages of logging. Finally, risk is a weaker deterrent in forestry than in peasant agriculture. Whereas farmers face the all-or-nothing risk that a new crop or technique will fail and expose their families to starvation, small logging is often a secondary or off-season activity. Large-scale operations, at the other extreme, are the preoccupation of more diversified and well-financed contractors or owners for whom the risks of new methods are less inhibiting.

More sophisticated stages of forest production — plantations, pulp and paper mills, veneer and plywood plants — can also benefit quickly from innovations if a government engages in astute joint ventures. Much of the technology is available in packages, the stipulations of which are often open to negotiation. Common stipulations include wood-supply guarantees, tax concessions, industrial-relations arrangements, and the right to use foreign personnel. Many of these stipulations are put forward by would-be investors as means to avoid risk.

The transfer of technology goes beyond the immediate forestry industry to the consumers. The growth of a logging industry is likely not only to increase local timber purchases but also to spark the invention of new processes for using forest products in place of traditional materials. A new lumber-export trade, for example, may not only encourage the house-building industry but also induce it to invest in methods that use lumber rather than other materials. Indeed, because the further processing and using industries are often the same industry, the whole continuum of technical advance must be considered as one.

Nathan Rosenberg (1972) is helpful on all these matters:

In order to exploit the vast forest resources of the country, the United States in the first half of the nineteenth century brought to an advanced

stage of perfection a whole range of woodworking machines. . . . During this same period per capita lumber consumption in the United States may have been as much as five times as high as in England and Wales.

By the 1950s American woodworking machinery was generally acknowledged by Europeans to be the most sophisticated and ingenious in the world. The relatively limited degree to which these machines were adopted in Europe, however, seems to have reflected the fact that they were, in many ways, wasteful of wood — a consideration much less important in the United States than in Great Britain in the first half of the nineteenth century.

A similar profligacy in wood consumption persisted within the household so long as wood supplies were locally abundant. Under these circumstances, fireplaces were designed to accommodate large logs, an arrangement which was wasteful of fuel wood but economized upon the labor-intensive activities of cutting or chopping wood. [As wood became scarce, better furnaces, stoves and fireplaces were installed to use pieces of wood more efficiently.]

Five points on the transfer of technology are worth reiterating. First, much wood technology is simple, being based on cutting tools and transportation systems and can be easily transferred to a developing economy. Second, being simple and standardized, it can easily be picked up by local people and diffused into other industries. Third, the logging and husbandry industries adapt to local problems by inventing new variants on foreign methods. Fourth, some processing technology, such as that in pulp and paper mills, is sophisticated and will have to be obtained from specialized consulting engineering firms and factories. The technology is normally obtained in a package, the components of which should be examined closely by the host country. Fifth, the processing and consuming industries adapt to wood availability and price by inventing new methods and products.

Comparative Advantage

The mere possession of large, forested areas of acceptable quality does not justify turning an economy to forest products activities. Other uses of labour and capital may be more rewarding. The different labour-capital-land ratios within forestry and between forestry and other industries determine whether, and to what extent, the forestland should be developed.

If neither labour nor capital were mobile internationally, then the greater a country's forest endowment (adjusted for quality), the more likely it would be that capital will find its way into forest production instead of general manufactur-

ing or agriculture. In the capital-intensive parts of forestry (pulp and paper manufacture, for example), factor ratios are quite inflexible, so that low wage rates in developing countries are unlikely to lead to increased use of labour. But in logging, low wages may induce the retention or adoption of labour-intensive techniques, especially if subcontracting or payment by piece rates is the practice.

If capital, but not labour, were mobile, as it is with multinational corporations, joint ventures, or financing by foreign customers, the national capital endowment would be augmented, and both capital-intensive methods in the woods and a mix of processing that involves capital-intensive products would be encouraged. Infrastructure, forest protection, and "waiting" for new rotations in a permanent-yield enterprise are also likely candidates for absorbing foreign capital, or for diverting capital from manufacturing and services. The fear of loss of tenure or of plant expropriation could lead investors to behave as though they were working under conditions of extreme capital shortage: cut-and-get-out forestry combined with minimal investment in processing and transportation. Fuel would continue to be the leading domestic output of the forest endowment. Of course, to counter this, a government might adopt an all-or-nothing development strategy, refusing to grant firms access to the forests without an agreed undertaking of both long-term husbandry and investment in large pulp mills.

Thus, a country that finds its forests within the price range of world demand could experience restructuring of its economy in a fashion that depends upon the availability of capital. A capital-poor country without access to foreign enterprise could mine its forests, shipping logs as final product, without regard to further crops. Very fast production would, however, be unlikely because the capital shortage would deprive the industry of the roads, ports, and other infrastructure needed for sudden deforestation.

If the same country were better endowed with capital, the demand for wood products would tend to draw capital and labour from agriculture, manufacturing, and services, and increase investment in more selective and less damaging logging and capital-intensive processing mills. It is obvious from examining old developed economies that investments in processing plants, in complementary skills, and in marketing channels might be more durable than the forest. A demand for housing, certainly, would survive. Then the export trade in wood might swing around to an

import trade, to keep the final-demand industries in business.

If the developing economy cannot supply capital, then the absence or poor quality of some types of infrastructure will raise the costs or lower the attractiveness of investment. In the case of mining, this dearth would probably raise the price that must be obtained in the world market for production to be worthwhile. Even with mining, however, the operations would be smaller-scale, i.e., less production per year per unit of natural resource, than they would be if capital were more plentiful. The reason is that capital scarcity can be revealed in another way: by withdrawing "waiting" from the enterprise and mining as rapidly as divisible labour and capital will allow. This is a partial application of a famous double-effect of capital scarcity in exhaustible resource production: although the scarcity tends to increase the impatience of resource holders to remove ore, at the same time it tends to ration the capital equipment needed to increase the removal rate. The final direction of output change is unpredictable unless one has full knowledge of the capital costs and production functions. Higher interest rates could actually justify an increased rate of investment.

The same model applies to forestry, where processes have smoother production contours and the range of techniques is wider than in mining. Under capital scarcity, the forest complex would have two characteristics. First, processing would tend to be confined to the most labour-intensive products: round or squared logs, posts, or large-dimension unplanned lumber; the fuller utilization involved in plywoods, pulp and paper, and the whole wood-chip economy would be avoided. Second, operations in the woods would be of a most destructive nature, the enterprises endeavouring to economize on road building, protection, and waiting and to avoid the expense of logging in such a way as to encourage the later further growth of immature trees and the regeneration of clearcut lands. Political risk, also seen as a cost of capital in developing countries, could work the same way.

Finally, if both labour and capital were internationally mobile, capital shortage would not prevent investment in reforestation and plantations nor in capital-intensive processing plants. Annual forest output would probably be within the bounds of the legal (or profitable) annual allowable cut — that rate of output that would allow production to continue indefinitely. Forestry could encroach heavily on land previously allocated to farming, pasture, or hunting. In

other words, if capital and labour are in elastic supply, the chief shift in comparative advantage is from agriculture to forest products and sectors linked to it. The rest of the economy would be unchanged.

This discussion of the adaptation of a country to the introduction of a forest-product industry can be extended into a three-stage analysis of the balance of payments or the terms of trade. To do this, one must know the cause of an export boom. I have suggested a cause that seems important in the Pacific region: rising incomes exhaust other sources of supply. Magee and Norman postulate a rise in demand, following Harold Innis's staples theory in mentioning a technological breakthrough that increases derived demand. Innis and others also suggested changes in tastes, transportation, and techniques of raw-material exploitation. Stage II may be a period of full-out production, in which there may be rising costs and competition from similar forest economies in other societies. Here, with respect to forestry, I have suggested that costs need not rise if capital is sufficiently available for the supplier to enter at once on a sustained yield of highly processed wood products. Otherwise, the supplier will be essentially mining the forest and must run into increased costs, inviting competition. In their stage III, Magee and Norman and I agree that substitution of "synthetic" materials with the same desired characteristics for an indirect utility function may move materials production from the forest to developed countries or to countries rich in some ubiquitous input that is the chief input into the synthetic.

A country that develops a wood-products industry that has about the same factor composition as its previous leading industries will have an adjustment problem in terms of trade but should easily accommodate the change. In contrast, if the logging sector and its linked processing industries have factor compositions different from those in the sectors it supplants, the change might result in a redistribution of the national "pie" for labour, capital, and land.

The redistribution is likely to start with an export boom that appreciates the currency and thus exposes other industries to invigorated competition. If these industries are land-intensive, the shift of labour and land from agriculture to forestry may be speeded up, but it does not usually take a change in the terms of trade to drive marginal farmers into higher-paying forest or milling jobs. Large areas of land would probably not be switched from food crops to trees: rural poverty might actually reduce migration

from the farms, increase land hunger, and inspire politically directed farm encroachment into forested areas.

The impact on manufacturing would depend on the sources of capital. A capital inflow for pulp and paper mills and other forest investment would accentuate the rate of exchange but reduce the migration of capital from other domestic industries. Later, foreign dividends, rents, or interest payments might have the reverse effect.

If there were no such capital mobility, the rise of the forest industry and the export boom would, if there were investment in infrastructure and pulp mills, weaken manufacturing and tend to lower the real wage relative to capital rental. My previous suggestion that large exports could result from small rates of investment — the cut-and-get-out approach — indicates the endless possibilities among national structural reactions to the growth of a forest sector. The similarities between forestry and mining and oil production (Gregory 1976; Kindleberger 1961) should not blind one to the fact that forests are a renewable, or potentially perpetual, resource like agriculture. Whereas structural adjustments made for mining will have to be reversed when the minerals become depleted, a forest industry is permanent if developed for sustained yield — a development that depends on profitability as measured by product price, land rent, and capital availability.

Revenues and Tenures

Many who have studied the place of mining and forestry in developing countries assert that the main benefits from natural resource production are public revenues. Why do they make this claim?

When roundwood is exported, there may be few benefits to the state or its economic development apart from various forms of revenue. The chief reason is that, because most land is potential forest, the system of farmland taxation has been widely applied to forested land. Furthermore, the system of personal taxation has been applied to year-round earnings, whether from farming or logging. Consequently, the yield of the forest to public revenues tends to look small.

In at least one type of forest economy, this revenue is indeed small. When property rights to the forestlands have not been securely assigned or when it is too costly for either private owners or public forest managers to enforce their exclusive rights, rental and taxation opportunities are lost. Both forest production and forest-product consumption go undeclared and untaxed.

In general, no forest operator has an incentive to report exploitation of the forest. In the extreme, the common property problems recognized in the fisheries literature will occur: an economically inefficient exploitation of forest resources with a dissipation of rents.

What is missing is some system of tenure and taxation. Where rights to the forests have not yet been alienated, if politically feasible, it may increase economic efficiency to assign rights randomly, giving away the forestlands outright, imposing an appropriate tax-collecting scheme, and leaving the burden of enforcement on the new owners. If such drastic and clear alienation of public lands were infeasible, a government could insert regulatory and financial controls at the export or processing stage to ameliorate the property-less and lawless regime in the woods. When trees and wood in various sizes and degrees of finish are forced to pass through the markets, the reported values as well as the volumes acquire some acceptable meaning to statistician and tax collector alike. Indeed much official forest finance today involves the laborious procedure in which stands are appraised or assessed backwards by the net values that emerge only in the final stages.

Public forest revenue is complicated by the fact that much forestland is publicly owned. In general, public ownership gives the authorities a choice among (or a combination of) five types of revenue:

- The forest, trees, and soil may be sold outright into private ownership. Thereafter the public revenue derived from forest operations will usually be confined to taxes on production, income, land, or inheritances (wealth).
- An annual or periodic licence or lease may be sold to operators or loggers, permitting them to enter the forests and cut trees over a specified area. The fee or rental tends to be a flat rate per unit area, regardless of forest quality.
- A royalty or an amount of money per physical unit of wood removed can be paid. If there has been an appraisal, then the royalty can be expressed in percentage terms.
- The right to remove certain or all trees from the stump can be sold at a price that usually depends on an appraised value.
- A contractor can be hired to cut the trees for the public agency.

Each of these techniques has enforcement and collection costs as well as compliance costs for the operator. I have arranged the revenue sources in order from the least costly to enforce to the

most expensive. In new forest economies where little apparatus exists for enforcement, measurement, or evaluation, the authorities often dispose of most of their rights by sale of the forest. Licences and leases are almost as simple to administer and comply with. Royalties require knowledge of the annual operations in the woods, whereas timber sales and contractors require detailed measurement, estimation, and monitoring.

A second way of comparing these methods of alienation is to examine their fertility. The timing and amount of revenue obtainable need not differ greatly between them if they are used with discrimination. However, outright sale or disposal of the forest at an early date tends to be unremunerative; fairly often, early disposal at a low price is regarded as a means of encouraging new forest operations. Licences and leases too are frequently handed out at a flat rate that does bring in an annual renewal revenue, sometimes for many years, but often at a low rate. Royalties often bring in more and are more often levied at special rates for special sites or species. Timber sales (or "stumpage") and hiring contractors to cut for the public can in principle capture all the rent or surplus from the operator.

A third way of comparing them is in their impact on operator behaviour. Some charges, for example, fail to reward good forestry practices or give a strong incentive to take a short-term, narrow, view of the forest's potential. I will cover these effects only briefly, as they are the subject of an extensive specialized literature. This literature is somewhat overblown because revenues may be linked to tenures, stipulations in the tenures, and regulations and orders that have a greater effect on forest practices than mode of levying the revenue. The ideal is private ownership. This gives the operator incentives to grow, protect, and harvest trees in a way that will maximize the present value of the property. Trees at the time of acquisition are both potential crop and productive capital.

Compared to this ideal, all other tenures are temporary or are feared to be temporary. They lack the power to induce the harvester to log in such a way as to assist regeneration in the manner that an owner would select, and the public agency either must impose regeneration-assisting logging practices or must take care of regeneration and protection itself. Because of the costs of the latter, public forest revenue is overstated, for part of it must be reinvested.

Licences and leases do not give certainty about access to trees in the next few years, or in future

rotations; therefore, the holder has an incentive to cut and get out. Furthermore, the annual licence fee is a carrying charge additional to implicit interest for "waiting," protection costs, and a risk premium; these will all tend to shorten the holder's estimate of the ideal cutting age. Of course, tenure could be guaranteed for a long period; for that matter, licences and leases could be perpetual, in which case there would be little difference between the ideal and the tenures, apart from the licence fee.

Forest alienation by royalty can be shown to have a small effect on the choice of cutting age even though the fees are not carrying charges; usually, however, the practice is that the operator is given only a few years in which to log, pay the royalty, and get out. Hence, the only effect of a royalty is likely to be high-grading. In the selection of sizes, species, or sites for harvesting, units of the crop that cannot carry the specific royalty charge per unit will be left behind. Probably, too, they will be damaged because selective logging usually harms other trees and sites. The public forest service must prevent, or treat, land and capital destruction.

Timber sales by stumpage usually have no effect on cutting age because the operator is given only a short period within which to log. If the stumpage fee is correctly set, there may also be no incentive to high-grade. As a harvesting tenure, therefore, timber sales for stumpage lack only the characteristic of encouraging regeneration practices.

Finally, I should say a little more about public ownership; the advantages of ownership cannot be divorced from the obligations. The owners must pay to make sure that they are collecting all the rent that is in excess of the amount needed to cover the real costs of harvesting and to make sure that their, or their tenants', employees are looking after the long-term needs of the forest as a source of future crops. Either the tenure must contain provisions that somehow tend to be self-enforcing in these two respects, or the owners must play an active role in monitoring and in operating in the woods. One way to handle these costly functions is to maintain a forest service that employs experts to perform these services. The danger of a forest service is that it may apply costly theories of forest regeneration, protection, or harvesting and that it may even be corrupt. Many people advocate keeping the forests public, whether run by a forest service or not; the reasons cited are to reduce the risk that the public will lose all the rent in one unwise transaction and to make more flexible the adjustment of forestland for use

in pasturage, watershed protection, fuel supply, and recreation.

I think one should be a little skeptical about such generalizations. Although they are roughly correct as description, there are viable alternatives. There is no absolute reason that private owners cannot be compelled to pay taxes that transfer the rent to the public purse; nor is there any reason that they cannot be bribed or regulated in such a way to provide the alternative or extra forest services needed by the society. Probably apprehensions about administrative difficulties, political susceptibilities to landed interests, enforcement costs, and the political power of the forest bureaucracy provide, among them, the explanation for the permanence of public forests rather than regulated private ownership.

I will now consider revenues from regulated private forests. The owners are usually subject to taxes and to regulations about cutting in some places. (The State of Washington has a law to compel conservation of private forestland.) The owners must pay to protect their property from thieves and trespassers; to maintain healthy crops; to finance thinning and spacing, road building, and harvesting; to cover implicit or explicit interest as well as price variability. However, I want to discuss only their taxes.

There are four main types:

- Taxes on private or corporate income from forest operations — the rules for such taxes usually make some arbitrary distinction between increase in value of the standing capital and revenue from the crop by dealing in a special way with "capital gains."
- Death duties — the need for liquidity to pay these duties may cause the owners, especially if they are landed families, to cut the trees for cash to keep the land.
- Property taxes — these can be a heavy carrying charge, inducing owners to shorten rotations or to cut and get out completely after one crop. Various intricate formulas and concessions have been worked out to prevent "double taxation" of the land, its roads and other improvements, its forested capital, and its intermediate and final crops.
- Yield taxes — these can take the form of output taxes, royalties, or severance taxes on physical or value units.

The principles I have used in discussing the forms of tenure and charge on public lands can also be applied to these four types of tax on private lands. The reader will see that income,

corporation, and death taxes tend to be neutral, having little or no effect on the timing of cutting, the incentive to high-grade, or the profitability of long-term investment in repeated cropping. (However, the actual rules and definitions for these taxes can have discouraging or even disastrous effects on forest practices.) Property taxes are usually criticized as rewarding short-horizon, cut-and-get-out forestry. Yield taxes tend to be neutral with respect to timing but discourage the use of marginal stems or sites. In other words, a lump-sum tax on the present value or "rent" would, in the absence of uncertainty, be the least distorting type of forest tax. The income or net royalty tax can be a good substitute.

To the economist, the tax or charge and the tenure are all-important. There are two reasons. First, most of the benefits will be smaller if the tax distorts harvesting or forest management. They may fade away entirely if the tax and tenure erode the incentive to keep the forest intact. Thus, the benefits of forest activity depend on complementary tenure and tax policies that may bring only a small revenue. Second, the other benefits may be too small, relying on income-destroying obstacles to free trade and to efficient private performance. If so, only the public's share of the rent can be considered to be a benefit at all.

More should be said on this second point. It may be that from the highest point of view, the economy of an "island" or isolated forest society would benefit most by a depletive policy. The rent from the first crop, like the rent of a mine, may be all that is worth realizing. Later growth may be just a delayed bonus, a free bequest to later generations. If this is so, there is little to be said for establishing an elaborate processing industry, encouraging dependent backward links, or spending on infrastructure apart from what can be quickly started and later abandoned. That is an extreme case; few forests are so structured that no part of them will repay careful and costly harvesting and some planting, protection, and road maintenance. The intermediate cases put the greatest burden on the design of the revenue system. A way must be steered between taxes like mining taxes that capture much of the rent for the state (there being no future after the resource has been exploited once) and those like agricultural or manufacturing taxes that encourage husbandry, conservative attitudes, long-run investment, and selective logging. The choice between these two extremes will dictate both the amount of public revenue and the benefits in the form of growth and employment that can be obtained from the forest.

Fig. 1 illustrates the policy choices. The assumptions are that most of the nontax benefits from forestry have some sort of present value placed on them by the state; that most of these benefits accrue from a permanent forest industry, renewed and cropped so that yield is sustained; that another separable benefit is net public revenue, from the proceeds of which many of the other benefits could be provided by other means. The diagram shows combinations of net public revenue and long-term forest renewal that bring equal discounted total benefits to the state.

The bell-shaped curve shows the assumed possible net revenue yield of forest policy. It is assumed that the net yield is greatest when only part of the forest is managed for long-term cropping and renewal, for both tax-revenue and public expenditure reasons.

The best position is at X. In many forested regions X is very close to the peak of the revenue curve, and the other benefits are therefore somewhat incidental to revenue maximization. But where forestry is found to be an instrument of development, the indifference curves will have a steeper slope, the optimum position will be to the right, and the revenue obtained is only one of the benefits of forest policy. Forestry will be brought under control to take place alongside agriculture as an important permanent activity. The steep slope of the indifference curves conveys a finding that, at the margin, forestry is more important for what it does for development than for the money

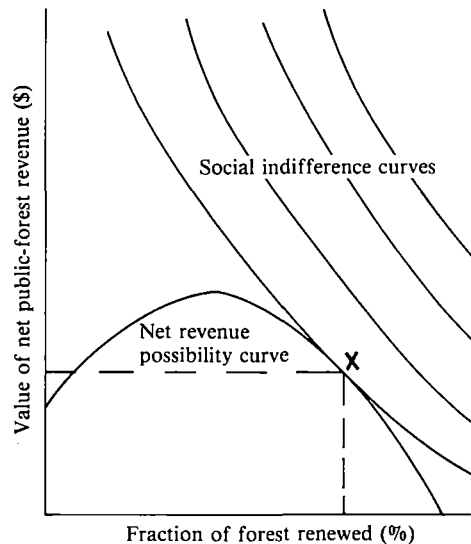


Fig. 1. Policymaking on forest renewal.

that could be gained from liquidation. In other words, money would not buy what the forest contributes by other means to national welfare.

Conclusion

This paper indicates the wide range of choice available to developing countries fostering a forest industry. Forest operators have flexibility in that neither the land-labour-capital ratio nor the time pattern for growth and processing is fixed. There exists not only a wide variety of mixtures of forest rotations, processes, and products but also an extensive array of tried and untried techniques that can be adapted to local terrain, costs, markets, skills, climate, etc.

There is room for choice in how long to make the forest rotation, how much to invest in silviculture and protection during each period, how much of the existing stands to harvest, how much of the land to allocate to agriculture and wood production, and what techniques to use in replacing national stands and plantations.

Although many forest economists see these choices important only in their relationship to a continuous wood supply for developed-country markets, the forests — and decisions about them — are instruments of national development. A decision to take advantage of high prices today involves a sacrifice of development tomorrow. Yet, it may be one of the only options for a developing economy whose forests represent a badly needed source of foreign exchange. A commitment to a continuing forest economy, involving slow liquidation and replacement of trees, is a choice with great promise for developing countries with substantial forest resources.

I am indebted to James Johnson for participation that went well beyond the obligation of research assistance and to John Bene for comments based on profound experience.

Editors' note: Discussion for this paper was combined with that for the following one and begins on page 48.

Optimizing the Use of Ocean Fish Resources in the Context of Extended National Jurisdictions

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The 200-mile fishing limit has created opportunities for improved use of the oceans' fish resources by bringing most of them under the authority of coastal states. Overexploitation of many stocks has been halted, but much remains to be done in developing national management systems that are socioeconomically rational and administratively effective. The new legal regime has created new problems of boundary determination and transboundary stock management. It has left unresolved the problem of fisheries management on the remaining high seas. It has favoured coastal states relative to distant-water fishing states and, in general, has brought immediate benefits to the former. In the long run, improved fisheries management made possible by the 200-mile limit may provide benefits on a global scale.

L'instauration d'une zone de pêche de 200 milles a contribué à améliorer l'exploitation des ressources halieutiques, dont presque toute la réglementation relève des états riverains. On a ainsi pu éviter la surpêche de diverses espèces mais il reste encore beaucoup à faire pour mettre au point des systèmes de gestion rationnelle au niveau économique et administratif. Le nouveau cadre juridique a fait apparaître de nombreux problèmes, notamment dans la détermination des frontières et la gestion des stocks transfrontaliers. Par exemple, la gestion des pêcheries en deçà des 200 milles reste sans solution. Les états riverains qui en général, tirent des revenus rapides des pêches, se voient donc plus favorisés que les pays éloignés des côtes. A long terme, la gestion plus rationnelle des pêches maritimes rendue possible par la détermination de la zone de 200 milles, pourrait offrir des avantages à tous les états pêcheurs.

A new international fisheries regime, based on coastal state control of 200-mile fishing zones, came into effect in 1977.¹ This development has momentous consequences for the use of fish resources. It has brought most of the world's fish stocks under national jurisdictions, where they may be rationally managed, in contrast to their previous uncontrolled exploitation. The new regime holds promise for improved conservation and, in the long run, better economic returns from fishing operations. Meanwhile, many existing fish harvesting and marketing operations are facing problems of dislocation, and the balkanization of fishing jurisdictions is generating numerous boundary problems with negative side

effects. The national property rights, established by the 200-mile limits, are also having a significant impact on the distribution of benefits derived from the use of ocean fish resources.

The Enclosure of the Oceans

Hugo Grotius, the renowned Dutch jurist, wrote in 1625 in his treatise, *De Iure Belli ac Pacis*: "... the extent of the ocean is in fact so great that it suffices for any possible use on the part of all peoples for drawing water, for fishing, for sailing" (Johnston 1965: 166). This notion was used by Grotius and his followers to reject national claims to jurisdiction over large stretches of the seas, such as those advanced by Spain and by Portugal. It was held that the vastness of the oceans precluded effective enforcement of national rights, except over a narrow coastal margin measured by the limit of a cannon shot

¹In international fisheries affairs the nautical mile is a common unit of measurement. It is equal to 1.151 statute miles or 1.852 kilometres. Throughout this paper the term "mile" means nautical mile.

(Christy 1975). Thus, the 3-mile territorial limit emerged as a standard in international law. This limit was also accepted in respect of fisheries jurisdiction. It was not seriously questioned until after the Second World War.

For centuries, Grotius' notion that the world's marine fish resources were virtually inexhaustible endured, although it was acknowledged that heavy fishing in a limited area could deplete local stocks. During the 20th century, a clearer perception of the limits of the world's fish supplies gradually emerged. Scientific exploration demonstrated that new stretches of the oceans were relatively barren. After the Second World War, advanced technology, in combination with a vast expansion of fishing fleets, increased fishing capacity to levels undreamed of in previous times. Pressure on the commercially more attractive stocks mounted rapidly. By the 1960s, many of these stocks were threatened with serious depletion.

Unfortunately, the legal framework for the oceans made it difficult to do anything about overfishing. Outside the narrow territorial limits in which coastal states exercised jurisdiction were the "high seas," over which no authority held sway and to which all nations had unimpeded access for purposes of fishing. The common-property resource literature has demonstrated convincingly that open-access fisheries are subject to massive external diseconomies that take the form of overexploitation.² The primary reason is that fishing operators have no property rights to the resource. They have no incentive to conserve fish stocks for optimum exploitation over time, because any fishes that they leave in the water are liable to capture by rival operators.

As a solution to overexploitation, fisheries economists generally have called for a limitation on fishing effort. Where stocks are entirely within waters under the jurisdiction of a single state, the government can introduce public management that conserves fish stocks by curbing effort. In fact, over the last few decades an increasing number of fisheries falling under jurisdictions of individual states have limited access and effort management.

The absence of authority to limit access on the high seas has left fish resources in international waters prey to unrelieved overexploitation. Attempts to manage fishing effort for various stocks of fish on the high seas through international commissions have been largely ineffectual.

²The basic theory was introduced in seminal articles by Gordon (1954) and Schaefer (1957).

Whereas such commissions have sometimes been successful in achieving mutual agreement among fishing nations, banning particularly destructive fishing practices, they have generally not been successful in curbing fishing effort. Member countries rarely agree on the shares each should receive from a limited catch, particularly when there is a threat that nonadhering nations, as "free riders," will take unlimited catches with impunity.

World fishing pressure was greatly increased after the Second World War when large distant-water fishing fleets were established by several countries, of which Japan and the USSR were the most prominent. The fleets consisted of powerful and technologically sophisticated fishing vessels, together with supply and other support ships. Many of these fleets were highly mobile and capable of exploiting fish stocks around the globe. The success of distant-water fleets in taking increasingly large harvests of valuable fish in competition with local fleets was viewed with alarm by countries off whose coasts the distant-water fleets were operating. Thus, a basic contention arose between coastal nations and distant-water fishing nations. Coastal states concluded that the only way to curb overexploitation was for them to manage the stocks along their shores; they advanced the proposition that, on equity grounds, they should be accorded preferential rights to adjacent fish resources, particularly when local communities were dependent for their livelihood on such resources.

Generally, new rules in international law may be introduced either through the adoption of an internationally negotiated convention (treaty law) or through the wide recognition of claims made by individual countries (customary law). In fact, a combination of the two was used to advance the claims of coastal states to extended fisheries jurisdiction (Moore 1980; Copes 1981 b), culminating in a general recognition of the 200-mile fishing limit in 1977.

The confinement of the coastal states' jurisdiction to the traditional 3-mile territorial sea was challenged with increasing force and frequency after World War II. The Truman doctrine, proclaimed in 1945 on behalf of the United States, posited coastal-state rights to the resources of the continental shelf (Watt 1979). It did not claim coastal-state entitlement to the fish in the superjacent waters. But the doctrine did propose that coastal states should be entitled to establish fisheries conservation zones in waters along their coasts provided the rules did not discriminate against any countries fishing in the area.

Encouraged by the Truman doctrine, a number of Latin American countries in the late 1940s and early 1950s laid claim to a full 200-mile jurisdiction in fisheries (and other matters) (Hollick 1977; Watt 1979). During the next 2 decades, similar claims were put forward by others. However, there were no major maritime or industrial powers among them. Indeed, the major powers resolutely resisted the claims. With a few exceptions (Peru, Ecuador, Iceland), no serious attempts were made to enforce the claims.

Claims for modest extensions of coastal jurisdiction fared better. Claims for a 12-mile territorial limit — although not recognized by some major powers such as the United States — were passively accepted. By the early 1970s, the 12-mile limit was claimed by a majority of coastal states so that it had become, in effect, a new international standard. Attempts were also made to change international law through the adoption of global conventions. To this end, the First Law of the Sea Conference was held in Geneva under United Nations auspices in 1958. Fisheries questions constituted a significant part of the agenda, but many other important matters concerning the use of the oceans were also under consideration.

The conference passed a set of conventions, one of which was the *Convention on Fishing and Conservation of the Living Resources of the High Seas*, which was subsequently ratified. It set forth a number of high-minded principles about the use of the living resources of the oceans for the benefit of all but achieved little change in fisheries exploitation practices. One modest change came about through the companion *Convention on the Continental Shelf*, which recognized coastal-state rights to the continental shelf. This brought with it an exclusive right of the coastal states to explore and exploit "... living organisms belonging to sedentary species, that is to say, organisms which, at the harvestable state, either are immobile on or under the seabed or are unable to move except in constant physical contact with the seabed or the subsoil." Many stocks of molluscs and crustaceans were thus brought under coastal-state ownership.

Significantly, members at the First Law of the Sea Conference failed to agree on an appropriate width for jurisdictional limits. The Second Law of the Sea Conference, in Geneva in 1960, failed to pass any additional convention, but some promising new approaches did receive substantial support. Particularly noteworthy were proposals for the recognition of a "functional" jurisdiction for limited purposes, such as fisheries.

Strong resistance to wide zones of jurisdiction came from major maritime powers, who feared a loss of freedom for navigation on the high seas. Past practice had been that coastal states held sovereign jurisdiction over all matters within their territorial seas. If coastal states were given wider limits for specific functions only — such as fisheries exploitation — the universal right to freedom of navigation would not be jeopardized. Canada worked hard to promote the concept of functional jurisdiction (Gotlieb 1964) and at the second conference proposed a "six-plus-six" rule, entitling coastal states to a 6-mile territorial sea with an extra 6-mile zone in which the coastal state would control fisheries. The proposal failed to gain the required two-thirds majority by a single vote.

Acting on its own proposal for a functional fisheries jurisdiction, Canada in 1964 unilaterally proclaimed a 9-mile fishing zone beyond the 3-mile territorial sea. There was no challenge to this position, as the total did not exceed the increasingly common limit of 12 miles. Canada extended its fisheries jurisdiction still further in 1970, when a full 12-mile territorial sea was proclaimed and "fisheries closing lines" were established to enclose large bodies of water that were surrounded mostly by Canadian territory (Gulf of St. Lawrence, Bay of Fundy, Queen Charlotte Sound, Hecate Strait, and Dixon Entrance). Canada claimed only exclusive fishing rights in these additional waters, thus maintaining the feature of functional jurisdiction.

The overexploitation of many of the commercially attractive fish stocks became increasingly apparent during the 1960s (e.g., in both northeast and northwest Atlantic waters) and heightened the concern of coastal states, who regarded with alarm the growing share of the harvest taken by distant-water fleets. To this was added the concern of newly independent states of the Third World, who feared depletion of stocks in their coastal zones by distant-water fleets before they acquired the capacity to utilize those stocks themselves. These concerns were an important element in the pressures that led to another attempt for international agreement through the Third United Nations Conference on the Law of the Sea (UNCLOS III), which was convened in 1973.

UNCLOS III was meant to produce a convention of a grand new design, covering all important aspects of a legal framework for the world's oceans. The task proved even more arduous than anticipated. Working through a long series of sessions, the conference members appeared close

to agreement on a formal *Draft Convention* (United Nations 1980a) by early 1981. However, a decision by the new Reagan administration in the United States to engage in a thorough reappraisal of the draft has led to indefinite postponement of a conference vote.

The first full session of UNCLOS III, which was held in Caracas in 1974, provided a forum in which coastal fishing nations were able to express their concerns and press their case to considerable advantage. Most of the developing countries (i.e., those with coastlines) together with a significant group of developed countries argued the coastal state case for extended fisheries jurisdiction. The distant-water fishing nations were outnumbered. Thus, the 200-mile fishing zone quickly became the standard of expectation and the basis of negotiation at the conference. That it would be universally accepted at an early date was soon considered a foregone conclusion.

The formulations developed at UNCLOS III for coastal state control of fisheries focused on the concept of a 200-mile exclusive economic zone (EEZ). In this zone, coastal states would control exploitation both of seabed resources and of the living resources (fisheries) in the "superjacent" waters. The former, of course, were already under coastal state jurisdiction as a result of the 1958 *Geneva Convention on the Continental Shelf*.

Unfortunately, a number of nonfisheries items on the agenda proved quite contentious, slowing the work at UNCLOS III. Anxious about the depleted fish stocks, many coastal fishing states had decided by 1976 that they could not wait for the conclusion of the conference and the ratification of a convention before taking action to protect coastal fish resources. Encouraged by the apparent consensus on a 200-mile fishing zone that had emerged at the conference, they gave notice of their intention to proclaim 200-mile limits. Many reluctant countries were persuaded to join in. By the end of 1977, most of the world's coastal nations had claimed 200-mile zones, including all the major maritime powers, as well as most of the industrialized nations and the great majority of the developing countries that possessed coastlines.

Some of the countries have confined their 200-mile claims to fisheries matters, whereas others have claimed a full EEZ or complete territorial rights. The last claims, undoubtedly, will remain subject to challenge, but there can be no doubt that, from 1977, the 200-mile coastal state fishing jurisdiction achieved international recognition. The coastal states that had not proclaimed 200-

mile zones by the end of 1977 have mostly done so since. The enclosure of ocean waters within 200 miles of land for fisheries purposes is now virtually complete.

World Fisheries Production

FAO data indicate that world fish production has increased persistently — with only minor interruptions — since World War II. The total world catch rose from 17.7 Mt in 1948 to 65.0 Mt in 1978.³ A detailed scrutiny, however, shows that output has dropped in some areas. The catch for the northwest Atlantic declined from a record 4.6 Mt in 1968 to 2.8 Mt in 1978. Considering the continued high levels of fishing effort that were applied in this area after the decline set in, one can only conclude that the stocks of commercial fish in this area have been seriously depleted. It is noteworthy that the northwest Atlantic has been a major target area for distant-water fishing fleets.

In other areas — the northeast Atlantic, the eastern central Atlantic, the Mediterranean and Black Sea, and the northeast Pacific — harvests have also declined after a period of historically high catches. All of these areas are characterized by mature, technically advanced local fisheries, by distant-water fishing activities, or by both. The signs suggest that here, too, the stocks are being overexploited.

The rise in the overall world fish harvest, despite a decline in the catch from several stocks, simply indicates that additional fisheries or previously unexploited stocks are being opened. This is made possible by advances in technology and expanded investments in fisheries, both adding to fishing capacity. Population growth and increasing real incomes are raising the demand for fish products continuously, providing the incentive for an expansion of fishing activity.

There are limits to sustainable output from wild stocks of fish. The conditions of unlimited entry that have applied to most fisheries until recently have meant that many of the commercially attractive stocks have drawn so high a level of fishing effort that they have been depleted to the point of falling annual yields. This condition, in fact, is more widespread than FAO statistics suggest because the opening of new fisheries often masks the decline in catch from existing fisheries. Overexploitation tends to affect particularly the most valuable fish stocks, for these are

³Unless otherwise indicated the data in this paper have been taken from FAO yearbooks of statistics.

the stocks that have a potential for yielding higher rents if exploited at optimum output levels. As the theoretical literature in fisheries economics indicates (Gordon 1954), this potential rent tends to be dissipated by overexploitation in open-access fisheries.

Not all declines in fisheries output should be blamed on overexploitation. Pollution or habitat degradation and occasionally nature appear to blame. For example, the spectacular collapse in 1972 of the Peruvian anchovy stocks (by far the world's largest single fishery in terms of physical yield) was largely the result of natural circumstances (Caviedes 1975), although exacerbated by excessive exploitation.

There has been much speculation regarding the ultimate potential for food production from the oceans (Carroz 1973). No accurate estimates are available — or possible. One FAO paper speculates that the annual production of living organisms in the oceans is of the order of 100 000 Mt but notes that most are small microscopic plants and much of the rest is zooplankton (FAO 1970: 282). Only a tiny proportion is represented by species of fishes and other animals of a range of size utilized by people.

Estimates have also been made by FAO of the potential yield of larger fishes and other animals that have been the subject of major fisheries in recent times. The total, aggregated from estimates for different fisheries areas and species groups, was 118 Mt (FAO 1970: 281). In another study, Fullenbaum (1970) estimated maximum sustainable yields (MSY) by species for various world fisheries. The aggregate of these estimates is an MSY of 120 Mt — remarkably close to the FAO estimates. Given 1978 world catch levels of 65 Mt, this suggests that output from conventional sources could not quite be doubled by concerted effort.

The figures may be misleading in that the MSY for many fisheries is not attainable, e.g., because part of the stock is too remote or scattered to be fished effectively. Also, it may not be possible to achieve the MSY for some stocks simultaneously because of interspecies relationships. For instance, increasing the catch of a species that is the food supply of another species would reduce the numbers of the latter.

In any case, it may be economically infeasible to pursue the MSY for many stocks because diminishing returns (lower catches per unit effort) would make higher exploitation levels privately unprofitable and socially unjustifiable. Moreover, MSY is generally considered an undesirable goal economically, because marginal

costs for the fishery as a whole tend to exceed marginal revenue for the fishery at the MSY level. Fishing generally should be conducted so that stock levels are higher and effort levels are lower than those compatible with MSY. However, in some cases — with dynamic considerations and a positive social discount rate, for example — effort levels should be equal or greater than those compatible with MSY (Clark and Munro 1975).

Although it may be both impossible and undesirable to achieve a full MSY from conventionally utilized fish stocks, it may prove quite feasible to produce total harvests in excess of the MSY output from conventional stocks. The reason is that many unutilized or barely utilized stocks will probably be attractive enough for exploitation in the future. So far, the majority of stocks of cephalopods (squids, etc.) and other molluscs have not been exploited (Gulland 1971). Even greater opportunities are offered by krill, consisting of tiny crustaceans. The potential annual harvest of krill from the Antarctic has been estimated at 50 Mt or more (FAO 1970). Other unconventional stocks representing a large harvesting potential include red crabs, lantern fishes, deep-sea smelts, and sandlances (Carroz 1973). The output of much of the unconventional species would have to go into such products as fish paste, fish flour, and fish meal, although this might induce the transfer of other catches from fish meal to food for human consumption.

Thus, total annual harvests from the oceans may eventually reach 150–200 Mt, three times the current level. Undoubtedly, the per-unit value of most of the additional output will be far below that from conventional species. However, the terms of trade for conventional fish supplies have improved steadily over the last few decades, as a result of increasing demand and an absolutely limited natural production capacity. The rise in real prices of conventional fish should leave increasing economic room for exploitation of unconventional stocks. The pace at which harvesting of unconventional stocks develops in the future will depend on many factors related to technology, market conditions, and production costs (Kasahara 1972).

The New Ocean Regime

A consensus that coastal states should have control of fisheries within 200 miles of their shores was established in the early plenary debates (1974) of UNCLOS III, but the rules of coastal state control had yet to be defined within a global framework. Early in UNCLOS III, it was

agreed that further debate and negotiation should be guided by a document containing a draft for a comprehensive new convention on the law of the sea. Such a document was introduced at the conference in 1975 under the title *Informal Single Negotiating Text* (United Nations 1975). The document underwent substantial amendment, as UNCLOS III ran on through session after session. The document finally emerged in 1980 as the *Draft Convention* (United Nations 1980). The fisheries sections of the negotiating document had overwhelming support, and, after some slight revisions at an early stage, they took permanent shape.

When countries around the world rushed to proclaim their 200-mile limits in 1977, the negotiating document at UNCLOS III (at that stage referred to as the *Revised Single Negotiating Text*) provided ready reference to a set of widely acceptable rules for fisheries control. Several countries, including the United States and Canada, explicitly accepted the rules specified in this document as the basis of their 200-mile claims and agreed to abide by its provisions. Other countries implicitly accepted the document, by framing their 200-mile legislation in conformity with its provisions. Several countries claimed more than fishing rights in their 200-mile EEZ, and some claimed jurisdiction for a full 200-mile territorial limit. The most extensive claims are unlikely to be recognized by the world community — at least not in the foreseeable future, but, as a minimum, the 200-mile fishing jurisdiction has secured virtually unanimous recognition. Also, the fisheries provisions of the *Draft Convention* appear to be so widely accepted that they have become de facto international law, even though they have not been formally adopted at an international convention.

Article 56 of the *Draft Convention* accords to each coastal state "... sovereign rights for the purpose of exploring and exploiting, conserving and managing the natural resources" in an EEZ extending beyond a 12-mile territorial sea to a distance of 200 miles from a coastal baseline. Article 61 gives the coastal state responsibility for conservation of the living resources in its EEZ, and Article 62 requires the coastal state to promote the objective of optimum utilization of these resources.

The coastal state is assigned the task of determining the total allowable catch for each fish stock in its EEZ, but "... where the coastal State does not have the capacity to harvest the entire allowable catch, it shall ... give other States access to the surplus of the allowable catch."

Implicitly, this clause infringes on the sovereign rights that Article 56 assigns to the coastal state, but the rights of the coastal state to set the total allowable catch (possibly at zero) and to determine conditions of access for other states to any surplus (possibly at prohibitive fees) mean that the actual constraints on the coastal state are of little or no consequence.

Essentially, the rules constitute a moral commandment: "thou shalt not waste fish," with an implicit obligation for the coastal state to be reasonable in sharing resources in excess of its own capacity to utilize. Coastal states are allowed to charge management access fees, without limit, for any fishing they permit other countries to undertake in their zones. Thus, they can capture rents from fishing in their EEZ. The moral dictum that a coastal state should be prepared to give other states access to surplus fish in its zone would, therefore, appear to be generally consistent with the coastal state's self-interest.

The *Draft Convention* singles out for special treatment five groups of marine species — highly migratory species, marine mammals, anadromous stocks, catadromous species, and sedentary species. Article 64 deals with the highly migratory species, including, among others, tuna, billfishes, oceanic sharks, and whales, which commonly migrate widely through the high seas and the EEZs of many countries. Sound management of these can be achieved only by a cooperative effort of all countries fishing in the region over which they migrate. Thus, Article 64 enjoins states to "... cooperate directly or through appropriate international organizations with a view to ensuring conservation and promoting the objective of optimum utilization of such species throughout the region, both within and beyond the exclusive economic zone." There is, perhaps inevitably, a lack of specificity regarding execution of these provisions, and individual states may decline to become a party to any convention regarding highly migratory species. There are, therefore, no secure provisions for effective management of these species.

Anadromous stocks consist of species that spawn in fresh water but spend much of their life at sea. Special provisions for anadromous stocks are needed only insofar as they migrate beyond the 200-mile zones of coastal states (Copes 1977). The only important fish stocks in this category are salmon. The bulk of the world's marine salmon is in the north Pacific. Much smaller stocks inhabit the north Atlantic, and a few transplanted stocks are elsewhere. Article 66 of the *Draft Convention* stipulates: "States in whose

rivers anadromous stocks originate shall have the primary interest in and responsibility for such stocks." This stipulation recognizes that the direct costs in maintaining and enhancing the freshwater habitats of salmon are considerable. Also, river systems that are devoted to salmon rearing often cannot be used for important alternatives, such as power generation, irrigation, and waste disposal. Furthermore, optimal exploitation of salmon stocks requires that harvesting take place in coastal waters near the mouths of spawning rivers. Here the fish gather when they have reached maximum weight, and catches can best be monitored and managed to achieve optimum renewal of the stocks.

Article 66 further provides: "... fisheries for anadromous stocks shall be conducted only in waters landwards of the outer limits of exclusive economic zones, except in cases where this provision would result in economic dislocation for a state other than the state of origin." This has been interpreted to mean that high-seas fisheries can continue but that no new high-seas fisheries for salmon should be developed.

Catadromous species, in contrast to salmon, spawn in salt water but spend part of their adult life in fresh water. Some important eel stocks are catadromous. Under Article 67, coastal states in whose waters catadromous species spend the greater part of their life cycle are assigned management responsibility. High-seas fishing for these species is not permitted, but as there are no notable fisheries for catadromous stocks outside 200-mile limits, this rule does not appear to have significant implications.

In deference to the many groups that have expressed concern about the conservation and welfare of marine mammals, Article 65 allows coastal states and international organizations "... to prohibit, limit or regulate the exploitation of marine mammals more strictly" than otherwise provided for in the *Draft Convention*. This evidently sanctions rules that prohibit hunting for marine mammals, even where these may be contrary to the general purpose implicit in the *Draft Convention* that renewable marine resources should not be wasted through underexploitation. The provision from the 1958 Geneva Convention that was concerned with sedentary species was carried over into the *Draft Convention*. Exploited sedentary species consist largely of molluscs and crustaceans. While the rights of coastal states to sedentary species have long been recognized, nations have disagreed on the applicability of the sedentary classification to some species (e.g., certain crabs).

The significance of the 200-mile fishing limit is that it has brought the bulk of the world's commercial fish stocks under undisputed management authority, for most of these stocks occur in waters outside the 12-mile territorial seas but inside the new limits. The area of the high seas to which all nations have free fishing access has been greatly reduced. The proportion of the world fish catch now available in the high seas is relatively small. Katz (1975) quotes sources estimating fish harvests outside 200 miles in the early 1970s at between 6% and 15% of the world total. Gulland (1979) in the late 1970s put the estimate as low as 1%.

A substantial proportion of unexploited or underexploited "unconventional" stocks occur in the remaining high seas. There still is, therefore, a significant potential for the expansion of undisciplined fisheries in international waters, with the attendant dangers of overexploitation. Many difficulties also remain to be resolved in bringing rational management to the stocks occurring within 200-mile limits.

Boundary Problems

Although the world's fish resources now are largely within waters under the jurisdiction of national governments with legal authority to manage them, use of these resources is still far from optimal. Several forces and circumstances militate against rational management (Copes 1981b). Some derive from the artificial barriers created by the establishment of separate national jurisdictions, whereas others result from forces within countries, reflecting their institutional or sociopolitical character.

The demarcation of boundaries between the 200-mile zones of different countries is not simple. Article 74 of the *Draft Convention* states: "The delimitation of the exclusive economic zone between adjacent or opposite States shall be effected by agreement in accordance with equitable principles, employing the median or equidistance line, where appropriate, and taking account of all the relevant circumstances prevailing in the area concerned." The equidistance line is clearly defined by objective criteria that leave little room for argument. Between two countries, it constitutes the locus of points that are equidistant from the nearest piece of land for the two. However, the equidistance principle has been eroded by the acknowledgment of special circumstances that allow for significant deviations from it. Special circumstances recognized in international jurisprudence may relate, for instance, to the presence and location of islands,

to the configuration of coastlines, and to physical and geological structure (Hodgson and Smith 1979).

The criteria defining special circumstances are ambiguous, as are the means for establishing boundaries with reference to them. Many countries have formulated arguments for special circumstances that would enlarge their 200-mile zones at the expense of neighbours who rely on the equidistance rule. Thus, lingering disputes have been a by-product of the extension of marine jurisdictions (Buzan 1978) such that a recent study observed: "... the majority of the world's putative maritime boundaries remain undelimited" (Irwin 1980). The potential mischief is well illustrated by the smouldering boundary-cum-fishery disputes that now exist between Canada and the United States, whose relations as neighbours usually have been exceptionally cordial. The disputes have been serious enough for the Canadian Secretary of State for External Affairs, Mark MacGuigan, to have referred to them as "... the most serious issue we have with any country."

Fish stocks may be considered in terms of biological units consisting of individuals of a single species utilizing a common habitat and forming a common gene pool. Effective management requires that exploitation of each biological unit be undertaken in a consistent and coordinated fashion. It is complicated by the fact that many biological units overlap to form stock complexes. Also, account needs to be taken of interspecies (and interstock) relationships, e.g., predator-prey interactions and competition for food and habitat.

Unfortunately, carving the oceans into geographically defined areas managed by individual states has impeded the task of rational stock management. Many stocks straddle the new boundaries or migrate back and forth across them so that they do not come under the unambiguous management authority of a single state. They are subject to common-property relationships among the nationals of different countries exploiting them so that the danger of overexploitation remains.

The *Draft Convention* attempts to solve the transboundary stock problem by enjoining states concerned in each case to cooperate in establishing joint-management arrangements. Although the guidelines of the *Draft Convention* in this area are weak and enforcement mechanisms absent, the prospects for such arrangements are often good because a large proportion of the cases involve only two neighbouring countries.

This reduces the complexity of the bargaining necessary to achieve mutually advantageous management, with an agreed arrangement for sharing costs and benefits (Munro 1979).

A more difficult situation arises when a transboundary stock straddles the line separating a country's 200-mile zone from the high seas. Such cases are few, but one significant example occurs on the Grand Bank of Newfoundland, part of which extends beyond Canada's 200-mile zone. The stocks here were seriously overexploited under the impact of distant-water fishing in the 1960s and early 1970s, and, although extended jurisdiction has allowed Canada to rebuild the stocks to a significant extent, efforts are hampered by lack of jurisdiction when stocks cross the outer boundary of the 200-mile zone.

In accordance with the prescriptions of the *Draft Convention*, Canada has helped to establish an international body, the Northwest Atlantic Fisheries Organization (NAFO), to manage the fish resources on the continental shelf outside the 200-mile limit in the Atlantic. In this context, Canada has also attempted to gain recognition for the proposition that the coastal state should be accorded the leading role and decisive influence in such cases and has offered NAFO member states some incentive to agree: modest harvesting quotas within the Canadian jurisdiction.

As might be predicted, the NAFO management arrangement is proving vulnerable to the problems that debilitated international fisheries commissions before extended jurisdiction. NAFO is operating in an area that is part of the high seas where the *Draft Convention* rules are in the nature of a moral prescription only. There are no guidelines as to the division of responsibilities, costs, and benefits among participating states, and there are no enforcement mechanisms.

Organizations such as NAFO have to rely on voluntary membership and voluntary adherence to a joint management plan with harvesting quotas for individual countries. It is rare for any country to be satisfied with its share so that there is a temptation to stay out, or pull out, of the organization and to fish without restraint while counting on member countries to moderate their fishing efforts in accordance with the management plan. In the case of NAFO, Spain has opted out and is fishing without restraint. With no solution in sight for this "free-rider" problem, effective management of fisheries in the high seas and areas straddling the outer boundaries of national 200-mile zones will probably remain difficult to achieve and to maintain.

The problem can be solved if the management organization develops sufficient authority. An example is provided by the common fisheries policy applied in the collective zones of members of the European Economic Community (Koers 1977). The members together have full fisheries jurisdiction in the area concerned and have invested their joint governing organization with considerable authority to enforce strict quotas on catch. A similar setup has been proposed for Southeast Asia and may prove a practical means of securing more rational management in major fishing areas (Valencia 1978).

The more important highly migratory species is tuna, which typically traverse great stretches of the high seas as well as the 200-mile zones of several countries. Without coordinated management and restraint on total fishing effort exercised by countries participating in a tuna fishery, overexploitation is likely. The *Draft Convention's* prescription for management cooperation lacks any mechanisms of control and is, therefore, of dubious effect.

The United States, which in most respects is a coastal rather than a distant-water fishing state (Copes 1972b), has a particularly well-developed distant-water tuna fleet, using technically sophisticated equipment and catching methods. A large share of its catch has been obtained in waters that are now part of the 200-mile zones of other countries. Over the past few decades, the United States has been in conflict with Peru and Ecuador, countries that made early claims to 200-mile zones and have attempted to collect fees from vessels operating within the area. United States' tuna vessels refusing to pay fees were placed under arrest — an action met by retaliatory measures from the United States. Even though the 200-mile limit achieved general recognition in 1977, the United States has continued to claim the right to fish freely for tuna in the 200-mile zones of other countries. Recently, vessels doing so have been arrested in Mexican and Canadian waters.

The United States claims that fisheries for highly migratory species are exempt from coastal state jurisdiction because the *Draft Convention* calls for cooperative management for these species. In the absence of an agreement among the states sharing the migratory route, the United States holds that participants are free to fish for tuna outside narrow territorial limits without reference to the coastal states' authority. In other words, the United States seems to claim what might be called a right of pursuit of highly migratory species into the 200-mile zones of other

countries. Such a right is hardly consistent with the *Draft Convention*, which places no explicit limit on the coastal state's 200-mile jurisdiction in respect of any species. The American position has attracted little, if any, support.

Although an international management authority seems essential for each highly migratory species, experience suggests that enforcing quotas is difficult, especially for species that can be intercepted on the high seas. The countries that control the waters in which fishing is most effectively conducted should have a relative advantage depending on the time the stock spends in their 200-mile zone, the degree of maturity (weight) of the stock at that time, and its proclivity to school- and contact-fishing gear.

It may turn out that where tuna stock spends little time on the high seas and is not easily fished there, the coastal states concerned jointly will be able to achieve reasonably effective management. But where there are good opportunities to intercept tuna stocks on the high seas, effective management may prove not to be attainable within the present framework of the law of the sea.

The special transboundary problems for salmon, which are subject to the anadromous stock provisions of the *Draft Convention*, are noteworthy. Although the priority rights of states of origin to salmon spawned in their waters have been generally conceded and the advent of the 200-mile limit has greatly reduced the area of the high seas in which salmon may be found, significant stocks still migrate through the high seas of the north-central Pacific. At present, the only substantial fishing operations in this area are undertaken by the Japanese who have agreed to limit them. And the *Draft Convention* disallows the development of any new fishing efforts for anadromous stocks on the high seas. Nevertheless, the principal states of origin (the United States, the Soviet Union, and Canada) have reason to remain uneasy. No country is obliged to accept the provisions of the *Draft Convention*, and any could opt to commence a salmon fishery on the high seas of the north-central Pacific. The fact that so many distant-water fleets have had their access to coastal zones reduced by the new 200-mile limits is an incentive for them to seek new sources on the high seas. Still, one should not underestimate the power and influence that the United States and the Soviet Union, as interested parties, are able to exercise in dissuading such activities.

A more immediate problem in salmon management is that a large proportion of the salmon stocks migrate through the 200-mile zones of

countries other than the states of origin, where they are liable to interception. The fishery for Atlantic salmon of Canadian and European origin in Greenland's waters during the 1960s and early 1970s posed a grave threat to the already seriously depleted stocks of this species (Copes 1977), and the interception by the United States and Canada of Pacific salmon originating in each other's waters has bedeviled fisheries relations between the two countries (Copes 1980b, 1981b).

Article 66 of the *Draft Convention* provides that "... where anadromous stocks migrate through the waters landwards of the outer limits of the exclusive economic zone of a State other than the State of origin, such State shall cooperate with the State of origin with regard to the conservation and management of such stocks." Again, the rule is one of moral admonition — calling for cooperation but providing no guidelines for negotiation or mechanisms for resolution of disagreement. There is no suggestion in the *Draft Convention* that coastal states must abstain from intercepting anadromous fish on the way to their home spawning grounds in another country, nor is any specific limit suggested in respect of such interception.

Protection against interception, it seems, must come from any leverage states of origin may have to dissuade potential interceptors. The United States government — prodded by an Atlantic salmon sport-fishing lobby — persuaded the Danish government to curb drastically the Greenland salmon fishery. The implied threat was that the U.S. would stop importing fish from Denmark (MacKenzie 1972).

In the case of mutual interception of Pacific salmon by Canada and the United States, both countries have a considerable interest in an agreed regulation of interception that recognizes the basic entitlement of the state of origin to fish produced in its waters. Both countries have expansive plans for salmon "enhancement," to augment their stocks greatly by such means as habitat improvement, hatcheries, and spawning channels. To justify the expenditures, each country needs to be assured that the benefits will accrue to its own nationals. In ongoing negotiations, the two countries appear to be striving for an agreement to avoid interception where possible and otherwise to balance the amounts of fish intercepted by the two sides.

Intranational Management

The 200-mile limit permits national governments to manage their fish resources economi-

cally, but it does not compel them to do so. Evidence suggests that the new opportunities offered to national governments by the 200-mile limit often are being used to accommodate social and political pressures at the expense of efficient resources use (Copes 1981b). Common occurrences are the use of fishing operations for welfare "make-work" purposes, assistance to fishing operations exploiting submarginal resources, and biasing the division of labour between foreign and domestic fishing operations in favour of the latter.

In many instances, fishing communities are relatively isolated, with few alternative employment opportunities, low levels of education, and reduced labour mobility. In other words, they are characterized by low opportunity costs for labour. With poor income alternatives and no chance to earn resource rents, remote fishing communities often have considerable underemployment and incomes so low that they require subsidies to meet minimum living standards, especially within modern states. The fishing communities on Canada's Atlantic coast are a good example, and remote coastal areas of Ireland, Scotland, and northern Norway have similar problems.

The extra fish made available to coastal states by the 200-mile limit could be used to rationalize fishing operations in depressed coastal communities. A relevant strategy would be to freeze entry to the fishery at existing levels, allowing the extra fish to go to increased catches and incomes for existing fishermen (Copes 1979). However, where a government has failed to resolve the unemployment problem of a depressed fishing area, it faces the temptation to use the fishery as an employer of last resort and dispenser of social welfare. The increased fish supply is then simply used to employ additional fishermen at inadequate income levels that require continuing subsidies to maintain.

Newfoundland on Canada's east coast (Copes 1980a) has long had extraordinarily high levels of unemployment, amounting in 1978 to 16.4% — a figure that understates the severity because many discouraged persons are not counted as unemployed but rather as outside the labour force. This is reflected in a very low labour force participation rate, which in 1978 stood at only 52% in comparison with a Canadian average of 63%. Despite very low average catches and incomes per fisherman, the number of licenced operators in Newfoundland was allowed to rise from 15 351 in 1976 (the year before extended jurisdiction) to 32 352, 3 years later.

Canada's east coast provides one of the most spectacular examples of the proclivity of Western countries to subsidize economically overexpanded fishing industries. However, the data assembled in a report by the Organization for Economic Cooperation and Development (OECD 1970) demonstrate that the practice has been widespread. The Canadian case shows that a favourable change in a country's fish resources may not be sufficient to break old habits.

In several instances, the 200-mile limit has given coastal states control over more fish than they can exploit. The United States, for instance, has acquired large stocks of groundfish that it is not able to utilize at present. The *Draft Convention* requires that surplus stocks be made available to other countries but coastal states can avoid this obligation by increasing their fishing industry's capacity to bring the surplus stocks under exploitation. Nationalistic sentiment, enflamed by the memory of recent overfishing by distant-water fleets, creates pressures to do so.

As one American economist remarked, "... countries which have acquired marine territory would be tempted to treat their new seafood accessions as infant industries requiring production subsidies and market protection" (O'Rourke 1977). Indeed, both these kinds of support are now being demanded by elements of the United States' fishing industry (Allen 1980). One may see in this a kind of Parkinson's law: domestic fisheries tend to expand to utilize all the stocks available for their exploitation. The history of the industry, however, suggests that it already tends toward overexpansion — a tendency that can only be exacerbated by subsidization.

The contemplated expansion in the United States focuses on stocks, some of which are likely to remain economically submarginal for the foreseeable future. Probably the largest of these consists of Alaskan pollack — an acceptable food fish but one of low value and undoubtedly high exploitation cost in the Alaskan circumstances. Unfortunately, the new regional fisheries management councils in the United States are dominated by industry representatives, many of whom have contributed to the pressure to overexpand into economically marginal or submarginal fishing activities.

Leaving stocks for distant-water fleets rather than expanding into submarginal operations would probably constitute an economically more rational division of labour (Munro 1977a, b), particularly among high-income coastal states with high real costs of operation of offshore

trawlers. Successful distant-water operations are characteristic of countries that are technologically advanced but that still have modest labour costs deriving from moderate income levels (Copes 1972b).

There is evidence, however, that distant-water fishing countries have also often engaged in state subsidization of uneconomic fishing operations. In the case of several western European countries (OECD 1970), it has frequently been a matter of shoring up the declining fortunes of an established industry based on distant-water trawling. For the planned economies of Eastern Europe, which have acquired an extremely important distant-water fishing capacity, it has been different. A serious failure of agriculture to come close to meeting domestic requirements in these countries for protein, in combination with a strongly autarchic economic structure, has induced the countries to rely heavily on an enormous distant-water fishing effort, with uncertain attention to the real economic costs of this effort (Kaczynski 1977, 1979a).

The proclivity toward uneconomically high levels of fishing effort in both eastern and western countries contributes to an understanding of why some of the attractive commercial stocks of fish were so heavily depleted prior to 1977. The event of extended jurisdiction undoubtedly has much reduced the extent of overfishing. Coastal states, in most instances, have now reduced fishing efforts at least to levels compatible with the achievement of MSY.

With the readjustments in overall fishing effort that have taken place, there remains the question of what is the optimum division of labour between distant-water and domestic fleets among countries with the technology required for full utilization of commercial fish stocks. Given the complexity of comparing the production functions of highly diverse systems, involving many externalities and distributional considerations, one may hazard only a speculative answer with respect to any particular case. A general observation, however, seems in order. In the short run, at least, given the enormous investment extant in distant-water fleets, it seems sensible that they be given opportunities to exploit surplus stocks in preference to the premature expansion of the domestic fleets of coastal states into currently submarginal operations. In view of the nature of investment in distant-water fleets, the privilege of continuing to fish should be worth a fair amount to the operators, and coastal states could demand the payment of fees that would make the renting of their stocks advantageous.

In the long run, it may be a different matter. Fishing from a nearby shore, with most processing done ashore, essentially has many cost advantages (Copes 1972b). This comparative advantage of the coastal state eventually may outweigh the initial cost advantages held by distant-water fleets, particularly when the time comes for these fleets to be replaced. Released from the external diseconomies of open-access competition with the fleets of other nations within its jurisdictional limits, the coastal state may structure an economically efficient resource-use pattern for its domestic fleet. The distant-water fleets, on the other hand, will have lost much of their particular advantage of being able to move around the world's best offshore fishing grounds. In the end, even the highest cost coastal states may take over substantially all fishing operations in their 200-mile zones and be justified in doing so on the basis of unrestrained comparative advantage.

New Accommodations

The sudden advent of extended jurisdiction in 1977 required an immediate adaptation, particularly by the distant-water fishing countries. They not only had large fleet investments that they needed to utilize to best advantage but usually also had large domestic markets that were critically dependent on the supply from their fleets. By far the largest distant-water operations were maintained by Japan and the Soviet Union. Moderately important distant-water operations were conducted by several countries, of which Poland and Spain were prominent examples (Kaczynski 1979b). The strongly developed operations of South Korea and Taiwan in Asia also deserve notice.

In seeking access to the newly enclosed 200-mile zones, distant-water nations were dealing, basically, with two distinct groups of countries. One consisted of developing coastal nations, most of which had an inadequate capacity to exploit the marine resources of their zones fully, and the other consisted of developed coastal states with resources surplus to their immediate harvesting capacities. Prominent among the latter were the United States, Canada, South Africa, New Zealand, and Australia.

Cooperative arrangements are possible under which distant-water fleets are allowed to participate in fishing operations within the zones of specific coastal states (Tomlinson and Vertinsky 1975; Kaczynski 1979b; Tomlinson and Brown 1979). One possibility is an agreement by which distant-water vessels fish under specified conditions in a country's 200-mile zone, providing a fee

or other consideration for the privilege. Other arrangements include requiring distant-water vessels to land their catches for processing in the coastal state. Conversely, over-the-side sale of fish from small coastal state boats to large distant-water processing vessels may be arranged. Finally, joint ventures may be entered, with various financial, equipment, and personnel contributions being made by the two sides. All of these arrangements — and some others — have occurred, the greater leverage usually being possessed by the coastal state because of the 200-mile jurisdiction. Payments or other considerations extracted by coastal states should be sufficient to defray costs of management, inspection, and enforcement as well as to provide some rent for access to stocks.

The tendency among developed coastal states with surplus stocks is to bring these under domestic exploitation. And there are reasons to believe that this may be economically rational in the long run. For the immediate future, however, the distant-water fleets are likely to retain a considerable cost advantage, particularly with respect to stocks for which they have a lead in fishing experience and technology development (Copes 1978). Moreover, many distant-water fishing countries (particularly those of Eastern Europe) exercise strict control over access to their markets. As they often have the only significant markets for certain species and refuse to expend foreign exchange on purchases of such fish, coastal states would not be able to dispose of any catches of such species. Several of the agreements made by Canada and the United States in recent years, giving Eastern European fleets fishing access to stocks of (for North America) unconventional species of groundfish, are an illustration.

Many coastal states are committed to honour, in word and spirit, the rule that they should give other countries access to their surplus stocks. At the same time, several coastal states face political pressures to deny all access to foreigners. The pressures stem from the fear, suspicion, and resentment held by domestic fishing industries long exposed to depletion of their fishing grounds by distant-water fleets. Canada is one country caught in this dilemma. It has attempted to resolve the problem by bargaining judiciously with distant-water countries to secure from them commensurate benefits that would visibly redound to the advantage of Canada's domestic fishing industry. These have included, in some instances, in addition to standard fees, access for Canadian fish products to foreign markets; pro-

cessing in Canadian shore plants of the catch taken by foreign vessels; over-the-side sales of fish caught by Canadian inshore fishermen to foreign factory vessels; increased use of Canadian ports, ship repair facilities, and chandlery services by foreign vessels; continued abstention from high-seas fishing for Canadian salmon; and recognition of Canadian leadership in NAFO.

Some of the arrangements pressed by Canada on distant-water partners are difficult to justify in terms of optimal resources use because they require foreign vessels to be used in a nonoptimal fashion (Copes 1981b). Thus, West German trawlers, built for full processing of their catch, were allowed to fish for cod off Labrador on condition they would land their catches in Canada for processing (Copes 1978). Polish factory trawlers were allowed to purchase hake over-the-side from west coast Canadian fishermen, but not to fish directly. The inferior overall economic returns resulting from such featherbedding arrangements suggest that they are unlikely to endure in the long run.

For the time being, cooperative arrangements between developing coastal states and distant-water fishing countries appear to make good sense for both sides, at least where the former are not yet in a position, technologically or economically, to utilize their fish resources fully. The developing state may obtain much-needed foreign exchange from access fees. It may also require a distant-water fleet to supply fish to its domestic market at a reasonable cost and to help it develop its own fishing industry. Requirements may include the construction of port, handling, and processing facilities as well as the supply of equipment and training of labour (Copes 1981b).

For the developing countries, there are clear hazards in these kinds of arrangements, which have been borne out by disappointing results in a number of cases. Usually the developing state does not have an adequate capacity to monitor the stocks or to check and control the level and pattern of foreign catches. Inadequately controlled activity of distant-water fleets may lead to excessive depletion of stocks and fail to provide revenue for unobserved excess catches. Developing countries providing fishing access to distant-water fleets are well advised to give high priority to the buildup of their monitoring capacity.

As more developing countries acquire the capacity to fish the stocks of their 200-mile zones, the opportunities for distant-water fleets will shrink. Many western European countries, beset by falling productivity of their fleets during the period of heavy fishing pressure in the early

1970s, have phased out much, or most, of their distant-water operations. Countries with a demand for fish products far in excess of their domestic supplies more and more are seeking to gain access to adequate supplies by other means. Japan offers a good example of this new adaptation (Copes 1981b). Japanese fishing companies are seeking to invest in the fisheries operations of countries that have an actual or potential surplus of fish products attractive to the Japanese market. They have promoted a variety of arrangements, ranging from outright purchase of local fishing firms to the extension of commercial loans to local fishing firms in return for a privileged trade. Significant Japanese fishing investments have been made on the Pacific coast of both the United States and Canada (Josephs 1978; Proverbs 1978). Official reservations have been expressed by both countries regarding foreign investment in their fishing industry (Quadra Economic Consultants Ltd and MacDaniels Research Ltd 1979). It is ironic, in view of the poor profit record of the industry, especially in Canada, that there should be more concern about keeping foreigners out of fishing than out of more profitable industrial sectors. Perhaps, the public perceives an implied threat to the new ocean frontiers of the 200-mile limit or expects the industry to become much more profitable now that fishing jurisdiction has been extended.

Distributional Considerations

Along with changes in the international pattern of fishing activities, the 200-mile limits have meant concomitant changes in the distribution of benefits deriving from the use of the world's ocean fish resources. Unfortunately, the restrictive theoretical analysis of conventional welfare economics provides little help for those who wish to judge how this redistribution of benefits may contribute to optimizing the use of ocean fish resources.

There is good reason to assume that the enclosure of the oceans under the 200-mile regime will bring about an overall increase in welfare because the establishment of national property rights will greatly reduce the external diseconomies that previously attached to open-access fishing on a global scale. But the incomparability of the values of benefits accruing to different persons or nations does not allow one to judge whether in welfare-theoretic terms the redistribution of fishing benefits among nations per se has brought about an improved use of ocean fish resources. Nevertheless, such a judgment may be made in terms of some widely held notions of equity.

What is equitable ultimately is subjective. However, there is a widely established disposition to consider that a redistribution of economic benefits is desirable if it favours population groups that are recognized to be particularly disadvantaged in their living standards. In plain terms, one may consider a gain by the developing countries relative to the developed countries to be beneficial.

There is strong evidence that the developing countries, as a group, have secured an immediate net improvement in their fisheries position as a result of the 200-mile limits. FAO data show that developing countries were taking only 0.6 Mt from waters off the coasts of developed countries, whereas the latter were catching as much as 3.6 Mt off the coasts of the former (Popper 1975). As a result of the 200-mile limit, all states are in a position to appropriate the benefits of catches off their coasts. The developing countries, as a group, consequently may appropriate net benefits of 3.0 Mt of fish at the expense of developed countries.⁴ The benefits could be achieved by substitutions of domestic catches for foreign catches, where the developing countries acquire an economically appropriate capacity to exploit their coastal resources. Alternatively, they could extract fees or other benefits from foreign countries who wish to continue fishing in the area.

Some authors have taken a much less sanguine view of the benefits of the 200-mile limit for developing countries (Kent 1978). Although it is clear that the 200-mile limit is achieving an immediate improvement in the position of developing countries, it should be recognized that this improvement is in relation to their current state of underdevelopment. One may speculate that possibly greater improvements have been foreclosed by the 200-mile limit than have been introduced.

It might be supposed that, in the longer run, developing countries could acquire a distant-water fishing capacity and that, because of lower labour costs, they could then outfish distant-water fleets from developed countries. There is evidence to suggest that a disproportionate share of the potential distant-water fishing grounds has now fallen into the hands of developed countries. One may assume at least a crude relationship between the size of the ocean areas acquired under 200-mile zone enclosures and the fisheries

potential gained thereby. The largest ocean areas gained (in order of extent) have gone to the U.S., Australia, Indonesia, New Zealand, Canada, USSR, and Japan (Shyam 1976). By this rough criterion, only one of the top seven beneficiaries is a developing country.

The 1972 catch in waters off the coasts of developed countries amounted to 31.3 Mt, whereas that in waters off developing countries yielded only 24.5 Mt (Pepper 1975). The disproportion appears much worse when one considers the much larger number of developing countries and, particularly, their much larger populations. Some caution is warranted in interpreting these figures, however, because the fisheries potential in the coastal zones of developing countries may have been less fully exploited than that of developed countries. Gulland (1971), for instance, attributes a particularly good potential for additional fisheries development in the Indian Ocean and parts of the western-central Pacific.

Any consideration of the distribution of benefits between major groups of countries — developing vs developed, or coastal vs distant water — masks a great variety of different cases. There are many geographically disadvantaged countries, both among developing and developed states, whose 200-mile zones are small, poor in resources, or both. And, of course, there are landlocked countries looking on with dismay as the acquisitive coastal states carve up the oceans that were once considered the common heritage of all. Articles 69 and 70 of the *Draft Convention* speak of special consideration that should be given to the needs of landlocked and geographically disadvantaged states in allowing access to surplus stocks of coastal states in the same region. The provisions are so vague and weak as to have little or no practical import, and there is no evident equity in the grossly uneven distribution of resource gains brought by the 200-mile limit.

In the debates on the law of the sea, some developed coastal states have pointed out that many of their fishing communities are crucially dependent on preservation of the local fish resource for their continued use. The conditions of economic distress in these communities may make their needs worthy of equal attention with those of developing countries. FAO data show that, of the world's total distant-water fishing catch, of 15.3 Mt, 11.2 Mt were taken off the coasts of developed countries (Popper 1975), so that coastal fisheries there have borne the brunt of the distant-water fishing impact.

This argument has been stressed particularly by Canada — and with good reason. The Atlantic

⁴In an alternative calculation, also based on 1972 FAO data, Gulland (1979) concluded that the developing countries' net advantage amounted to 4.1 Mt.

coast fishing communities have long been in a notoriously difficult economic position and were hard hit by heavy distant-water fishing prior to 1977. The new 200-mile zone has greatly helped these Canadian communities — and those in other countries facing similar conditions. If coastal communities dependent on local resources are considered, on equity grounds, to deserve priority access to these resources, the 200-mile limit may be considered to have unambiguously improved resource use.

It is, perhaps, too readily assumed that the 200-mile limit will naturally benefit a coastal state. Careful consideration reveals many perverse effects of the 200-mile limit that may prove disadvantageous to particular coastal states (Copes 1979, 1980b). Geographically disadvantaged coastal states, with negligible fish resources of their own, may find themselves cut off from accustomed fishing grounds in their neighbours' 200-mile zones. In fact, this circumstance may affect also better-endowed coastal states whose fleets have been accustomed to utilizing fishing grounds off a neighbour's coast.

The British Columbia halibut fleet used to take more than half of its catch in waters off the Alaska coast, from which they have now been barred. In turn, American trawlers have lost access to their accustomed sources of groundfish in British Columbia waters. Both fleets have suffered economically, as a consequence, providing examples of a deleterious economic effect of the 200-mile limit.

Perverse effects would also result if greater efforts were devoted to intercepting Pacific salmon stocks when they migrate through the high seas and 200-mile zones of countries other than their states of origin. Another problem for a coastal state could be trade diversion in fish products. Canada's east coast groundfish industry, heavily dependent on the United States market, could lose much of that market if and when the U.S. develops more of the groundfish resources it acquired with its 200-mile limit.

Despite some instances to the contrary, one may assume that both developed and developing coastal fishing states have gained from extended fisheries jurisdiction. Although the distant-water fishing states have lost in relative terms, they may not have lost in absolute terms. The globally improved fisheries utilization that is likely to be the result of national jurisdictions, at least in the long run, may benefit all. With prospects of more rational management, more fish may become available in international markets, at lower economic cost.

Coastal states will make more direct use of the stocks that have been brought under their control; distant-water countries are bound to lose many of their accustomed sources in the zones of coastal states. They could make up quantitatively for the catches lost by switching their effort to underutilized stocks that are surplus to coastal state requirements or that are still available on the high seas. However, such stocks are likely to be most often in remote locations or difficult to catch and will usually be inferior species, often at lower trophic levels.

There has been a widespread tendency among countries representing different fishing positions and different political systems to engage in heavily subsidized fishing operations. The economic rationality of this behaviour is open to question. If the loss of access to other countries' 200-mile zones provides the shock necessary to persuade distant-water countries to phase out uneconomic fishing operations, they could well gain substantially in the process. The labour and (replacement) capital resources that would be released from former fishing pursuits might well be put to better use in alternative land-based, protein-producing enterprises or in other economic activities that would yield the foreign currency needed to buy increased supplies of fish products from coastal states. Japanese enterprise, quick to adjust to changing opportunities, already has moved in this direction. Several western European countries also have reduced their distant-water operations, although the practice of providing lingering subsidies to declining industries has slowed the adjustment in some cases. There is less evidence that Eastern European countries will soon make this kind of adjustment, constrained as they are by an autarchic political framework and relative insensitivity to economic profit considerations (Kaczynski 1977). Globally, the oceans are capable of yielding a much larger annual harvest than is now being taken, much of it from the remaining high seas. Potentially, there remains room for a substantial distant-water fishing effort, with the real question being how much expansion can be justified in terms of cost-benefit comparisons.

Conclusion

The extension of national fishing jurisdictions to 200 miles is bringing about an improvement in the utilization of the world's ocean fish resources. The gains are resulting from the imposition by national governments of restrictions on access to the fish stocks they have now acquired. Overex-

plottation of the commercially desirable stocks, which was threatening to spread throughout the oceans, has been halted. The distributional implications of the changes that are taking place also appear, on balance, to be beneficial, at least for the near future.

The establishment of national jurisdictions, by itself, gives little assurance that fish resources will be used optimally. National governments still have far to go in developing and implementing fully rational fisheries management within their respective jurisdictions. There still are powerful social and political forces within many countries that deliberately promote the wasteful application of excessive amounts of labour and capital to exploitation of the limited fish stocks available.

The balkanization of the oceans that is the consequence of 200-mile jurisdictions also has given play to many new diseconomies, as a partial offset to the efficiency gains flowing from enclosure of the ocean commons. Establishing a vast network of new boundaries within the oceans is itself costly and disputatious. And, as fallout from the new national jurisdictions, a vast number of problems in managing transboundary stock have emerged.

Although economists may have heaved a sigh of relief when the irrational condition of open-

access fishing on a worldwide scale came to an end, they now find a host of national irrationalities to contend with, within the fisheries policies and practices of individual states. Certainly, the first task in any further effort to improve utilization of the world's fish resources should be to develop, at the national level, socioeconomically rational and administratively effective fisheries management.

At the international level, important tasks need to be carried out to improve world fisheries utilization. Most important is the development of effective mechanisms for transboundary stock management in its many bilateral and multilateral manifestations. Next, there is the need to bring an effective discipline to fishing on the remaining high seas. An international management authority with some powers of sanction is needed. For the longer term, there still are the scientific, technological, and economic challenges of exploration on the ocean frontier to seek resources that so far have remained beyond reach and to bring them under beneficial exploitation.

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Discussion

Peter Drysdale: My sole qualification for opening the discussion on these two papers is that I know absolutely nothing about forests or fishes so that, unconfused by rich detail and deep expertise, I might try to effect some kind of metamorphosis between two physically quite different products and, in the tradition of my craft, concentrate on more universal, if somewhat dissociated, truths. One must confess, at first blush, that forests and fishes are, superficially at least, very different. But my profession is not one that lets the facts get in the way of analysis, so it is in this spirit that I am approaching the rather daunting task of trying to say something useful about these two papers together — a presumption for which at the outset I must beg the authors' indulgence.

These are two extremely valuable papers. They provide not only a wealth of background information and expertise on two of the product

markets that are the subject of this conference but also many insights into the analytical issues and major themes that must inform discussion over the coming few days.

Scott's paper provides an extremely comprehensive survey of factors affecting the utilization and management of forest products in international markets. It raises every important question that has occurred in policy discussion about forest exploitation, management, and trade. It is a rounded paper full of beautiful literary allusions, and one is confident at the end that one knows quite a lot about the optimal development of forestlands, however innocently and ignorantly one begins.

Copes provides similar reassurance to those previously uninitiated in his fishery world. His concise review of the economics of international fisheries from Grotius onward makes the unfamiliar and complex, familiar and manageable.

The developments in the jurisdictional system governing the exploitation of fisheries resources around the law of the sea conferences are particularly deftly handled, and with becoming national modesty, especially when one considers how well Canada did out of all this. My comments are not to imply any disagreement with Copes' main conclusions about the virtues of the new regime. But the particular circumstances of the Canadian fishing industry (whether seen as an infant needing protection or in terms of its disadvantaged fishing communities) have had, one suspects, an important bearing on how interests in the new regime were presented so vigorously and perceived so clearly from this part of the world.

In reading both these papers, I was struck (and perhaps this is the Australian in me coming out) by the strong similarities there appear to be between minerals and forests and fisheries. Indeed, the thrust of the argument in the Scott paper revolves around the notion that the international exploitation of forests consists in forest mining roughly according to Ricardian rules. The Copes paper also intimates that a good proportion of fisheries exploitation until relatively recent times has been really a mining-type operation. The mining phase in the exploitation of both of these renewable resources occurs as stocks are taken out without deleterious effects on yield. Then there appears to be a distinctly forestry or fishy phase (perhaps best described as a stable hunting or gathering phase) where the focus is on natural harvesting in a way that sustains yield. And finally, there is a closely related farming phase where plantation forestry, for example, or aquaculture are subject to the same principles of husbandry as other farm products and can be treated accordingly.

Obviously all these phases can happily coexist in the international marketplace for both products without defying any of the laws of comparative advantage. For example, the relative resource endowments and demand structures in China and New Zealand encourage efficient aquacultural production in the former and fish mining in the latter. Or in Japan and Papua New Guinea, forest farming is efficient in the former and forest mining (with some qualification) sensible in the latter. (Incidentally, I think that Scott perhaps underestimates the range and potential of agroforestry, which is not confined to exotic cases but is being investigated commercially in New Zealand and Australia.)

These simple distinctions may help to clarify the nature of the resource allocation and management problems, as well as the nature of production and trade specialization and their

dynamics over time in both industries, as one traverses the detailed argument in both papers.

A fundamental question in both papers relates to how the authors approach the issue of optimization of resource use. Curiously, neither paper quite comes to grips with the question of how to optimize the use or development of the product with which it deals, although this is the subject to which attention is ostensibly directed. Scott introduces the useful analytic device of the virgin island and poses the right questions, but there is no analytic island in Copes paper. One is left wondering at the end exactly what are the quasi-market rules that both authors are using or would use to ensure efficient (or optimal) exploitation of each resource's commodity.

The crux of the matter is that both papers fudge the important stock-in-trade distinction between efficiency conditions in resource use and distributional and other broader social objectives. In reality, of course, the latter considerations do influence the pattern of resource use. Copes provides illustration of the distributional interests in the fishing industry in Canada and elsewhere, and Scott carries examples in the forest area through to an analysis, which more or less presumes that distributional and other social objectives must directly affect resource allocation. At least it has to be argued carefully in each case that the efficiency objectives cannot be handled better separately from the distributional and other objectives. This is not done in either paper.

If the optimization objective is addressed in this (admittedly) conventional way, the problem becomes the familiar one of allocating the rights to exploit the resources to the most-efficient exploiters (whether they are foreigners or nationals), with an appropriate rent-value of the resources being extracted for the community at large. There is a further question of how to optimize trade specialization in the utilization of the resources and trade in resource-based products.

Viewed in this way, it is by no means clear, for example, that even over time national fisheries need be exploited according to what Copes calls unrestrained comparative advantage or that countries like Australia and New Zealand (not the homes of great seafaring people) should not continue optimally to auction fishing rights to distant-water fleets.

As for the equity and other social objectives, they can be dealt with independently through the mobilization of the rents or taxes from resource harvesting and their application to equitable and social purposes, including broad developmental purposes.

After observing that the new regime in fisheries jurisdiction represents an improvement over the previous circumstances in which there was potential overexploitation of a common-property fisheries resource, Copes notes that the new regime by itself gives little reassurance that fish resources will be used optimally but notes that an important problem remaining is the management of transboundary stock. Indeed, countries are enjoined in the law-of-the-sea conventions to cooperate regionally to solve these problems. What are the possibilities for such cooperation in the Pacific region? What countries might sensibly be involved? What regional mechanisms might be required to deal with these problems? And would it be possible to proceed with Pacific cooperation on fisheries management even if the United States were reluctant to be involved? I would very much welcome some comment on these questions.

Narongchai Akrasanee: The Scott and Copes papers set the tone for this meeting on renewable resources. The purpose of my comments is to assist in setting the tone for the rest of the seminar. I consider the subjects to be most important to Southeast Asia because the region was endowed with considerable quantities of fishes and trees. Unfortunately, overexploitation has been common to both resources and is the problem with which Southeast Asia must deal. In this respect, neither paper had too much to offer.

Scott's paper promises to deal with the problems of forest utilization in Southeast Asia and, although it takes examples of the adverse effects of deforestation from Southeast Asia, it examines only general factors contributing to deforestation and proposes a strategy to increase forest production by advanced management techniques that are found only in advanced countries at present. The economic analysis in the paper is general and is not directly related to the strategy to increase production. And, finally, the solution proposed is meant for forestry in an isolated island!

The adverse effects of deforestation are well known. Perhaps, as a group, we do not need to spend too much time on this topic. The circumstances in Southeast Asia are evidence of the adverse effects of deforestation. Scott has touched upon the factors contributing to deforestation and has correctly included slash-and-burn agriculture. But the factor that has not been made explicit is the lack of law enforcement, even though this is one of the most important factors

in the overexploitation of forests in general and is the key factor in Southeast Asia. Scott's analysis of the economics of forest development does not incorporate the costs of enforcement, nor does it deal with the political economy of forestry concessions. Thus, his solution has limited applicability and is only suitable to a law-abiding country such as Canada — or to a small island somewhere in the Pacific. The solution is obviously not meant for Southeast Asia where deforestation started with the export of hardwoods and was aggravated by rapid population growth. The governments gave log concessions to a few people, some of whom overexploited their concessions. Those without concessions poached. A model applicable to Southeast Asia must incorporate the costs of control mechanisms and must be based on more than tax and incentive measures.

The mechanisms within an optimization model for Southeast Asia would include careful monitoring of exports, penalties for log poaching, and incentives for the application of intensive farming techniques. As it is difficult to supervise tree cutting, control or even banning of exports may be necessary to slow the rate of tree harvesting. Log-poaching penalties should be severe enough to make log poaching too expensive to continue. Finally, intensive farming techniques should be encouraged as a much-needed replacement for slash-and-burn agriculture.

On Copes' paper, I only have two short comments. First, I think his analysis should have taken into account the fishing ability and fish-eating habits of both coastal and distant-water states. Copes recognizes that countries supporting distant-water fishing fleets — South Korea and Thailand, for example — will be adversely affected by the 200-mile zone. However, he stresses only the advantage for the coastal states in charging rents to foreign fishing vessels. Coastal states whose populations do not eat large quantities of marine products can, indeed, begin to demand rents from distant-water fleets, but the disadvantages for the developing countries with such fleets are considerable. Second, this approach to analysis fails to recognize the possibility that the imposition of the 200-mile zones will lead to international conflict. This possibility is real and is enhanced by the difficulty in enforcing regulations over foreign vessels operating in the zones.

John Bene: In his paper, Scott deals with a complex subject on which many people hold strong

views. It is hard to overstate how important the forests are to the economic, social, and cultural welfare of the people around the Pacific. He points out that few economists have studied the contribution of the forest to development. When they have, they have concentrated mostly on the international trade of forest products, which is no more than the tip of the iceberg. In 1974, which is the most recent year for which I could find data, only 17% of the $2500 \times 10^6 \text{ m}^3$ of wood harvested found its way into international trade.

Developing countries produce about 40% of the world's timber harvest, and 85% of this wood is burned to cook meals. In the monsoonal countries, branches of tropical trees are the only green fodder available during the dry winter months to sustain cattle, sheep, and goats. Billions of tonnes of topsoil are washed into the sea each year because too many trees have been removed.

None of this is reflected in the statistics from which the economists derive their conclusions. There is little agreement on how to translate into dollars and cents the value of shade for humans and beasts under the hot tropical sun, the value of a windbreak against the searing winds in the Sahel or in Rajasthan, or the value of the trees that slow runoff after a tropical downpour. Economists are hard at work on these problems. Unfortunately, so far they have been more successful in quantifying the goods contributed from the forest than the "bads" from the lack of trees. Next to the role of the homemaker in the world economy, the contribution of the forest is the worst-documented item in the field of economics.

This conference is supposed to discuss renewable resources, but the forest is a renewable resource only as long as it is allowed to renew itself or if it is replanted. Most lands will revegetate with trees and shrubs if left fallow after the trees have been removed. But, under the onslaught of a rapidly growing population, the forest turns into bare rock, desert, or coarse grassland if overused or poorly managed.

At one time, about one-third of this planet's land surface was forested. More than half of this forest was in the tropics. In the countries of the temperate zone, progress has been equated too long with clearing of the forest for agriculture. In Europe, the forests were at a minimum about 150 years ago; since then, they have increased in many countries, including France and the Scandinavian countries. Productivity is now increasing almost everywhere in Europe as a result of better management and better utilization.

In the tropics, of 3500 Mha tropical forest, 1000 Mha have been destroyed during recorded

history, and the land has become unproductive wasteland. Destruction continues at the rate of 200 000–400 000 ha annually. The 800 Mha humid tropical forests are the source of most of the tropical timber trade. If high-grading and shifting cultivation continue at the present rate, there will be little tropical wood to be harvested from the natural forest by the end of this century.

Scott generalizes about the role of trees in the economy, but the role of trees in the tropics, where most of the developing countries are, is very different from that in the temperate zone, where the industrial countries are. Also, he focuses mostly on conditions in the humid, tropical forest of Southeast Asia, but some of his assumptions would have to be revised if one talked about the coniferous forests of North America's west coast, Chile, New Zealand, Australia, or Siberia.

The problem with generalizing is exemplified in the term "forestland." There are vast areas in the more northerly and southerly regions of the globe where the growing of trees is the best use of the land. The climate may be too harsh and the quality of the land too poor to grow annual food crops on these lands economically. In most tropical countries, the simultaneous or sequential use of the land to grow trees, annual food crops, and pasture may be the best use of the land. Thus, to describe any land in the tropics as forestland is somewhat ambiguous.

The high cost of waiting — the term Scott uses to describe interest on the money invested — requires that some income be derived from thinning or other forms of selective cutting in the managed forest. It is just not economic to invest in planting and tending and then wait 100 years for a return. Another alternative is to harvest by clear-cutting and then to wait for the next crop of trees from natural regeneration.

In the tropics, as Scott points out, only intensively managed plantations of fast-growing trees make economic sense. The results of natural regeneration are unpredictable. Enrichment planting of the natural tropical forest looks good on paper but has not worked in the field.

There are many reasons to preserve areas of unmanaged tropical forest, but they are not economic ones — for example, the preservation of gene reservoirs or the protection of steep slopes. Until the value of these services can be quantified, it is not practical to argue their value based on return on investment.

If tree plantation is the only economically justifiable method to sustain timber production in the tropics, one has to forego forests on land that

can sustain annual food crops. Food is in short supply and likely will become even scarcer as the world population climbs toward the 10 billion mark early in the next century. However, only 10–15% of the tropical land can sustain annual food crops even if fertilizer and water are freely available.

One-third of the tropical land mass will not sustain any kind of vegetation, because the land is too high, too steep, too rocky, too dry, too salty, too alkaline, etc. This leaves about half of the tropical land mass for pasture or land on which trees can be grown alone or in alternation with other crops. Most trees build up the fertility of the soil so that it can support food crops. Crops can be planted between newly planted trees for 2–3 years until the canopy closes or for about the same amount of time after the trees have been harvested. Some trees grow very rapidly in the tropics; there are many that can be harvested 5–15 years after being planted, and many will regrow quickly from root shoots after the tree has been cut (coppice growth).

Scott states that 100 Mha plantation forest, equivalent to only 4% of the world's forests, could supply all the industrial roundwood requirements in the year 2000. Technical improvements in the use of wood make substitution with fast-grown, less-dense wood increasingly practical for high-valued, slow-growing woods such as mahogany or teak. The average rotation age in the tropical forest plantation approaches 10 years, and this makes "waiting" more economically acceptable even at present high interest rates. Shortage of capital and political uncertainty are more serious impediments than the availability of land or labour or the high interest rates.

Not only economists, but also the general public, must gain a better understanding of the contributions that trees make to human welfare. In China, South Korea, India, and several other countries, programs of social forestry have been initiated during the last 10–20 years. Trees are grown along roadsides, canals, railway lines, and farm boundaries. These trees are planted by either the forest services or the farmers and are managed by the villagers. The forest service acts as an adviser only. Many schools operate tree nurseries; the seedlings are bought and distributed by the forest service. This operation generates some money for the children to buy books or go for school excursions, and it raises interest in the forest among young, impressionable people. Schoolteachers as well as presidents of the country preside over tree-planting ceremonies and

preach the importance of forest management.

I suggest that the world will see a faster increase in the number of planted trees than Scott foresees and that these trees will grow in locations where they will not compete with any other land use; in fact, I think they will assist agriculture and improve the amenities of the land.

Scott's discussion on alternatives for distributing revenues from the forest and tenures to optimize the value of the forest to society should be read carefully by anyone who wants to see that his or her children and grandchildren live in a world where trees continue to provide food, fuel, shelter, and beauty. Nowhere is the conflict between the perceived interest of the individual and that of future generations more acute than in the management of the globe's forest cover. Scott describes eloquently how different objectives can be served if the forest is made a public trust or private property. Responsibility for forest management or enforcement of good managerial practices can be allocated to one or another group of the society.

Decisions on how to reinvest the gains from the harvest of the forest should not be taken lightly, especially if the liquidation of the forest is contemplated. There are many legitimate objectives and quite a few illegitimate ones that can be easily disguised to appeal to an unsuspecting public. The economist who contributes to decision-making must be confident that all important factors are known and have been properly weighed. Although it may take longer than a lifetime to establish a forest and bring it to maturity, careless or irresponsible action may doom reestablishment for all time.

Wontack Hong: Most of the world's distant-water fishing catch has been taken off the coasts of developed countries (11 Mt of the total 15 Mt), such as the U.S. and Canada. The numbers of developing countries that have substantial resources off their coasts are few. Therefore, most of the benefits from the introduction of the 200-mile fishing zones have accrued to developed countries. Although the globally optimal policy for fisheries conservation is simply to restrict fishing efforts, these coastal states have taken advantage of their new-found wealth and have begun extracting exorbitant entry fees from other nations; for instance, the U.S. collects nearly 10% of the gross value of fish caught by South Koreans in the Alaskan fishing zone. Under the pretext of fisheries conservation, what has resulted is a fishing colonialism and an exploita-

tion of resource-poor countries by the resource-rich countries.

Copes contends that the 200-mile limits have brought about an overall increase in welfare. I believe the opposite: the fact that many developed states ended up with resources surplus to their harvesting capacities implies suboptimal fish harvests for the whole world. The expulsion of distant-water fleets or the imposition of fees means that the coastal developed countries have gained at the expense of developing countries with distant-water fishing fleets. The 200-mile limit has not improved the welfare of disadvantaged groups; it has changed the focus of disadvantage from one group of developing countries to another. To the developing countries that have a distant-water fleet, the shift doubles the disadvantage because of the waste it entails.

Copes contends that fishing from a shore base nearby, with most processing done ashore, has cost advantages that outweigh the initial disadvantages in setting up the processing facilities. However, the fish can be processed in factory vessels of distant-water fleets. Furthermore, off-shore trawlers do not operate more cost-effectively than do distant-water fleets. Unless an extraordinary, labour-saving device is developed in the fishing industry in the near future, fishing will continue to be a poor person's pursuit in the developed countries. The developing countries have comparative advantage in labour-intensive activities, such as coastal and distant-water fishing. As a disproportionate share of the potential distant-water fishing grounds has now fallen into the hands of developed countries, developing countries, such as South Korea and Thailand, are being deprived of the opportunity to specialize on the basis of comparative advantage. Furthermore, the coastal developed countries will end up subsidizing and promoting domestic operations that are economically marginal or submarginal with no comparative advantage.

What is left now is an international agreement on the fishing of the remaining high seas. My hope is that the super powers will adhere strictly to the objective of fisheries conservation and will not stray into the colonialism and exploitation that permeate their activities with regard to the 200-mile fishing zones.

Francis T. Christy Jr. (My remarks are personal comments and should in no way be construed as reflecting the position of FAO.) Copes presents a good summary of the development of extended fisheries jurisdiction and the evolution of the

exclusive economic zone (EEZ) as well as the nature of the problems that are emerging. As he points out, the new setup provides the opportunity for greatly improved management of marine fisheries because of the acquisition of significantly extended authority by the coastal states. He is also quite correct in noting that there remain numerous difficulties for coastal states in achieving efficient exercise of their authority and numerous problems for bilateral and multilateral management of shared stocks. However, I had hoped for something more.

One of the major tasks at FAO is the provision of advice to coastal states, at their request, on the management of fisheries within their extended zones of jurisdiction. In fulfilling this task, my colleagues and I need more information, better tools, and greater understanding than we presently possess. We are fully aware of the problems of management (which I roughly define as those activities designed to increase the flow of net benefits from the resources), but we have difficulties in dealing with them effectively. That is, we have difficulty in improving the practice of management in real life.

In the hope of stimulating greater inputs from academia, I would like to elaborate some of the problems identified by Copes and indicate some of the areas where we feel the need for greater attention. First, however, some background. The traditional approach has been to measure global production of fisheries by the simple addition of the tonnes of fish caught, with equal weight being given to each species. Thus, a tonne of lobster has counted for no more than a tonne of anchoveta, even though the former has an average unit value roughly 100 times that of the latter. This regrettable state of affairs is partly a result of the inordinate difficulty of deriving satisfactory price information for hundreds of different species of fish, many of which have different uses and are sold in widely disparate markets.

At FAO, we have recently attempted to remedy this problem by the construction of a unit-value weighted output index (FAO, in press). This index is based on rough approximates of the average unit values of major species and groups of species in 1969-71 and by the application of the La Speyres formula. The calculations provide quite a different picture from that of the traditional unweighted measure of output. Whereas the unweighted measure shows a growth rate from 1970 to 1978 of only 1% annually, the unit-value weighted index increases at 2.9% annually. This figure takes on special significance when one considers that the new fisheries

jurisdiction means that the rights to this increasingly valuable catch have been granted to the coastal states.

Catches of distant-water fleets in 1972 (the last year before there were significant extensions of jurisdiction) indicate the vast disparities in gains among countries (FAO, in press). Two-thirds of the value of catches (excluding tunas and salmons) were taken off developed countries and only one-third off developing countries. Most of these catches were taken by the fleets of developed countries; therefore, the change in gains to developed countries represents mostly a transfer from one to another.

About 40% of the total gains among developing countries accrue to the states of the east-central Atlantic, particularly to Morocco, Mauritania, and Senegal, and 25% to the states of the southeast Atlantic. The developing coastal states of the Indian Ocean, Southeast Asia, and the western coast of Latin America have achieved small immediate gains (excluding tunas) by the extension of jurisdiction because they have control over few resources of interest to the distant-water fleets. This fact reflects the specialized interests of the distant-water fleets in a few highly valued species that can be taken at relatively low costs. In fact, two individual species — Atlantic cod and Alaska pollack — accounted for 25% of the total value of catch (excluding tunas) by distant-water states in foreign zones in 1972.

It is also noteworthy that two of the distant-water states accounted for more than half of the value of the 1972 catch in foreign zones — 31% by Japan and 25% by the USSR.

These rough estimates indicate that the effects of the extension of jurisdiction have been far from uniform, both for the coastal states and the distant-water states. Copes is quite right in pointing out that the ultimate constraints resulting from the *Draft Convention's* call for coastal states to share excess resources are of little or no consequence. It is important to emphasize this point to correct some of the misconceptions currently being held by a number of developing coastal states. The wording of the negotiating text as well as that of the U.S. Fisheries Conservation and Management Act (sometimes adopted as a model) tends to perpetuate the concept that fish are biologic rather than economic resources and that the right to dispose of them is constrained by some obligations to the international community. This concept, to the extent that it is perceived as having weight, is the source of some mischief. For example, a few countries have rejected offers of help in the assessment of their

stocks for fear that there may be surpluses that they will be obliged to offer to their neighbours. And a few states are concerned that they do not have the scientific expertise or the knowledge to go through the tortuous calculations necessary to derive optimum sustainable yield estimates or measures of their own fishing capacity. In addition, this concept tempts states to invest in the development of their domestic capacity because of the feeling that this is the only way they can increase their share of the wealth.

There are four sets of problems identified in Copes' paper that deserve special attention. It would be useful to have an analytical framework for dealing with these problems, but I am not sure that one exists.

One of the difficulties is how to manage transboundary stocks; it is a problem inherent in common property: distribution and efficiency seem to be inextricably intertwined. In the absence of property rights, the only way one can share in the wealth is by investing in the means of production or in illegal means (bribery, extortion, collusion, etc.). In fact, I believe that the difficulty in distinguishing distribution and efficiency decisions is the heart of the problem of adopting and implementing improved management practices. Copes rightly states that the resolution of these problems is the most important task to be undertaken at the international level. However, I cannot agree with his remark that a large proportion of the transboundary stock involves two neighbouring countries only. Aside from the tunas and billfishes, there are sardinellas and hakes off the northwest African coast, pilchards in the southeast Atlantic, scads and mackerels in the South China Sea and the Gulf of Thailand, as well as numerous species in European and Mediterranean waters that are each shared by several countries.

For some of these stocks, the problems of joint management are not great because use within one zone does not affect use in another zone. For other stocks — those that are not readily depletable — the management problems are essentially economic rather than biologic. The upstream users can diminish the supplies available to the downstream users without incurring damage to their own interests. Bargaining in this case is difficult unless side payments or sanctions can be used. The shared stocks that are depletable are another matter; excessive use by one state will diminish its own potential yields as well as those of its neighbours. Although this may provide an incentive for cooperation, the technical problems of managing these stocks are often complicated

by the fact that use in one zone may be more profitable than use in other zones.

As Copes states, the solution to the transboundary stock problems is a system of joint management. But I think his comment begs the question: management for whom and for what purpose. In citing the European Economic Community as an organization able to enforce a management plan with strict quota limitations for its members, Copes calls attention to an organization that has failed completely to adopt, much less enforce, a management plan.

Management for the purpose of achieving increased net economic revenues requires a reduction in fishing effort, and this, in turn, requires a reduction in jobs. Ultimately, the item of wealth being traded is employment in the ports of England, Scotland, France, Germany, etc. Making such trades greatly increases the mortality of politicians because their constituency is united by nationalism. Thus, management of shared stocks for the purpose of increasing net economic revenues is unlikely to occur until the mortality of the fishermen has become great enough to reduce the mortality of the politicians.

The intertwining of efficiency and distribution decisions is particularly acute and critical for shared stocks, but it also plagues management in domestic situations — a second set of problems requiring attention. It is often thought that the proper education of fishery administrators will be sufficient to get them to adopt the management practices we advisers are fond of suggesting — whether these be vessel limits, fishing personnel quotas, taxes, price controls, etc. I believe that this thinking underestimates the intelligence of the administrators. There are still some that need to be persuaded of the efficiency of reducing effort in an overcapitalized fishery, but I suspect there are many more who know full well that management to improve net revenues cannot be achieved without one group being hurt for the benefit of another.

The problem is that few fishery administrators are equipped to make such distribution decisions. These decisions are made at a higher level of government, either through the political or, as in a few cases (e.g., allocations to native Americans), the judicial process. In these trade offs, the politicians are protected by having a diverse rather than a uniform constituency, and they can decide on a distribution that meets the majority interest. They can respond to the question of management: for whom and for what purpose, thus greatly facilitating the task of the fishery

administration in adopting and implementing fisheries management practices.

Another set of problems emerges after management objectives have been decided, especially if a decision has been made to improve the lot of the small-scale or artisanal fisherman. Copes states that where a government has failed to resolve the unemployment problem of a depressed fishing area, it is tempted to use fishing as "... an employer of last resort and dispenser of social welfare." "Tempted" may not be the word to use, when one considers the devastating problems of unemployment in the rural coastal communities of many countries.

In these situations, where the opportunity costs of labour may be at, or close to, zero and where fish stocks are fully or overutilized, the determination of the optimum utilization of the resources becomes difficult. Efficiency may mean that the best management technique is to preserve the condition of free and open access to maintain opportunities for employment, even though they will produce low levels of earnings. If this is the case, managers should avoid subsidies directed at fishermen, because these will tend to encourage the flow of additional labour into the fisheries. They should also avoid encouraging technological innovations, such as motorization of boats, that are labour-saving in nature because these will tend to concentrate the earnings in the hands of a few to the detriment of the many. Copes states that there are still powerful social and political forces within many countries that deliberately promote the wasteful application of excessive amounts of labour and capital to exploitation of limited fish stocks. The question that deserves attention is whether the application is wasteful.

A final set of problems of significant importance, which is mentioned only in passing by Copes, relates to the capacities of coastal states for the monitoring, control, and surveillance of their economic zones. Optimization implies net benefits — the costs of enforcement (and research and administration) must be considered along with the costs of production. In the U.S., it has been estimated that the rents collected from foreigners have been about \$10 million, whereas the costs associated with regulating foreigners have been more than \$50 million a year. Although fees have recently been increased and may match the costs, questions can still be raised as to whether this is an optimal solution.

Problems of enforcement are relatively easy to solve in the north Pacific. In the central and west Pacific, however, the isolated island states set in

the vast open seas will have considerable difficulties in the enforcement of their zones. And, in Southeast Asia, enforcement of regulations on even domestic fishermen is notoriously difficult, as noted by some of the other participants in this conference.

The new jurisdiction for marine fisheries provides a necessary but not a sufficient condition for the optimization of benefits from the sea's wealth. A large number of difficult problems remain to be solved, several of which have been identified by Copes. I have sought to elaborate

some that appear to be of particular importance and difficulty for those of us who have a hand in guiding policy and planning decisions.

Two of these — the management of shared stocks and the management of domestic fisheries — are greatly complicated by the difficulties of separating distribution and efficiency decisions. The third is the problem of improving the lot of small-scale fishermen using limited resources. And the fourth is the problem of enforcement. Although these problems have not been ignored by scholars, they merit greatly increased attention.

Trade and Investment in Fish Products among Pacific-Area Countries

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What effects, if any, have the new exclusive economic zones (EEZs), dramatic changes in exchange rates, higher fuel costs, and changes in the price of alternative protein sources had on trade and investment in fisheries? Although world harvests of seafoods have increased since 1967, fish landings among Pacific-area countries, taken in total, have increased even more over the period. Furthermore, trading patterns have changed: Japan, the world's leading seafood exporter in 1965, has been a net importer since 1972. Canada and the U.S. have experienced declines in their shares of world exports, and developing Asian countries have increased theirs. On the investment side, a variety of joint-venture arrangements have emerged. Thus, fishing patterns have changed with respect to areas and species fished as well as vessel type. Preliminary results from two general econometric models suggest that relative prices, while important, account for a small percentage of the varieties in export-market shares; that, on the demand side, such shares are relatively inelastic with respect to relative prices; that the income (food expenditure) elasticity of demand for shrimp in Japan has been decreasing over time (price elasticities of demand are relatively low); and that the exchange rate may serve as a separate explanatory variable. Although certain insights can be gained if one looks at broad aggregates (countries and species), the more interesting questions should be addressed through a detailed investigation of the role that fisheries play in particular countries and of the market characteristics for particular species.

Les nouvelles zones économiques exclusives (ZEE), les fluctuations brutales des taux de change, la hausse du prix du pétrole et l'évolution du coût des nouvelles sources de protéines ont-ils influencé ou non les investissements et le commerce des pêcheries? Le volume mondial des pêches a augmenté depuis 1967 mais encore plus les captures des pays des côtes du Pacifique. Le commerce lui-même a évolué : le Japon, premier exportateur de produits de la mer en 1965 est devenu un importateur net depuis 1972. Les exportations du Canada et des États-Unis ont diminué et celles des pays en développement asiatiques ont augmenté. Au niveau des investissements, de nombreuses conventions ont été signées. Par conséquent, le modèle des pêches a aussi changé, qu'il s'agisse de zones, d'espèces ou de sortes de chaluts. Les premiers résultats de deux modèles économétriques généraux indiquent : que les prix relatifs n'influent, malgré leur importance, que sur un faible pourcentage de la variation dans la répartition des marchés d'exportation; que du côté de la demande, ces proportions sont relativement stables; que l'élasticité du revenu des crevettes a diminué au Japon (l'élasticité des prix à la demande étant relativement faible); que les taux de change peuvent constituer une variable explicative séparée. L'analyse d'agrégats globaux (pays et espèces) permet de dégager quelques indices, mais les points les plus importants devraient être étudiés au moyen d'une enquête détaillée sur le rôle que les pêches jouent dans divers pays et les caractéristiques du marché de certaines espèces.

For the purposes of this paper, Pacific-area countries are considered to be those of the Middle East, South Asia (bordering on the Indian Ocean), Oceania, Asian countries bordering on the Pacific Ocean, the United States, and Canada. Central and South American countries

have been excluded, except for Mexico in the case of shrimp, although their role in Pacific-area seafood trade may soon increase.

Country-by-country descriptions of seafood trade in 15 Pacific-area countries reveal general trends, affected perhaps most significantly by the

proclamation of 200-mile exclusive economic zones (EEZs). Since the EEZs were widely accepted, the fishing activities of many fleets have been subjected to controls — joint ventures, special quotas, and permits. The new patterns of activities are profoundly influencing international trade in seafood. For example, countries that now allow foreign nations to harvest underutilized species within their EEZs may develop their own capacities in future. Such shifts in access to fish resources are bound to influence the flow of seafood between countries. The country that eventually takes over the foreign-fishing activities will have reduced imports for that species; likewise, exports by the foreign nation will decline.

The emergence of 200-mile EEZs has resulted in new patterns of fishing activities, in terms of areas and species fished as well as vessel types, and has affected investment patterns in the fishing and seafood processing industries. Whereas fleets currently fishing in foreign EEZs are generally scaling down their vessel and equipment investments, coastal states are attempting to expand their domestic industry (both in vessels and processing facilities) to begin focusing on foreign-harvested or underutilized species within their EEZs. Some of this domestic investment comes through governmental channels or international organizations, although investment by foreign private enterprises is playing an increasing role. Japanese private investment in various countries' shrimp processing facilities and Norwegian private investment in Indonesian tuna industries are but two examples of attempts to satisfy domestic demand previously met by distant-water fishing activities.

The general trend in the Pacific area during the past 10 years has been increased total catches and values. Except for the U.S., Japan, Singapore, and Hong Kong, all the countries in the Pacific were net exporters (by value) of seafood in 1977. In fact, in Singapore and Hong Kong, the presence of imports for resale abroad may mask a true, net-exporting status.

Between 1967 and 1978, total world harvest of fish, crustaceans, and molluscs increased from 60.4 to 72.3 Mt, an increase that pales beside the nearly 200% during 1950–67. The Food and Agriculture Organization (FAO) of the United Nations has estimated that, in 1967, international trade accounted for 42% of the total catch. This figure fell to 31% in 1973 but has been increasing since. Among the Pacific-area countries, the role of Japan and Israel (the developed market economies of Asia) as seafood exporters declined in

relative terms during 1967–79, whereas that of Asia's developing-market economies increased substantially. The shares of exports from Oceania, Canada, and the United States fluctuated.

As importers, the developed markets of Asia and North America showed opposite trends. Between 1967 and 1979, the former's share tripled for fresh and frozen seafood, whereas the latter's fell by one-third. The relative positions of Canada, the United States, Australia, and New Zealand as importers of prepared seafoods — especially in the canned form — also declined. Asia's developed economies increased their combined shares of world imports of prepared seafoods from less than 1.5% to almost 8%.

Thus, the general picture is that of an expanded total world harvest (of both marine and freshwater species) with a recent increase in the relative importance of international trade to its pre-1973 level (Table 1). In addition, the developing economies of Asia have increased their share of the world's seafood exports, at the expense of most of the developed economies for products requiring little processing and at the expense of Japan for the more processed products.

Between 1967 and 1978, nominal catches for Pacific rim regions increased: U.S. and Canada 33%; Japan 37%; Australia and New Zealand 37%; USSR 55%; Asia's developing countries (including China but not Taiwan) 52%. Harvests from all these regions have expanded more rapidly than the world totals, an important factor underlying some of the international trade patterns. These larger harvests are the result, in large part, of expanded investments in fishing effort — especially vessels — and, to a lesser extent, of changes in fishery jurisdictions.

Increases in population and incomes as well as reductions in tariffs have contributed to increases in imports. The degree to which seafoods substitute for other protein sources has not been explored on a global basis. However, the Asian countries' share of world trade in meat, both imports and exports, more than doubled between 1970 and 1979.

Data for 1973 and 1978 for fresh and frozen seafood (UN 1978) indicate the value of Japan's exports declined. Japan's exports to the United States fell dramatically, whereas, on a percentage basis, shares to other markets expanded. Canada's total exports increased, with sales to Europe growing at the expense of Japan and the U.S. The value of U.S. exports also increased, with Japan's share showing a large increase and Europe's share a large decrease. (Preliminary data for 1979

Table 1. Shares of Pacific-area countries in world seafood trade, 1967-79.

Fish, crustaceans, molluscs	Share (% of total world trade)												
	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
Fresh, chilled, frozen, salted, dried, or smoked													
Exports													
Asia, developed economies	8.0	7.9	6.6	6.6	6.2	7.9	8.3	6.9	3.9	4.8	3.4	3.2	2.4
Asia, developing economies	9.3	9.2	12.0	11.9	12.1	13.6	16.6	16.1	21.4	21.4	24.6	21.4	22.5
Oceania, developed economies	3.8	4.5	4.6	4.1	4.6	4.4	3.4	3.3	2.8	3.0	3.1	3.1	3.5
Oceania, developing economies	0.2	0.3	0.6	0.7	0.9	1.2	0.7	1.0	0.9	0.7	na ^a	0.9	0.3
America, developed economies	20.3	19.9	20.1	18.6	17.6	16.4	18.4	14.5	15.3	16.5	17.9	20.4	17.8
Imports													
Asia, developed economies	10.3	10.3	12.7	13.6	17.4	18.6	23.6	22.2	24.4	27.6	29.8	32.3	33.3
Asia, developing economies	5.0	4.7	5.0	5.1	4.8	4.5	4.5	4.3	4.5	4.3	4.3	4.1	4.2
Oceania, developed economies	1.3	1.3	1.2	1.3	1.2	0.9	0.9	0.9	0.7	0.9	0.7	0.7	0.6
Oceania, developing economies	0.2	0.2	0.3	0.3	0.2	0.3	0.2	0.2	0.3	na	na	na	0.0
America, developed economies	35.5	39.0	38.5	36.6	34.8	36.6	32.3	30.8	27.6	28.9	28.0	24.7	23.6
Prepared or preserved													
Exports													
Asia, developed economies	35.3	39.4	37.4	38.9	37.0	34.5	26.3	26.6	26.4	26.7	22.9	20.3	17.5
Asia, developing economies	3.5	2.8	3.3	4.1	4.5	5.4	7.4	7.3	8.3	8.2	10.0	12.7	na
Oceania, developed economies	0.6	0.7	0.6	0.7	1.6	1.4	1.1	1.0	1.0	0.9	1.2	0.8	0.7
Oceania, developing economies	na	0.0	0.0	0.1	0.0	0.0	0.0	0.2	0.2	0.2	0.5	0.7	0.0
America, developed economies	17.5	12.9	14.6	12.4	13.5	13.2	16.2	12.3	11.7	11.3	12.0	16.8	19.5
Imports													
Asia, developed economies	1.3	0.8	1.0	1.6	2.4	3.0	5.0	5.1	6.1	6.7	6.8	6.5	7.6
Asia, developing economies	7.3	7.3	8.0	7.6	8.1	7.0	6.8	7.5	9.4	8.2	8.8	8.9	na
Oceania, developed economies	3.6	3.3	4.1	3.3	4.0	4.2	4.6	6.7	3.8	4.7	5.0	4.4	4.1
Oceania, developing economies	0.3	0.9	1.0	0.9	1.1	1.0	1.0	1.8	1.1	1.2	na	na	0.1
America, developed economies	22.9	23.1	23.6	25.6	23.6	25.6	19.7	21.1	16.4	19.2	17.3	16.0	15.2

^a na = not available.

Source: Various issues of the UN Yearbook of international trade statistics, New York, USA, UN.

Table 2. Distribution of seafood (fresh and frozen):^a percentage of exports from selected Pacific-area countries to listed world markets, 1973 and 1978.

Importers	Japan		Canada		South Korea		Australia		USA		Thailand		Indonesia		Hong Kong	
	1973	1978	1973	1978	1973	1978	1973	1978	1973	1978	1973	1978	1973	1978	1973	1978
Japan	-	-	14.7	12.7	80.5	70.1	37.0	53.7	66.2	62.1	59.7	86.5	85.1	64.7	66.3	
USA	60.4	38.8	71.0	62.8	7.5	11.0	49.7	37.0	-	10.1	7.5	5.7	4.1	12.9	13.2	
Europe ^b	13.4	17.7	11.7	20.6	2.9	7.4	6.8	4.4	26.7	15.7	17.1	1.9	0.8	4.7	3.9	
Hong Kong	2.7	4.5	0.1	0.2	3.4	0.6	1.8	2.8	0.1	0.2	7.5	3.1	3.9	-	-	
Canada	0.8	1.3	-	-	0.1	0.1	0.1	<0.1	16.2	10.6	0.1	<0.1	na ^c	4.5	2.9	
Australia	2.3	4.4	0.2	0.2	0.6	0.2	-	-	0.5	1.0	0.1	<0.1	na	3.0	3.9	
Singapore	0.6	1.3	0.1	<0.1	1.1	0.4	0.5	0.2	<0.1	<0.1	2.1	2.2	4.8	5.1	4.4	
Other	19.8	32.0	2.2	3.5	3.9	10.2	4.1	1.9	9.4	6.3	6.7	0.6	1.3	5.1	5.4	

^aCorresponds to SITC 031.^bFrance, Italy, West Germany, U.K., Spain, Belgium, Luxembourg, Netherlands, Denmark, Sweden, Switzerland, Portugal.^cna = not available.

Source: Various issues of the UN Yearbook of international trade statistics, New York, USA, UN.

suggest that increasing volumes may be moving to Europe.) The values of exports from the other Pacific-area countries for which data are readily available (Hong Kong, Indonesia, Thailand, Australia, and South Korea) were all larger in 1978 than in 1973 (Tables 2 and 3). On a percentage basis, Japan is the largest market for these countries, although Australian exports to the U.S. exceeded those to Japan in 1973. Japan's imports from South Korea fell during the period and increased for Australia. The U.S. and Europe are also major markets for the seafood products of these countries.

In general, the developed countries continue to be the primary importers of seafoods, even partially processed forms. Some changes may be occurring, however; for example, Japan's share of annual exports to "other" countries increased by more than 60% over the period.

For processed products, Japan is the primary supplier, suggesting that it imports raw materials for processing and subsequent export. Nonetheless, Japan continues to be a major market for the processed seafoods of South Korea and, beginning in 1978, of Canada.

Japan

Between 1950 and 1978, Japan's harvest of fish and shellfish increased more than threefold, making that country the leading fishing nation in the world. Indeed, Japan's 1979 harvest exceeded the combined catches of the United States, Canada, Mexico, and China. In 1965, Japan was the world's primary exporter of seafood and ranked sixth as an importer. A net exporter of seafood in 1958, Japan has been a net importer since 1972.

Japan's fishing industry includes both distant-water and local fleets, as well as aquaculture operations. Despite massive destruction during World War II, the fishing fleet and industry infrastructure have made remarkable recoveries. Much of the increase in harvest came from expansions of the catching capacity in both offshore and distant waters, particularly for species such as Alaska pollack and mackerel. In 1964, these two species, together with the tuna species, led all others in terms of volume, whereas the tunas had the highest exvessel value followed by squid (including cuttlefish). By 1978, sardines had replaced tuna in the top three, by volume, and Alaska pollack had joined tuna, salmon, and squid as a leading income generator.

The United States is Japan's principal market for exports, although six other Pacific-area countries accounted for 21% of Japanese exports in

Table 3. Distribution of seafoods (prepared):^a percentage of exports from selected Pacific-area countries to listed world markets, 1973 and 1978.

Importers	Japan		Canada		USA		South Korea	
	1973	1978	1973	1978	1973	1978	1973	1978
USA	22.6	17.0	17.6	12.3	-	-	22.4	39.8
Japan	-	-	<0.1	52.2	18.0	8.8	70.9	39.4
Canada	9.4	6.2	-	-	17.5	24.2	1.1	4.0
Australia	4.6	1.8	2.8	3.9	4.2	9.3	2.0	4.2
Philippines	7.5	3.9	na ^c	0.1	0.9	0.4	<0.1	na
Singapore	4.1	3.4	0.1	<0.1	0.8	1.5	0.2	0.8
Europe ^b	26.3	13.1	63.6	24.4	51.0	37.0	1.6	6.3
Other	25.5	54.6	15.9	7.1	7.6	18.8	1.8	5.5

^aCorresponds to SITC 032.

^bFrance, U.K., West Germany, Belgium, Luxembourg, Sweden, Netherlands, Denmark, Switzerland, Italy, Austria.

^cna = not available.

Source: Various issues of the UN Yearbook of international trade statistics, New York, USA, UN.

1978 (up from 17% in 1970). Pacific-area countries also play a significant role as suppliers of seafood to Japan. South Korea supplied between 11% and 22% of Japan's imports during the 1970s, and Taiwan accounted for about 10%. Indonesia increased its share of the Japanese market substantially during the 1970s, largely through exports of shrimp. Japan imports fresh and frozen tuna and exports canned, as well as fresh and frozen, tuna. South Korea and Taiwan are Japan's major tuna suppliers (aside from its domestic fleet), whereas the United States is the leading importer of Japanese tuna.

Among the factors underlying Japan's switch from net exporter to net importer are relaxation in its trade restrictions, increased domestic demand, expanded domestic processing (canned sardines and anchovies production alone increasing 50-fold between 1970 and 1978), and changes in supply conditions, such as restrictions on fishing operations in foreign fishing grounds, pollution of domestic fishing grounds, labour shortages,¹ appreciation of the Japanese yen, and, in common with other fishing nations, increased fuel costs.

The Japanese government is involved in the fishing industry in several ways, from restrictions on efforts for certain species, through research and development programs, trade policies (including import controls on selected fishery products), to management of Japan's 200-mile economic zone. Japan's large distant-water fleet was adversely affected by the introduction of the 200-mile fishing jurisdictions claimed by other

nations. The government's response has been increased involvement in domestic fisheries, including encouragement of aquaculture, water-purification projects, plans for exploiting new fishing grounds, participation in investment activities abroad, and the pursuit of other fishing resources, such as the Antarctic krill.

Japan's investments in developing countries include the provision of technical expertise and capital to encourage shrimp production, some of which it later imports. It also participates in joint ventures ranging from tuna, squid, and shrimp production in Africa to salmon marketing in Chile. A substantial number of joint ventures are in Eastern Asia, and major investments have been made in American and Canadian fisheries.

The composition of the domestic fleet has changed somewhat, in step with expanded attention to the coastal areas of Japan. In 1961 there were 379 187 fishing boats, of which 1168 were 100 t or larger. In 1974, there were 372 151 vessels, of which 3196 were 100 t or larger. However, in 1978, when the total number of vessels had increased to 412 423, the figures for 100-t plus boats had grown by only 92.

China

The People's Republic of China is one of the world's greatest producers of fishery items. Its output of aquatic animals and plants has consistently ranked among the top four countries of the world. Yet the fishing industry in the country remains somewhat of a mystery to the rest of the world, and only recently has detailed information been made available.

The 1978 marine fish yield in China comprised 605 900 t from the South China Sea (19% of total

¹The International Marketing Fund reports that labour costs in Japan rose 28% between 1975 and 1978 when expressed relative to those of other industrial countries.

marine fish yield) and 2.54 Mt from the East China, Yellow, and Pohai seas (81% of total yield). The latter fishing region increased in yield by 62% during 1970–78, whereas yield from the South China Sea increased only 14% for the same period.

Marine and freshwater aquaculture form a significant portion of China's annual output of aquatic products. In 1978, total output of aquatic products reached 5953 Mt, and aquaculture accounted for 41% of this production (including kelp). Moreover, aquaculture yields more than doubled during 1970–78, whereas catch increased by less than 50%. China's catches have been mainly sold at home. Exports in 1970, for example, represented only 1.5% of China's nominal catch in that year. Total exports averaged 96 000 t during 1970–78.

Although detailed data for China's seafood trade are scarce, available information does provide some insights. A 1966 study cites the USSR as one of China's most important fish export markets. Britain and Czechoslovakia were importing fish meal from China by 1955. An effort to expand exports by 50% began in 1956. In 1962, eels in tomato sauce, spiced hairtail fish, croakers in oil, and braised cuttlefish were identified as important canned export products for China. A 1978 study points to Hong Kong and Macao as China's primary buyers of fresh and frozen fish, whereas Japan and Southeast Asia purchase most of China's jellyfish and frozen prawn exports.

Import tariffs for the fishery products as published by the International Customs Tariff Bureau are high, ranging from 30% to 250% ad valorem. A supplement to the customs journal for China stated "... the Embassy of the PRC [has advised the International Customs Tariff Bureau] that until further notice, no export duty is leviable on commodities exported from the PRC."

Thailand

Thailand's fishery products reached 2.3 Mt in 1978, an astounding increase of 1055% over the volume landed 20 years earlier. Major species for Thailand in 1978 included sardinellas, scad, and natantian decapods. The country has long been a great fish-producing nation of the South China Sea countries (second to China), although this may change as the result of the establishment of EEZs in numerous countries.

Thailand's 1974 fleet consisted of about 40 000 vessels, primarily small boats with outboard engines for inshore fishing. In the early 1960s, a

Thai–German bilateral project to introduce trawl fishing led to overfishing in nearby waters and sent the Thai fleet to distant fishing grounds. Fishing operations employed about 64 000 in 1978.

Thailand's fishing fleet, already dependent upon distant fishing grounds for its trawlers, faced considerable problems as various countries established 200-mile jurisdictions. In 1978, estimates were that newly established fishing limits would cut Thailand's fishing grounds by 780 000 km² and reduce catch by 30%. Thailand, thus, made special efforts to become involved in joint ventures and to obtain foreign fishing permits. One joint venture reported in early 1979 involved trawling in the waters of Bangladesh.

Thailand was a net exporter of fishery products during 1963–78; indeed, the value of 1978 exports was more than 37 times the value of imports in 1978. Crustaceans and molluscs — fresh, frozen, dried, and salted — are Thailand's most important fishery export, accounting for more than 60% of the total value of exports. Primary importers of Thailand's seafood products in 1966 included Japan (crustaceans), the United States (crustaceans), and Malaysia (fish).

Thai 1978 imports were also headed by crustaceans and molluscs, although they were only 2% (by value) of the exports. Imports from Malaysia were the greatest (in value) of all Thailand's fishery imports, but those from Japan and South Korea were also important.

USSR

Fish and fishery products in the USSR were 8.93 Mt in 1978, representing a decline for the second year in a row. However, the Soviet Union's production remains among the top five countries of the world in terms of total catch. The recent decline is said to be due to the USSR's exclusion from various countries' 200-mile limits, as well as other factors.

The species landed in greatest volumes in the USSR in 1978 included Alaska pollack, chub mackerel, clupeonella, cunene horse mackerel, and blue whiting. Japanese pilchard was also an important fish for the USSR that year, apparently a previously underutilized species.

In 1970, the Soviet Union's fishing fleet included trawlers (58.8%), drift-net vessels (6%), purse seiners (9.2%), and passive-method vessels (10.1%), and the share of trawlers in the fleet was said to be expanding.

With the imposition of 200-mile EEZs around the world, the Soviet vessels were excluded from

important fishing grounds. Thus, the late 1970s brought in a new era for Soviet fisheries, with joint ventures and international negotiations for permits and quotas playing a greater role. The Soviets began fishing for hake in a joint venture in the late 1970s off the west coast of the U.S. In 1979, another joint venture began off the coast of Alaska, with 136 t harvested in the first year. In 1978, two Soviet factory ships were purchasing and processing more than 2000 t of mackerel a month, provided by the U.K. vessels in a joint venture off the English southwest coast. The Soviet Union has also been allocated quotas of unused fishery resources in several countries' EEZs, such as those of New Zealand and Australia.

In addition, the USSR announced in 1978 its involvement in a U.S.\$12 million venture in Singapore. The project was to build a processing and storage complex in Jurong that would convert trawler catches into convenience foods. The company engaging in the venture was founded in 1975 by Straits Fisheries and V/O Sovrybflot.

Exports of seafood products from the USSR grew from 316 400 t in 1970 to 516 230 t in 1978, a 63.2% increase. The total value of these exports increased by 163% during the same period. The share of fresh and frozen fish exports, as well as those for fish products and preparations and fish meal, all increased during 1966–78. Exports in 1978 were dominated by fresh and frozen fish and fish products and preparations. The country exported 5.8% by volume of its total catch in 1978 (the comparable figure in Japan was 6.9%).

As export data by country for the USSR are unavailable, we attempted to locate the Soviet markets for seafood products from the import data for various countries. European Economic Community (EEC) imports from the USSR in 1978 were approximately 4.5% of the volume of USSR exports for that year, whereas the value of imports reached 21.1% of the total value of USSR exports. The 1966 import figures for the EEC showed a lower volume and share of Soviet fishery products, although Denmark, the U.K., and Ireland were not EEC members at the time. Important fishery exports from the Soviet Union to the EEC include frozen fish, shrimps, and prepared and preserved salmonids.

Japan, the world's greatest importer of seafood products, imported 31 720 t of seafood products from the USSR in 1979. Alaska pollack and fish fillets were the top Soviet exports to South Korea in 1978, whereas fresh and frozen marine fish were Singapore's major import from the USSR in 1977. India and Malaysia data for 1978 and 1974, respectively, showed no imports of seafood

products from the USSR. Small amounts of USSR fishery imports were found for Hong Kong, Australia (mostly canned salmon), and New Zealand.

Taiwan

Taiwan's fishery products reached 675 025 t in 1976 at a total value of U.S.\$383.7 million. Top-valued landings in 1976 were Spanish mackerel, sharks, and squids, together accounting for more than 15% of the total value of production in that year. Taiwan's output has been rising, with 1976 landings nearly 250% of those in 1956 (by volume). One major factor in the expansion of Taiwan's fishing industry has been the availability of government and World Bank loans for vessel construction.

Taiwan's fishing fleet included 11 997 powered vessels in 1974, almost a fivefold increase over the number in 1954. Fishing personnel in 1976 were more than 300 000, of whom 63% were full-time employees of the fishery.

In September 1979, the government of Taiwan announced the establishment of its 200-mile EEZ. The Philippines had earlier declared the 200-mile limit, excluding Taiwanese vessels from the water of the Bashi Channel—fishing grounds that had once provided annual catches of 50 000 t for the Taiwan fleet. Taiwan's establishment of an EEZ affected fishing activities of the Japanese fleet, which had been harvesting about 30 000 t annually in Taiwan's waters.

Taiwan's fishing fleet was adversely affected by the emergence of the EEZs as well as the rising cost of fuel; in 1976, nearly 300 Taiwanese long liners were not able to fish. The government of Taiwan began several projects to boost the fishing industry, by providing loans of U.S.\$70 million to improve port facilities, technology, and training.

In addition to developing underutilized species in its own waters, Taiwan has been involved in international negotiations to gain access to fishing grounds in other countries' EEZs. In early 1980, for example, Taiwan had been granted fishing rights in Australia's zone for squid jigging as well as trawling and gill netting for certain demersal and pelagic finfish and sharks.

Before efforts were made to expand the fishing industry, Taiwan was a net importer of fishery products, particularly salt-dried and canned products. Exports began rising in 1959 as frozen tuna began to be marketed internationally. In 1963, large volumes of frozen shrimp exports further expanded Taiwan's total value of fishery exports. In 1976, the total value of Taiwan's

fishery exports was U.S.\$340 million, more than seven times that of imports.

Fishery exports generating the most revenue for Taiwan in 1977 included fresh and frozen saury, fresh and frozen eel, and dried and smoked stone bream and eel. Japan was clearly the major market for Taiwan's seafood exports in 1977, although Hong Kong and France were also important buyers.

Major imports for 1977 were salted and dried squid and cuttlefish, fresh and frozen squid, and salted and dried sea blubber. A large share of the imports were from South Korea, Japan, and Argentina.

Taiwan's domestic fish market has been well protected by a system of heavy import tariffs on fishery products. In 1976, tariffs ranged from 65% of value (roes, salted herring, dried squid, fresh and frozen shrimp, prawns, and lobsters) to 130% (sharks' fins, bicho de mar). We do not know whether these have been reduced since that year. Fishery products imported by Taiwan for processing and resale are duty free.

Singapore

Singapore's role in the international seafood market is apparent from the basic data each year. For example, in 1978, total landings of fishery products were 16 124 t; total exports in that same year were 57 271 t and imports were 104 273 t. Given that the volume of exports was more than 3.5 times that of landings, importing for resale abroad (perhaps after processing) appears to be an important activity for Singapore.

Although the country's 1978 landings were larger than those of the previous year, total landings have been declining gradually since 1973. Major species for Singapore in 1978 included fusiliers, natantian decapods, and threadfin breams.

In 1968, Singapore's fleet numbered about 1700 licenced vessels, of which about 85% operated in coastal waters either without power or with outboard engines. The remaining 15% of inboard-engine powered boats harvested 75% of Singapore's total catch.

Joint ventures and foreign investment in Singapore's fishery include a Soviet investment of U.S.\$12 million for a processing and storage complex in Jurong.

Singapore's top-valued export in 1977 was freshwater aquarium fish, the bulk of which was domestically produced (96%) and destined primarily for the U.S., West Germany, the U.K., and Australia. The second-highest export by

value was fresh and frozen prawns, and 55% of the total value was domestically produced. Japan was the major purchaser of these prawns, with the U.S. and Australia also being important markets. Marine fish exports (excluding tuna) went primarily to Japan in 1977, as was the case for fresh and frozen molluscs (excluding oysters).

Singapore's four top-valued imports in 1974 were: fresh and frozen marine fish (excluding tuna), canned horse mackerels, canned sardines, and dried and salted sharks' fins. The USSR and Malaysia supplied 60% of Singapore's total value of imports of marine fish (excluding tuna). Japan's share of horse mackerel imports was 94% of the total value. Major suppliers of Singapore's salted and dried sharks' fins included Japan, India, Korea, and Sri Lanka in 1974. Japan was also the primary country of origin for Singapore's imports of canned sardines in that year.

Malaysia

Total landings of fishery products in Malaysia in 1978 were 685 107 t, of which 83% were harvested on the Malaysian Peninsula, 6% from Sabah, and 11.3% from Sarawak. Major species for the country in terms of volume included blood cockles, Indian mackerels, and russell's scad. Although Malaysia's total production fell in 1975, the 1978 landings represented a 194% increase over those of 1967.

In 1974, there were about 29 000 fishing vessels in Malaysia, of which 61% were powered with inboard engines, 18% had outboard engines, and 21% were nonpowered. The fishing industry of Malaysia employed some 81 000 in that same year, about 23% of the country's total labour force.

The country's total value of fishery exports fell in 1977 from the previous year's level; however, the amount represented a 156% increase over the value of exports in 1970. Exports by species for 1974 reveal that fresh and frozen prawns were the number one export that year in terms of total value. Tuna and other marine fish were also leading exports for Malaysia that year. The major markets for these products included Singapore, Japan, the United Kingdom, and the U.S. During 1965, Singapore was clearly the major market for Malaysia's fishery exports, whereas Japanese and U.K. imports of Malaysian seafood products were growing in value.

Except for 1967, Malaysia has been a net exporter of seafood for 1965-77. Japan and Thailand accounted for a large share of the total value of Malaysian imports during 1965-74, although

Taiwan's increasing exports to Malaysia exceeded those from other countries for 1971-73. China began exporting seafood to Malaysia in 1972, although the total from China is a small share of Malaysia's imports.

The top-valued imports for 1974 were fresh and frozen tuna, fresh and frozen marine fish (other than tuna and sauries), prepared and preserved horse mackerel, and fresh and chilled prawns. Taiwan was the source of the largest share of tuna, whereas Thailand supplied 90% of the total value of fresh and frozen marine fish (other than tuna and sauries). Japan's share of Malaysia's imports of horse mackerel was more than 95% of the total value, and fresh and chilled prawns originated primarily in Thailand.

Malaysia's three top-valued exports were also its top-valued imports. This suggests the possibility that imports are processed for export, although no data on resale abroad are available to verify this hypothesis.

Indonesia

Indonesia's total fish and fishery products were 1.7 Mt in 1978, having followed an increasing trend over the past 10 years. Freshwater species from inland waters (including aquaculture) accounted for 21% of this total production. The species landed in greatest volume in 1978 included scads, natantian decapods, Indian mackerels, and anchovies.

The Indonesian fleet consisted of 284 707 vessels in 1972, of which only 2.6% were powered. The number of powered vessels has been increasing, however, through various domestic and international fishery modernization projects. Employment in the fishing fleet was nearly 900 000 workers in 1971, with an additional 350 000 persons employed in inland fisheries.

Indonesia's underutilized fishery resources present a significant potential for development, thus attracting domestic and foreign public aid, as well as private foreign investment. In 1972, 13 fishing and processing ventures involved private foreign companies; 11 of these were backed by Japanese firms (total investment, more than U.S.\$13.5 million). In November 1980, a Norwegian consortium of firms announced plans to establish a large Indonesian tuna venture. More than U.S.\$200 million was invested in Indonesia's fishing industry during 1969-75, 48% coming from the government, 35% from foreign sources, and 17% from private domestic enterprises.

Indonesian imports increased by 322% in volume and 845% in value from 1970 to 1977, and exports increased by 300% and 2704% in volume and value, respectively. The average price of imports was U.S.\$0.574/kg in 1977, whereas the average price of exports in that same year was U.S.\$3.16.

In 1958-77, crustaceans and molluscs clearly took the lead, in both value and quantity terms, in Indonesia's exports of fishery products. The top-valued exports for 1978 were shrimp and prawns, which constituted 88.2% of the total value of exports in that year, and were primarily shipped to Japan. In contrast, tuna exports, second-highest in value, were primarily destined for the U.S. and Singapore. U.S. imports of fishery products from Indonesia in 1978 were more than 36 times the volume imported in 1970.

Indonesia's imports of fishery products in 1977 were 15 630 t, valued at U.S.\$8.98 million. These imports were 32.3% of the volume and 5.9% of the value of exports for that same year. Fresh and frozen saltwater fish and dried, salted whole fish were the seafood products imported at the greatest volumes in 1978. The major suppliers of these products were Singapore, Japan, Thailand, and the U.S.

Hong Kong

Total production from fisheries for Hong Kong reached 162 498 t in 1978, rising steadily for the previous 8 years. The major species landed in 1978 included threadfin breams, natantian decapods, scads, and pike congers. The small country's access to distant fishing grounds, particularly the South China Sea, has been curtailed by the imposition of 200-mile EEZs in these waters.

In 1967, its fishing fleet consisted of 6814 vessels, with about 56 000 persons actively engaged in fishing. The composition of the vessels in the fleet was 865 long liners (13% of total fleet), 826 purse seiners (12%), 1913 trawlers (28%), 2142 gill netters (31%), and 1068 miscellaneous fishing vessels (16%).

Hong Kong's 1978 exports of fishery products were more than four times those of 1970 by volume, and the value increased more than eight-fold over the same period. The highest-valued exports, in 1979, were marine fish, prawns and shrimp, cuttlefish, other crustaceans, and aquarium fish. Japan is clearly the major destination for Hong Kong's fishery products, although the U.S. and Canada also account for large shares of exports.

Whereas exports represent Hong Kong's sale of domestically produced fishery products, resales abroad are seafood products that are imported, sometimes processed, and then exported. The country's total resales abroad of fishery products in 1978 were nearly 80% by value of total exports. Average price/kg of resales for that year was U.S.\$5.55, the corresponding figure for exports being U.S.\$3.75. The difference indicates resales were processed fishery products. The four top categories for resales in 1978 in terms of total value were prawns and shrimp; dried, salted cuttlefish; dried, salted shark fins; and dried, salted abalone. Japan and the U.S. were major purchasers of Hong Kong's exports and resales, although a large share of the salted and dried products was sold to Taiwan and Singapore.

A significant portion of imports into Hong Kong is destined for processing and export. Of the 89 438 t of fishery products imported by Hong Kong in 1978, 11 826 t (or 13%) were exported. Its imports of seafood products have followed an upward trend. However, they are not rising as rapidly as exports. The average price/kg for imported fishery products was U.S.\$2.85, considerably lower than that for exports.

Philippines

The total catch of the Philippines has risen steadily since 1955. The 1978 harvest of 1588 t represented a 65% increase over the volume of production 10 years earlier. Major species landed in 1978 included scads, milkfish (aquaculture), ponyfishes, anchovies, and freshwater molluscs.

The Philippines' fishing fleet in 1978 consisted of 214 797 vessels, of which 62% were nonpowered. The total number of fishing personnel in that year was 365 388.

The government of the Philippines declared its 200-mile limit 11 June 1978, causing considerable conflict with its neighbour to the north, Taiwan. Several areas and species within the Philippines' jurisdiction are believed currently to be underexploited, and, thus, with investment, the total production may increase.

The fishing industry in the Philippines has been enhanced by domestic and foreign investment projects, both public and private. In early 1979, the government announced plans to establish five additional fishing port and market complexes with a loan from Japan of U.S. \$180 million. A joint project financed with local funds as well as Norwegian aid and export credits was planned in 1979. The goal of the project was the

establishment of a processing plant and landing jetty in Leyte province. The Asian Development Bank lent U.S.\$18 million to continue a project aimed at developing the small-scale fisheries sector in late 1979.

During 1961–76, the country was a net importer of fish. This trend was finally reversed in 1977, exports growing by 189% in volume from those in 1961 and imports falling by 40% in volume. Canned seafoods were the most popular imported fishery product, accounting for 91% of the total value of imports in 1970. Mackerel is the major imported canned seafood, Japan being the primary supplier during 1964–70. Fish meal was also an important import for the Philippines over these years, originating primarily in Peru.

Shrimp and lobster were the top-valued seafood export for the Philippines in 1970, amounting to 62% of the total value of exports in that year. Fresh, chilled, and frozen tuna were also important.

Japan's share of shrimp exports from the Philippines in 1970 was, at 65%, the largest of all importing countries. The greatest share of tuna exports went to the United States — 70% of the total value.

South Korea

South Korean landings of Alaska pollack were 361 871 t in 1978. Other important species included Japanese anchovies, threadsail filefish, the Pacific cupped oyster, and groundfish.

Total production of South Korean fisheries hovered around 250 000 t, during postwar 1944–55. Since then, catch has risen steadily, enhanced since the early 1960s by efforts to modernize and expand the industry. South Korea's 1978 total catch was 2.4 Mt, nearly 3% less than that in 1977, yet representing more than 2.5 times the catch 10 years ago.

The South Korean supply of pollack was curtailed when the USSR extended its fishery jurisdiction to 200 miles, ending South Korea's harvest along the Kamchatka Peninsula. The Korean Marine Industrial Development Corporation negotiated a joint venture with the U.S. to supplement its pollack catch by harvests from the Bering Sea. Fishing finally began in 1979, with a total processed product of nearly 1.4 million kg/year. Other joint ventures have been with Ghana and Australia.

South Korea's fishing fleet varies from small, unpowered wooden vessels to large, modern distant-water vessels with steel hulls. In 1973, the high-seas fleet comprised 552 vessels. These ves-

sels produced 382 800 t of fish in 1973, 31% operating in the Atlantic Ocean (primarily off the western coast of Africa), 20% in the Indian Ocean, and 48% in the Pacific.

The country's deep-sea catch fell by 18.6% in 1977, as its fishing grounds were curtailed by the newly declared American and Soviet 200-mile EEZs. The deep-sea fleet, which in 1978 was composed of 860 vessels, has been pursuing other fishing grounds through joint ventures.

South Korea was a net exporter of seafood products during 1970–78, as the total value of exports rose by 1423% over those years. Its top-valued fishery exports in 1978 were frozen tuna, frozen fish fillets, frozen cuttlefish, frozen hard clams, and fresh chub mackerel. Japan was the greatest buyer of the products other than the frozen fillets and, along with the United States, has always been a major market for South Korean fishery exports.

The Middle East appears to be a new and growing market for South Korea's fishery exports. In 1967, Syria and Iran were the only significant importers of South Korea's seafood products. By 1978, Oman, Bahrein, Kuwait, Jordan, United Arab Emirates, Saudi Arabia, Qatar, North Yemen, Sudan, Libya, and Iraq were also importing large shares of South Korea's dried, salted, and in-brine fish, crustaceans, and molluscs. South Korea has also expanded its markets in Africa. In 1967, export schedules noted South Africa and Ghana as importers of South Korean seafoods, but, in 1978, African buyers included Kenya, Mauritania, Senegal, Central African Republic, and Guinea.

South Korea protects its domestic seafood market through tariff and nontariff barriers to trade. Nontariff barriers are similar to those in Japan, with certain products subject to government approval. The government considers domestic supply and demand for the seafood item, and its import price, before deciding whether or not to allow imports. The country also uses export barriers designed to stabilize its domestic seafood market by restricting exports of domestically consumed species. In late 1978, the Office of Fisheries relaxed export restrictions on 10 kinds of fish.

Australia

Australian landings of fishery products in 1978 were 122 947 t, down slightly from the previous year's level. Major species included natantian decapods, southern bluefin tuna, and Australian

spiny lobster. Crustaceans, particularly prawns and rock lobsters, are important to Australia's fisheries; for the year ending June 1979, crustacean landings accounted for 67% of the total exvessel value of landings.

Australia's 1978 fishing fleet consisted of 10 920 vessels (an increase of 23% over the 1970 level), of which 51% were less than 6 m long, 40% between 6 and 15 m, 9% between 15 and 26 m, and less than 1% more than 26 m. The total number of fishing personnel reported in 1978 was 20 272, up 30% over the 1970 level.

The government of Australia imposed a 200-mile EEZ on 1 November 1979, establishing the world's largest exclusive fishing zone at that time. Numerous foreign licences, joint ventures, and foreign stock-assessment projects have been allowed in Australian waters. In 1980, Japanese, Korean, Taiwanese, Polish, Soviet, and American vessels were involved in squid jigging, trawling, and tuna purse seining in the Australian EEZ.

During 1970–78, Australia was a net exporter of fish in all but 2 years. Total exports in 1978 reached 25 262 t valued at U.S.\$165 743, an increase of 44% in volume and 274% in value over exports in 1970. Imports approached 125 t in 1972, followed by a sudden drop of 50% the next year. The 1978 level of imports was the lowest volume for 1970–78, but the value was the highest.

Data on imports by species reveal that the import of greatest total value in 1978 was fish fillets in packages larger than 1 kg; these were primarily from Japan, although New Zealand and South Africa were also major suppliers. Canned salmon imports represented the second-highest value in 1978, 88% (by value) of these originating in the U.S. and Canada. China supplied nearly 50% of Australia's imports of shrimp and prawns. New Zealand is an important supplier of fresh and frozen fish for Australia, and a great share of canned and prepared crustaceans and molluscs originates in the South China Sea countries.

The top-valued seafood export for Australia in 1978–79 was rock lobster tails, of which more than 97% (by value) were shipped to the U.S. Headless prawns and shrimp, another important export, were primarily destined for Japan (97% by value of total sales), and, in general, Japan is Australia's major customer for seafood products.

A comparison of 1969–70 export data for Australia with those for 1978–79 reveals interesting trends. The Middle Eastern countries — particularly Saudi Arabia — are increasing their seafood

imports from Australia, and the volume of imports into Pacific-area countries (excluding the U.S. and Japan) from Australia does not appear to be declining.

New Zealand

New Zealand's total seafood production reached 98 000 t in 1978 at a value of nearly U.S.\$51 million. Rock-lobster landings were up 7% over the previous year and accounted for 28.3% of the total exvessel value of New Zealand fishery production. Snappers were also important species for New Zealand in 1978, with catch up 41% over the 1977 level and exvessel value amounting to 19% of total landings.

The total number of fishing vessels in New Zealand's fleet was 5430 in 1978, up 63% since 1972. The fleet was composed in this year of 88% vessels less than 12 m long; 11%, 12–27 m long; and 1%, greater than 27 m. The number of personnel rose by 79% from levels in 1972 to 9928.

The government of New Zealand declared a 200-mile EEZ on 1 April 1978, establishing exclusive fishing rights over an area more than 3.6×10^6 km². In 1979, New Zealand's domestic fleet had the capacity to harvest an estimated 25% of the "safe biologic yield" of wet fish in the EEZ. The remainder was allocated to joint ventures and foreign fleets. By 1979, Korea, the Soviet Union, and Japan had signed agreements with the government of New Zealand.

Foreign catch allocations announced 30 November 1979 covered finfish, squid, and tuna. Japan's fleet in New Zealand's EEZ amounted to 202 vessels in 1979, whereas Korea had 31 and the USSR 30. Total quotas were 90 900 t for Japan, 82 800 t for the USSR, and 21 200 t for Korea. Twenty-eight cooperative fishing ventures were approved by the end of 1979, directed at squid, southern bluefin, skipjack tuna, and various finfish species.

New Zealand was a net exporter of fishery products during 1970–79, as exports grew by nearly 400% in value and imports grew by 154%, with a brief peak in 1974. Rock lobsters accounted for 27% (by value) of total seafood exports in 1979, down from its 40% share in 1978. Most of the increase in export sales in 1979 over the previous year reflected the growth in landings and value of wet fish. Snappers were the most important of these, their sales amounting to 10% of total exports. Australia and Japan are the primary importers of New Zealand's fresh and frozen fish, whereas Japan and the U.S. take a large share of New Zealand's molluscs and crus-

taceans. Australia is also an important buyer of dried, salted, smoked, and brined fish.

New Zealand's imports of seafood products rose slightly in 1979, with most increases in frozen fish, canned salmon, herrings and pilchards, and canned and frozen crustaceans and molluscs. Fresh, chilled, and frozen fishery product imports in 1974 came primarily from Australia and the United Kingdom, canned and prepared fish originating largely in Canada, Japan, and Malaysia.

Canada

Canada's fisheries can be divided into the Pacific, the Atlantic, and the freshwater areas. In both volume and value of catch, the fisheries of the Atlantic coast contribute the largest share by far. Major species harvested there include cod, herring, other groundfish, and pelagic species. Lobsters and scallops also generate substantial revenues at the exvessel level.

On the Pacific coast, landings have fluctuated in the past 25 years. In value, salmon has been dominant, accounting for 48% of landed value in 1979 and for more than 60% in 18 of the 25 years to 1979. Herring, especially the roe, experienced substantial growth during the 1970s.

Canada is a net exporter of seafoods, with the United States being the principal market. Japan's share of Canadian exports increased significantly during the 1970s and, in 1978, surpassed that of the European community. The role of the Caribbean countries has declined on a relative basis. Australia and New Zealand are importers of Canadian products and, since 1972, so is South Korea.

In 1955, Canada's import-export ratio for seafoods, in value terms, was 1 : 10. By 1970, it was 2 : 10, and, in 1975, it was up to 3 : 10. Since then, it has declined somewhat, but Canada continues to import substantial volumes of both finfish and shellfish, in canned, fresh, and frozen forms. The United States is the major supplier, with Japan in second place. In 1978, other Pacific-area suppliers accounted for 8% of Canada's seafood imports, in excess of supplies from all of Europe and greater than 60% of Japan's share. Shellfish is the primary import from these countries.

The Canadian government has, especially since World War II, provided technical and financial assistance to both its harvesting and its processing sectors to encourage new product lines and new species' exploitation. This assistance has ranged from price supports to vessel

programs. In 1964, there were 47 508 fishing vessels in Canada's fleet, of which 157 were 150 t or more. By 1978, the total had declined to 37 992, but the number of large vessels had increased by almost 100%. During the same period, personnel (saltwater fishing) increased by about 5%, whereas between 1964 and 1977, the number of persons working in fish processing plants increased by more than 45%.

The Canadian fleet does not engage in distant-water fishing, except for tuna. However, Canada is involved in fishing projects abroad, including at least one joint venture in the South Pacific.

Fishing by foreign fleets is substantial off both Canadian coasts. Since Canada's EEZ took effect in 1977, this activity has declined, but the decline has been accompanied by increased investment in both harvesting (for example, through joint ventures) and processing. In 1978, Japan was the source of most foreign investment in the British Columbia processing industry, with U.S. companies also having substantial interests.

The Canadian government has a history of involvement in the management of its fisheries. The 95% decline in the Pacific herring catch between 1965 and 1968, for example, resulted from a ban on herring fishing, although, initially, the decline was offset by increased catches of Atlantic coast herring. Management of Pacific salmon has involved agreements with the U.S., Japan, and the USSR, programs restricting fishing efforts, and a massive enhancement program.

In summary, Canada, with active government participation in investment and management, remains one of the world's leading seafood exporters but has also expanded its role as an importer.

USA²

The U.S. has fish resources along its west coast, the Gulf of Mexico, the Atlantic coast, and in fresh water. Tuna is the primary species harvested by a distant-water fleet.

In 1950, the U.S. commercial catch was 2.2 Mt. In 1975, the figure was also 2.2. During the next 4 years, it rose to 2.8 but was only 4% of world commercial catch, compared with 10% in 1950. The 1979 catch was dominated by menhaden (41% of total landings, by weight), which is used largely for industrial purposes. In terms of value, the most important seafood species groups are salmon, tuna, shrimp, and crab. Because the

major tuna species are distributed throughout the tropical and temperate regions of the Pacific, Atlantic, and Indian oceans, most tuna fishing is done outside the U.S. EEZ.

The U.S. is a net importer of seafoods, with Canada being the major supplier. South America and Europe have increased their roles as suppliers of edible seafoods over the past decade. Asian countries accounted for 26% of U.S. imports (edible) in 1967 and 23% in 1980, with Japan being the major Asian exporter. Import growth has occurred most prominently in frozen ground-fish products, tuna products, and shrimp.

The U.S. also exports seafood products, especially high-valued species (salmon, crab, and, recently, roe). Japan is the largest buyer of fish and shellfish, having recently replaced Canada. Asia, excluding Japan, accounted for 3.5% of the U.S. seafood exports in 1967; by 1980, this figure had risen to 15.6%.

Although the U.S. does not have any explicit seafood quota system for any country, there is a general quota on some product forms of fresh, chilled, and frozen white fish and some canned tuna. With respect to tariffs, the U.S. recognizes favoured country status for developing countries, as do other parties to the General Agreement on Treaties and Tariffs (GATT).

With respect to investment, the U.S. increased its fleet size from 72 000 fishing craft in 1955 to almost 104 000 in 1979, with substantial growth occurring on the Pacific coast. During that period, the number of fishing personnel increased from 144 359 to 184 000, whereas the average number of individuals employed in processing facilities declined from 97 825 to 93 100. This comparison conceals the upward trend in processing plant employment since 1970.

Several countries participate in joint ventures for access to resources within the U.S. EEZ and for U.S. access to fish meal in Angola, shrimp trawling off Nigeria and Cameroon, tuna off Ghana, shrimp in Indonesia, tuna off the Philippines and Korea, tuna ventures off Australia, New Zealand, French Polynesia, and Papua New Guinea, and tuna and shrimp in South America. In short, the U.S. is an active fishing nation, involved in international trade.

Conceptual Issues

To our knowledge, there is little empirical work on international trade in seafoods. On the basis of our examination of fishing, investment, and trade patterns in Pacific-area countries, we developed models appropriate to the testing of

²The material in this section draws heavily on an unpublished manuscript by James R. Wilson.

hypotheses regarding relationships between trade flows and resource availability and competitive relationships among suppliers.

The first examines factors affecting the shares of a country's, or region's, imports coming from competing exporters. This market-shares model is a modified, distributed lag version of a model used by Hickman et al. (1977) and Mikesell and Farah (1980); it incorporates relative price variables and catch ratios. The second model is a more standard treatment of supply-and-demand relationships in a system of equations. As in the shares model, emphasis is on a particular importing country's demand for a specific product or group of closely related products. This approach uses a somewhat difficult set of data, including measures of market conditions in the importing country and, on the demand side, does not necessarily differentiate among suppliers. Such a result generates estimates of the price elasticities of import demand and export supply, substitutional relationships among competing commodities, and income elasticities of import demand. It also permits explicit treatment of exchange rates and of other factors believed to influence import and export behaviour, including tariffs, nontariff trade barriers, and transportation costs. In addition, estimated relationships lend themselves to employment in spatial equilibrium models, which permit examination of trade flows among particular countries and regions.

In both models, expenditures for food were found to be highly significant — a finding in earlier empirical studies (Batie 1974; Doll 1972). The models worked satisfactorily, but their usefulness can be improved, and we are attempting this work.

Refinements Needed

Although there may be substantial price competition among seafood-trading nations, our econometric analysis suggests that traditional methods for testing the existence of price competition need to be augmented by more in-depth investigations of the institutional environments within which seafoods are traded. The roles of long-term contractual arrangements, the trade offs emerging from agreements to permit cooperative investment opportunities, and details on product form are among factors needing additional investigation. It appears that these and other factors are more influential in explaining trade patterns than are relative prices.

In the case of shrimp, a test of the hypothesis that the exchange rate is an important variable accounting for export-supply decisions was inconclusive. We are not prepared to reject the hypothesis, but, rather, we suggest that multicollinearity problems disguise causal relationships. Furthermore, a test of the hypothesis that exchange rates are important on the import-demand side was not conducted here.

Trade-Pattern Changes

Trade-pattern changes are occurring among Pacific-area countries. These are intimately linked with investment decisions. Batie (1974) has argued that foreign investments in natural-resource development will occur under conditions of relatively price-inelastic domestic supply conditions. This seems to be occurring with respect to shrimp, where the price elasticity conditions are associated with the conditions of the stocks. It also seems to be occurring where such conditions result from political constraints on availability (e.g., Alaska pollack). Preliminary empirical results suggest that changes in harvesting opportunities are affecting trade patterns.

Pacific-area countries are increasing trade among themselves. There is evidence to suggest that some specialization is taking place, with importation being undertaken for purposes of processing and resale abroad. However, the present phase seems to be one of transition, as adjustments are made to new political arrangements and economic conditions.

For shrimp, changes in expenditures for food (including away-from-home food expenditures) appear to be an important factor in the demand for imports, at least in Japan. This finding is consistent with the hypothesis that, with increased leisure time, families tend to dine out more and, as a result, increase their purchase of seafoods (this tends to confirm a similar finding by Paez, 1980, with respect to U.S. markets).

Competition

The developed economies of Japan, Europe, and North America compete in their demands for certain seafoods. A complete model should take this into account but should also recognize the growing role of the developing countries. Additional empirical work is crucial to an understanding of the workings of international seafood markets. We hope the present paper has provided a preliminary — if modest — introduction to the subject. Interested readers should contact us for additional information on the models.

Discussion

Hak Yong Rhee: I have three brief comments on the paper by Biing-Hwan Lin et al. The first comment is about the desired direction of the study. The authors are trying to explain the changes in trade structure in the fishery industry in the Pacific basin by estimating price responses in a "market-share model" and a demand-and-supply, simultaneous-equations model. The more fundamental issue, however, in my opinion, is the identification of distortions and the magnitude of their effects in the fishery market. If there are market distortions, the identification of the factors causing them is more important for policymakers than trying to come up with information on price responses.

My second comment is a technical one on the market-share model used by Lin et al. The model uses basically two explanatory variables, namely relative price and the so-called catch ratio. The first variable indicates the comparative advantage factor mainly from the demand side, whereas the catch ratio represents the comparative factor from the supply side. What happened in developing countries like South Korea in the late 1960s and in the early 1970s, however, had little to do with either of those variables. The South Koreans exploited the profitability that existed in the fishery industry because of low wages. As soon as the developing countries obtained access to world capital for securing fishing vessels and fishing technology, they began to move into distant-water fishing. Thus, it seems to me, the relevant variable from the supply side is the wage differentials between the developed countries and the developing countries. Wage differentials may even be more important in the simultaneous-equations model than in the market-share model because wages are one of the shifting parameters of the supply curve.

My third comment is concerned with the imposition of the 200-mile fishing zones. The authors conclude that the new EEZs will have tremendous effects on the trade structure in the Pacific basin. In the analytical model, however, the effect of the fishing zone is not dealt with at all.

This fact brings me to the issue of the problems related to the 200-mile fishing zones. The restriction of exploitation of fish stocks has a strong theoretical base in the literature on the problems

of externalities. The important issue, however, is the efficient allocation of access to restricted stocks. The authors point out that, since the imposition of the fishing zone, many coastal countries have increased investment in fishing vessels as well as processing facilities. If these investments are taking place with artificial barriers in the industry, the coastal countries are, in fact, misallocating resources and will, thus, have to face adjustment problems later. Thus, it seems to me, an orderly market for allocation of access to fishing zones should be developed. The economic rent collected from the market should be allocated in such a way that the countries concerned are properly represented in the allocation decisions.

Yoshiaki Matsuda: The country-by-country examination by Biing-Hwan Lin et al. of trade in 15 Pacific-area countries is informative and their call for more attention to relative prices, exchange rates, food expenditures, and resource-management patterns in econometric analyses is reasonable. However, the theme of their paper — trade and investment in fish products among Pacific-area countries — is broad and implies details about:

- The economic feasibility of fisheries;
- The reasons for changes in trade and investment patterns of fish products;
- The reasons for investments in production, processing, and marketing in fisheries;
- The ways that investment has been handled and rewarded;
- The consequences of investments; and
- The roles of government in fisheries.

Just using available statistics is certainly not sufficient to provide readers with an understanding of these aspects. I believe that most participants in the UN law of the sea conferences do not know these aspects, and most coastal nations now believe in economic viability of fisheries development. However, reality is different from aspiration. In fact, the economic feasibility of fisheries production is not vital. Without heavy government support, the Japanese fisheries would not exist. Even the tuna industry in Japan belongs to the welfare sector.

As the paper points out, this is a preliminary study, and in-depth study is essential, especially on the roles of long-term contractual arrangements, the trade offs emerging from agreements to permit cooperative investment opportunities, and details on product form.

With respect to the importance of long-term contractual arrangements, I would like to bring to your attention the Solomon-Taiyo Skipjack Fisheries Joint Venture, one successful skipjack joint venture in the southwestern Pacific. After 1.5 years preliminary feasibility study by Taiyo Gyogyo, Japan, this joint venture was founded in 1973. It is said that at least 10 years is needed for such a joint venture to become profitable. Unlike short-term contracts that reflect investors' fear of political and economic instability such as nationalization or discontinuation, the Solomon-Taiyo venture is a 10-year contract. The joint venture is long enough to allow its partners to coordinate resources effectively. The problem of ensuring a supply of bait (one of the most serious problems in skipjack pole-and-line fisheries) has been successfully solved in the contract by a clause to include Okinawa fishermen, and the problem of reaching an appropriate market has been solved by a clause to use the Taiyo Gyogyo network. Two-thirds of the crews are natives, and technology transfer problems have been solved by the reliance on Okinawa fishermen who are capable of working with natives in the tropics. About 20 of the best local participants a year are given the opportunity to visit Japan for a month in winter, and people with supervisory potential have been encouraged. The second 10-year contract has been signed.

Regarding the trade offs emerging from agreements to permit cooperative investment opportunities, I would like to introduce a study from the East-West Center in Honolulu entitled: "A strategic goal analysis of options for tuna longline joint-ventures in Southeast Asia: Indonesia-Japan case study." With the advent of extended maritime jurisdictions, new arrangements have been, and will be, sought between fisheries-resource owners and distant-water fishing fleets. Each party in a joint venture wants to exploit the fishery, and each has strengths and weaknesses in doing so. The purpose of this study was to develop a logical process to identify arrangements that are fair and profitable for both parties. As a case study, my colleagues and I examined conflicts and agreements between Indonesia and Japan for exploiting Indonesia's tuna fishery. Forty-eight possible arrangements between the two countries were evaluated by a

multinational, multidisciplinary team employing goal analysis, an optimization technique for dealing with multiple objectives. This study found many agreements in which the two countries can share in efficient and profitable fishing, processing, and marketing operations.

Finally, with respect to details on product form, I would like to point out that the developed economies of Japan, Europe, and North America are not necessarily competing demanders of certain seafoods. For example, market differentiation between Japan and other countries is certainly clear. So-called international items, such as tuna, salmon, and shrimp, that are sought by consumers in the United States or Europe are often irrelevant to Japan. In many cases, fisheries trades are complementary rather than competitive. An understanding of tastes and preferences among different people, countries, and regions is needed as a basis for production planning. The impact of changes in exchange rates on trade patterns may be clear in a long-term trend study; however, I feel that short-term studies may be equally or more fruitful.

I agree with the contention by Lin et al. that some specialization is taking place, with imports being processed and resold as exports. However, I believe that production, processing, and marketing should be integrated. If one does not consider economic feasibility and income distribution problems among these three activities, the risk is that inequality will be the result and political uncertainties will increase. In the past, income distribution in fisheries was favourable for the processing and marketing sectors and was unfavourable for the production sector — that is, the production sector has less bargaining power than the other two sectors at both resource and product markets. Fisheries policymakers need more studies on structural changes in each sector, interactions among these three sectors, and functional changes of participants.

With regard to the importance of changes in expenditure for food on demand, I would say that generalizing on correlations in the future is difficult, at least for Japan, because the relative price for shrimp is high. Before 1979, imports of fisheries products to Japan increased yearly, but imports of squid, shrimp, and tuna decreased in 1980 because of the prolonged low domestic prices in Japan. Japanese consumers are eating meat rather than fish because the prices of imported fish are too high and the quality (taste and appearance) is not acceptable.

In conclusion, I would like to emphasize that fisheries development is vital for coastal nations only if it is managed wisely.

Pacific Trade and Investment in Forest Products

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Trade and investment in forest products among Pacific-area countries have increased more slowly in the last 10 years than in the preceding decade. However, growth in production and exports from many developing countries of the area has been greater since 1969. For Pacific countries as a group, four related factors have primarily influenced recent growth in forest-products trade and investment. First, world economic conditions in the aftermath of the oil-price increases of 1973 and later years have resulted in slower growth in principal end-use markets for forest products, e.g., housing construction, industrial packaging, printing and publishing. Second, manufacturing costs have risen sharply with the direct inflationary impact of higher oil prices on wood, energy, and capital costs and their indirect impact on labour costs. Third, capital costs of minimum economic plant size, mainly in the capital-intensive, pulp-and-paper industry, have escalated to the point where "greenfield" investments are rare. Finally, the availability of other sources of low-cost timber has diminished. For some developing countries of the Pacific, higher growth has resulted from increased domestic demand associated with industrialization and from expanded manufacturing capacity to process existing mature-timber reserves or fast-growing plantation forests. Further restructuring of forest-product trade and investment is implied by these developments and by regulation of raw-timber exports to recover greater revenues from forest resources and to capture industrial benefits of increased domestic processing of indigenous timber resources.

L'accroissement des investissements et du commerce des produits forestiers entre les pays de la région du Pacifique a été moins rapide au cours de la dernière décennie que pendant la précédente. Cependant, plusieurs pays en développement de cette région ont accru leur production et leurs exportations depuis 1969. Pour l'ensemble des pays, les quatre facteurs suivants ont principalement contribué au ralentissement de la croissance de ce secteur : premièrement, la situation économique mondiale, après l'augmentation du pétrole en 1973 et au cours des années suivantes, a freiné la demande des principaux marchés des produits finis tels que la construction d'habitations, le conditionnement, et les pâtes et papier. Deuxièmement, les coûts de fabrication ont accusé une hausse marquée, cause directe de l'impact inflationniste produit par l'augmentation du pétrole sur le bois, l'énergie et les coûts du capital qui se sont répercutés sur les coûts de la main-d'oeuvre. Troisièmement, le coût en capital de l'établissement de petites usines, surtout dans l'industrie papetière à forte proportion de capital, a augmenté au point de freiner le développement de ce secteur. Enfin, la disponibilité des autres sources de bois de construction à bon marché a aussi diminué. La croissance enregistrée dans certains pays en développement de la région du Pacifique provient de l'augmentation de la demande domestique associée à l'accroissement de l'industrialisation ainsi que de l'extension de la capacité manufacturière au traitement des peuplements en réserves ou des plantations d'essences à croissance rapide. Il s'impose de restructurer le commerce et les investissements dans ce secteur et de réglementer les exportations de bois brut afin d'augmenter les revenus provenant des richesses forestières et des nouvelles capacités de traitement industriel.

The countries of the Pacific area produce and consume most of the world output of industrial wood and wood products. They also import about 44% and export some 52% of all forest products traded on world markets. Intraregional trade dominates the pattern of world trade in

Table 1. Value-added (\$U.S. million) in forest-products industries in selected Pacific-area countries, 1977.

	Wood	Paper and allied	Total value-added (%) of value-added in all manufacturing
Australia	859	573	6.7
Canada	2594	3732	14.9
Chile ^a	0.07	0.15	6.7
Colombia ^a	24	101	4.0
Ecuador ^a	13	18	5.4
Indonesia	62	34	5.2
Japan	6085	6410	5.9
Malaysia ^b			
Peninsular	92	9	11.1
Sabah	6	-	40.6
Sarawak	20	-	49.4
Mexico ^a	121	376	na ^c
New Zealand ^a	158	151	11.1
Papua New Guinea	18	7	15.8
Peru	63	102	4.6
Philippines	71	89	9.1
Singapore	57	19	4.1
United States	12190	21880	5.8

^aData are for 1976.^bData are for 1974.^cna = not available.

Source: Various yearbooks of industrial statistics from the UN.

forest products from these countries. The capacity to supply major shares of domestic and international markets has resulted in part from large investments in timber-processing plants and equipment. For example, 68% of world capacity to produce paper and paperboard and 73% of world wood-pulp capacity were located in Pacific countries in 1978. The combined benefits of foreign-exchange earnings from forest-products trade and value-added and employment from forest-product investments continue to contribute significantly to meeting the broad economic and social-development objectives of many countries in the region.

Forest-Product Industries

Industries in Pacific countries produce 77% of the world output for coniferous roundwood and 67% of its nonconiferous wood output for industrial use. They also account for more than half of the world production of pulp, paper, lumber, and wood-based panels. The potential to maintain or increase shares of the world's output of forest products depends on the relative cost and avail-

ability of industrial inputs in the respective countries, e.g., labour, capital, energy, and forest resources.

Most countries of the area actively pursue the objective of increased domestic processing of their forest resources and primary wood products prior to export. A major benefit of domestic processing is the value added to the resources originating in the forest industries. Among Pacific-area countries, for which comparable data are available, value-added in the forest industries has varied from 4% of that in all manufacturing in Colombia in 1976 to about 49% in Sarawak in 1974 (Table 1). For most countries, the share exceeded 5% in 1976. In all countries other than those of Oceania, Indonesia, and Singapore, value-added in the paper and allied industries was greater than that in the wood industries, partly because of the greater degree of processing in the former.

A closely related industrial benefit is the direct employment generated by the manufacture of forest products. The forest-products industries in

Table 2. Employment (1000 persons) in forest-products industries in selected Pacific-area countries, 1977.

	Wood	Paper and allied	Total forest-products employees (%) of all employees in manufacturing
Australia	50	28	6.7
Canada	109	123	13.6
Chile ^a	13	7	9.1
Colombia	8	11	4.2
Ecuador	3	2	7.1
Indonesia	40	9	6.2
Japan	451	288	7.3
Malaysia ^b			
Peninsular	38	3	16.1
Sabah	2	-	35.5
Sarawak	8	-	53.8
Mexico	5	27	na ^d
New Zealand ^a	14	10	9.1
Papua New Guinea	4	1	29.5
Peru ^c	5	5	4.7
Philippines	42	15	8.4
Singapore	9	4	5.9
United States	523	627	6.2

^aData are for 1976.^bData are for 1974.^cData are for 1973.^dna = not available.

Source: Various issues of the yearbooks of industrial statistics of the UN.

the region accounted for a low of 4.2% (Colombia, in 1976) and a high of 53.8% (Sarawak, in 1974) of all workers involved in manufacturing (Table 2). For most countries in the region, the proportion is greater than 6%. Furthermore, domestic processing creates indirect employment in industries supplying services and equipment to the forest-products industries and employees.

Increased export earnings are often ranked as a greater priority in the development of trade and investment strategies than are value-added and employment. Canada and Asia-Pacific countries other than Japan, China, and the USSR were the principal net forest-product exporting countries in 1979 (Table 3). Leading net importers were Japan and the United States; outside the Pacific area, countries of the European Economic Community were major importers.

Table 3. World forest-products trade (U.S.\$ million), 1979.^a

	Exports	Imports
Pacific-area countries	23574 (52)	23746 (44)
Canada	8151	586
United States	5702	8293
South-Central America	958	1468
Oceania	570	701
Japan	516	8873
China	444	520
Other Asia-Pacific	4675	2703
USSR	2558	602
Europe	20935 (46)	27113 (51)
Other countries	1127 (2)	2603 (5)
World	45636 (100)	53462 (100)

^aFigures in parentheses are percent of totals.

Source: Various issues of the FAO Yearbook of forest products, Rome, Italy, FAO.

Forest Resources and Production¹

The availability of secure supplies of timber at low cost has become a principal factor in determining investments in processing capacity and in efforts to restructure the flow of forest-products trade. In most countries in the area, the growth in industrial wood supplies in the region toward the end of the century promises to be much slower than that of the last two decades for both coniferous and nonconiferous industrial wood production. The exceptions are countries in South-Central America and the Asia-Pacific region (excluding Japan) (Tables 4 and 5).

In Canada, timber harvests of 162×10^6 m³ in 1979, predominantly softwoods, represented about 60% of the estimated annual allowable cut from all forestlands. Although harvests are expected to increase at reduced rates to about 88% of the current allowable cut (256×10^6 m³) by 2000, they may not be sustainable for four reasons: timberlands may be withdrawn from production and reallocated for other uses; second-growth forests may produce reduced yields; natural regeneration rates may be lower than anticipated because of the effects of past logging practices; and the reforestation effort may be less than required (Aird and Ottens 1980).

The United States produces and consumes more industrial wood than any other country. Despite the anticipated shift in importance of internal-supply sources — the shift from the fir forests of the Pacific northwest to the relatively fast-growing pine forests of the South — the U.S. is expected to remain a net importer of wood products in the next 20 years (United States

¹The data in this section have been taken from FAO yearbooks of forest products unless otherwise indicated.

Table 4. World production (10^6 m³) of coniferous industrial wood, 1959–79.

	1959	1969	1979	Average annual change (%)	
				1959–69	1969–79
Pacific-area countries	601	688	765	1.4	1.1
Canada	78	111	146	3.6	2.8
United States	211	238	258	1.2	0.8
South-Central America	15	20	35	2.9	5.8
Oceania	6	10	12	5.2	1.8
Japan	34	28	20	-2.0	-3.4
Other Asia-Pacific	22	28	42	2.4	4.1
USSR	235	253	252	0.7	0.0
Other countries	159	191	232	1.8	2.0
World	760	879	997	1.5	1.3

Source: Various issues of the FAO Yearbook of forest products, Rome, Italy, FAO.

Table 5. World production (10^6 m³) of nonconiferous industrial wood, 1959–79.

	1959	1969	1979	Average annual change (%)	
				1959–69	1969–79
Pacific-area countries	168	227	283	3.0	2.2
Canada	5	7	11	3.4	4.6
United States	60	72	73	1.8	0.1
South-Central America	20	25	40	2.3	4.8
Oceania	9	10	13	1.1	2.7
Japan	9	18	12	7.2	-4.1
Other Asia-Pacific	30	62	102	7.5	5.1
USSR	35	33	32	-1.0	-0.3
Other countries	78	125	140	4.8	1.1
World	246	352	423	3.6	1.8

Source: Various issues of FAO Yearbook of forest products, Rome, Italy, FAO.

Department of Agriculture, Forest Service 1980). Declining inventories of mature timber on private forestlands, slower expansion of allowable harvests from national forests, and withdrawals of forestlands for other uses have combined to reduce the availability of timber from the northwest.

Whereas Japan is the second-largest consumer of forest products in the Pacific, in 1979 it produced only 36% of its industrial roundwood requirements. Although additional supplies are expected from domestic forests replanted in the post-War period, only 43% of consumption is forecast to be supplied domestically by 1996 (Japan, Ministry of Agriculture and Forestry 1978).

The forests of the USSR hold 55% of world softwood reserves distributed over an extensive area. Western and central southern regions have been extensively harvested for internal wood requirements and exports, primarily to western Europe. Exploitation of northern and remote eastern regions has begun and could benefit from the infrastructure for hydroelectric and railway development in those regions, particularly in Siberia, which is a major source of softwood logs and lumber for Japan. The future impacts are difficult to assess as rugged terrain and a severe climate are constraints to extensive forest operations in the remote and sparsely populated eastern regions (North and Solecki 1977).

The countries of the South Pacific, or Oceania, significantly increased their production of industrial wood between 1959 and 1979 from 6×10^6 m³ to 12×10^6 m³ for coniferous wood and from 9×10^6 m³ to 13×10^6 m³ for nonconiferous. This trend is expected to continue and will probably be supported by the large natural forests of Papua New Guinea and the fast-growing radiata pine plantations of New Zealand and, to a lesser

extent, some parts of Australia (de Vries 1978).

The largest increases in industrial wood production among the world regions occurred in South-Central America (from 15×10^6 m³ and 20×10^6 m³ in 1959 for coniferous and nonconiferous wood, respectively, to 35×10^6 m³ and 40×10^6 m³ in 1979). Leading producers of coniferous industrial wood are Brazil, Chile, and Mexico, whereas most nonconiferous industrial wood is produced in Brazil, Colombia, Ecuador, Peru, Costa Rica, and Paraguay. Brazil, with the large natural hardwood forests of the Amazon Basin and the softwood forests of its southeastern region, will continue to be the dominant producing country in this area. The natural forests of South America have been heavily depleted and reduced in area by shifting cultivation in agriculture and by logging practices that are unfavourable to natural forest regeneration. Its large mixed hardwood forests have either been exploited for their most valuable species or are unused because commercial uses, except for relatively few species, have been slow to develop. Potentially large additional supplies are expected from fast-growing, industrial plantations of eucalyptus and gmelina pine, again, mostly in Brazil but also in Chile, Argentina, and Uruguay (Lanly and Clement 1979).

The countries of the Asia-Pacific area, other than Japan, as a group, produced the largest quantities of nonconiferous industrial wood in 1969 (62×10^6 m³) and 1979 (102×10^6 m³). Moreover, production increases in nonconiferous wood in both decades before 1979 were larger than for any other region. Indonesia, Malaysia, and the Philippines were the largest producers. Supplies have been based on the use of dipterocarp species with similar commercial characteristics, e.g., merantis and lauans. Past logging practices, severe depletion, shifting cultivation, and

fuelwood removals have led to dwindling resources, particularly in the Philippines and Peninsular Malaysia. Restrictions have been placed on log exports to conserve resources, to promote further domestic processing of logs, and to produce greater economic rents from the increasingly scarce timber resources.

Trade: Structure, Changing Patterns, and Issues

World exports of forest products in 1979 were valued at U.S.\$46 billion. Pacific countries accounted for 52%, with the balance being exported mostly from western Europe. Among Pacific countries, Canada netted the highest export earnings from forest products — about U.S.\$8 billion — followed by the USSR and Asia-Pacific countries (other than Japan and China) at about U.S.\$2 billion each (UN 1977). Japan, the United States, and, to a lesser extent, South-Central America, Oceania, and China were net importers of forest products. As a result of the growing interdependency among Pacific countries, forest-product trade has been increasing relatively faster than consumption.

The five principal trade flows of forest products among Pacific countries are: first, exports of newsprint, wood pulp, and softwood lumber from Canada to the United States and, to a much lesser extent, a reverse flow of lumber and paper products to Canada; second, exports of logs, lumber, wood chips, and wood pulp from the United States to Japan; third, exports of softwood lumber and wood pulp from Canada to Japan; fourth, exports of lumber and logs from Siberian USSR to Japan; and, fifth, exports of hardwood logs and, to a lesser extent, hardwood lumber and plywood from Southeast Asian Pacific countries to Japan and, in smaller quantities, to the United States and Europe.

Other significant flows of forest-product trade in the region include the export of softwood logs and lumber from New Zealand to Australia and Japan and from Chile to Japan.

Outside the region, western Europe, primarily the European Economic Community, represents an important market for a wide range of products, including newsprint, softwood lumber, and plywood from Canada and the United States, hardwood lumber and plywood from Southeast Asia-Pacific countries.

Newsprint, wood pulp, and softwood lumber account for more than 95% of the value of forest products exported to the United States from Canada. Of these products, about two-thirds of

softwood lumber exports originate from Canada's Pacific coast, i.e., British Columbia, whereas most newsprint and a large proportion of wood pulp exports are produced in central and eastern Canada.

Some restructuring of trade in these products has occurred in the past 20 years. First, the share of newsprint imports from Canada in U.S. consumption has been declining since 1960. Newsprint from new capacity in the southern U.S., based on faster-growing forests and on lower transportation costs to major U.S. markets, has displaced some imports from Canada. Second, the share of softwood lumber imports in U.S. lumber consumption has increased. Depreciation in the exchange value of the Canadian dollar since the mid-1970s has increased the competitiveness of Canadian producers.

Recurring issues in U.S.-Canada trade of forest products involve institutional conditions of market access. First, it is sometimes contended that the Merchant Marine Act of 1920, the so-called Jones Act, which requires that U.S. inter-coastal transport of commercial goods be by U.S. ships, is favourable to Canadian producers who can use lower-cost shipping than can their U.S. counterparts (Austin and Darr 1975). The Act also provides for a subsidy to U.S. producers who use U.S. carriers for shipment to offshore markets.

Much support can be given to the view that Canada-U.S. forest-products trade is largely determined by the structure of tariffs. Newsprint, lumber, and wood pulp are free of tariffs, whereas further processed products, particularly softwood plywood, are not. As a result of the recently concluded Multilateral Trade Negotiations (MTN), tariffs on softwood plywood have been retained by both countries but are to be reduced if and when a common plywood standard for North America is adopted. Only in particleboard and in some grades of printing papers are significant increases in trade expected as a result of the MTN.

Other than U.S.-Canada trade, the major trade flows in forest products in the Pacific consist of imports to Japan. In the last 20 years, Japan has increased and greatly diversified its sources of forest-products supply among countries in the region. Although Japan is expected to remain at the centre of this increasing regional interdependence, two developments will primarily influence the emerging pattern of trade. First, Japan continues to search for new sources of primary or relatively unprocessed wood products. Already it has expanded trade in logs from

the relatively untapped forests of Papua New Guinea. Second, in the face of log-export restrictions from traditional suppliers of hardwood logs, Japan could increase its imports of processed products from new sources, especially as traditional log suppliers develop processing capacity and as plywood production in Korea and Taiwan is reduced.

In 1979, Japan accounted for 71% of world imports of softwood sawlogs and veneer logs. The United States was the source for 64% of those, the USSR 28%, and New Zealand 4%. The Japan-U.S. log trade had its origins some 20 years ago when Japan became an outlet for logs salvaged from the forests of the Pacific northwest after a severe windstorm. Exports increased rapidly until the 1970s when log production in the U.S. was increasingly used for domestic demand. The Jones Act is said to encourage U.S. log exports to Japan by subsidizing use of U.S. ships for shipment to offshore markets while giving an advantage to Canadian west-coast producers by restricting intercoastal U.S. commercial traffic to U.S. ships only. Softwood log exports from the U.S. are expected to remain stable until about 1990 and then to decline primarily because of projected reductions in harvests from the U.S. west coast as industrial timberlands revert to second-growth timber (Darr 1980).

Japan imported 21×10^6 m³ of hardwood sawlogs and veneer logs in 1979 — just under 50% of world imports. Indonesia supplied 44%, Malaysia 50%, and the Philippines 4%. These countries have been the primary traditional sources of hardwood logs, primarily veneer logs to Japan, and growth of industrial roundwood exports from each of these countries was extremely high in the 1960s. In the following decade, growth rates were significantly lower, particularly in the Philippines, because of declining timber stocks. In 1975, representative trade associations established the Southeast Asian Lumber Producers' Association to stabilize the hardwood log market, to promote further domestic processing, to standardize grading, and to promote reforestation. Restrictions were placed on log exports, and the anticipated impact is a reduction in log exports and a restructuring of hardwood trade to include more processed products, particularly plywood from the traditional log-supplying countries.

The industrial impacts of reduced exports of hardwood logs from Southeast Asia are several. First, the Japanese plywood industry is totally dependent on these imports and will probably have to undergo some reduction in capacity or

other rationalization. Second, plywood industries in Korea, Taiwan, and Singapore, which have also been traditionally dependent on imported logs, will also face some contraction in output or capacity. However, Japan may not be willing to remove the 20% import duty on plywood under the General System of Preferences while its industry is undergoing contraction.

Japan is also a major importer of softwood lumber and wood pulp from Canada and the United States. A continuing issue in softwood lumber trade between North America and Japan is the complex and costly grading and inspection procedures used in Japan and the tariff on spruce-pine-fir lumber imports. These restrictions counteract the modest but important recent success attained in gaining Japanese acceptance of North American platform-frame construction techniques that use lumber sizes produced in the United States and Canada.

In 1979, New Zealand was the source of 5% of softwood sawlog imports to Japan, 6% of softwood lumber imports, 4% of pulpwood chip imports, and 12% of wood-pulp imports. Lumber and log imports were primarily whole logs or cants of radiata pine for further processing, about 70% of which were used in packing and only 20% in construction. The underlying issue has been the reluctance of Japanese authorities to accept radiata pine sawtimber for house building. This is viewed as a potentially serious constraint to the development of markets for products from the fast-growing plantation forests of New Zealand, which are predominantly stocked with radiata pine. Exports of pulpwood chips have doubled since they were started in 1970 to meet growing pulp fibre demands in Japan, to allow sawmills to recover additional revenues from processed logs, and to clear forestland for replanting. About 45% of wood-pulp production is exported, again, mainly to Japan. Large additions to capacity, particularly of mechanical pulp, are planned, and some involve joint ventures between Japanese and locally owned firms. Other forest-products trade occurs primarily with Australia, an established market for a wide range of forest products from New Zealand, protected by conditions of the New Zealand/Australian Free Trade Agreement (NAFTA). Small quantities of lumber and other wood products are exported to other Southeast Asian countries, the United States, and the Middle East.

Relatively smaller quantities of forest products, including significant volumes of hardwood products, are imported to New Zealand from Australia, which is a net importer of softwood

products, including lumber, from the Pacific northwest regions of Canada and the United States. Australian demand for softwood products is expected to be met increasingly by domestic timber plantations (de Vries 1978).

Chile is the largest net forest-product exporting country in South-Central America and, together with Brazil, accounted for 80% of export earnings of forest products from Latin America in 1979. Chilean exports of wood pulp, softwood lumber, and softwood sawlogs increased significantly between 1969 and 1979. Other exports of forest products, including paper, paperboard, and hardwood lumber were virtually unchanged. Principal markets for lumber and pulp were other South-Central American countries. Although Korea and Japan were major importers of logs from Chile, they imported relatively small quantities of its wood pulp and lumber. Raw material for the Chilean pulp-and-paper industry is mostly supplied from its radiata pine plantations while more than 50% of the domestic lumber consumption is also produced from plantation timber.

Forest-product demand has been increasing at rates exceeding world increases with the industrialization of major importing countries in the region such as Mexico, Argentina, Brazil, and Venezuela. Moreover, intraregional trade is protected by the provisions of the Latin American Free Trade area. In addition, most countries in this region have placed restrictions or regulations on exports of unprocessed logs. These and other conditions have resulted in rapid increases in regional self-sufficiency in forest products, particularly in newsprint.

Investment

In both major segments of the forest-products industries, capital expenditures in most Pacific countries increased rapidly between 1959 and 1969. Much of this growth continued until 1974 and then declined. In real terms, investment growth was probably sharply reduced after 1974, as rates of price inflation have been significantly higher since then. Even in nominal dollars, fixed-capital investment in both industry segments fell between 1974 and 1977 in Japan and New Zealand, whereas expenditures in the wood industries declined in Canada, the Philippines, and Singapore (Table 6).

The trend to reduced growth in investment in the 1970s can be attributed to five related factors. First, growth in demand for forest products has

been attenuated by the impact of rising energy prices on world economic conditions and, in turn, on major industrial markets such as housing construction, industrial packaging, printing and publishing. World industrial wood consumption increased at 1.8% annually between 1970 and 1980 compared with 3.7% a year from 1960 to 1970.

Second, forest-product prices have increased in real terms during the 1970s compared with stable-to-declining prices, as in the case of newsprint delivered to New York. Real-price increases have encouraged industrial users of some forest products to implement conservation measures or to substitute other materials, such as plastic films and cases for wrapping papers and paperboard boxes, thereby reducing demand.

Third, rising energy prices have resulted in higher manufacturing costs by adding to the delivered cost of wood, purchased fuels, and capital and indirectly by increasing labour costs by their inflationary impact on living standards.

Fourth, costs of maintenance, repair, or expansion of plant facilities in the capital-intensive pulp-and-paper industry have increased rapidly in the 1970s. The increase reflected the impact of higher price inflation on plant construction and new machinery costs but also the expanded minimum economic size of new pulp mills, mostly kraft pulp mills to produce pulps for relatively stronger paper and paperboard products. As a result, new "greenfield" investments have become scarce, and recent expenditures have been directed at modernization or expansion of existing facilities. Recent investments in new pulp capacity have been concentrated in refiner pulping, which produces paper-grade pulps requiring less wood input and a smaller capital investment per tonne of pulp than the kraft process.

Finally, availability of low-cost sources of prime-quality raw material either of temperate or tropical timber has diminished in Pacific countries and in most world regions. Rising wood costs will require substantial adjustment in the sawmill, plywood, and veneer industries where they account for a large share of manufacturing costs. Declining timber quality and additional costs of processing small timber or mixed wood will pose further adjustment problems requiring additional investment. In sawmills, recent investments have been for the installation of equipment systems for processing small-diameter timber and for increased automation, process control, and wood-chip recovery for sale to pulp mills. In wood-based panel industries, new

Table 6. Fixed-capital investment (U.S.\$ million) in forest-products industries in some Pacific-area countries.

	1959	1964	1969	1974	1977
Canada					
Paper and allied	199	294	347	562	715
Wood	55	57	140	293	233
U.S.					
Paper and allied	686	902	1419	2210	3290
Wood	301	362	461	1040	1080
Australia					
Paper and allied	18	26	52	55	78
Wood	15	22	21	66	71
New Zealand					
Paper and allied	6	8	28	94	46
Wood	5	5	10	29	16
Philippines					
Paper and allied	7	1	3	9	15
Wood	5	9	12	16	11
Singapore					
Paper and allied	na ^a	na	2	3	4
Wood	na	na	4	9	9
Japan					
Paper and allied	123	223	417	1142	845
Wood	39	103	172	367	172
Chile					
Paper and allied	na	2	3	2	na
Wood	na	1	1	2	na
Colombia					
Paper and allied	na	3	3	2	na
Wood	na	2	1	1	na
Ecuador					
Paper and allied	na	1	1	2	na
Wood	na	na	na	5	na
Mexico					
Paper and allied	14	18	31	31	na
Wood	6	1	1	5	na
Peru					
Paper and allied	na	1	15	3	na
Wood	na	3	3	5	na

^ana = not available.

Source: Various issues of the yearbooks of industrial statistics of the UN.

investments have increased rapidly in particle-board, particularly waferboard, capacity. Waferboard produced in Canada and oriented strand-board produced in the United States from wood residues or from relatively abundant but currently unused timber species have been rapidly penetrating traditional markets for the large softwood plywood industries of the Pacific northwest regions of Canada and the United States. Lower production costs of the new panelboards based primarily on cheaper raw materials favour continuation of this trend.

The impact on restructuring forest-products investment has varied among Pacific-area countries. For Canada and the United States, rising wood and energy costs have favoured increased investment in energy conservation and in refiner pulping in paper and allied industries, and recon-

stituted panelboard capacity has increased significantly.

In the Asia-Pacific region, Japan had been the leading exporter of tropical hardwood plywood, primarily to the large and growing U.S. market, in most of the post-War period. From the mid-1960s, Taiwan and Korea, aided by industrial-development policies of export promotion and by the appreciation of the Japanese currency, replaced Japan as dominant producers of tropical hardwood plywood. Until then, exports from the Philippines had also increased rapidly, with preferential access to the U.S. market provided by the Laurel-Langley agreement; these dropped because they were unsupported by export-promoting policies. Outside the region, exports to the U.K. and the entire European Economic Community expanded steadily under preferen-

tial access afforded to members of the Commonwealth and as a result of successful market promotion efforts. The traditional role of Japan, Korea, and Taiwan as intermediate processing countries for hardwood log imports from Malaysia, Indonesia, the Philippines, and more recently Papua New Guinea appears to be threatened by the decision of those countries to restrict log exports as a means to increase resource rents from log sales or to benefit from domestic processing. Investment in new or expanded capacity in the hardwood plywood industries of the former group of countries appears unlikely, and a number of problems, including removal of

domestic-market price restrictions and improved shipping and storage facilities, need to be addressed if domestic plywood industries in the latter group are to be strengthened to meet development objectives (Takeuchi 1981).

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Discussion

Kenji Takeuchi: The paper by Aird and Calow reviews the trends and issues in Pacific trade and development of forest products. In my view, these are less pressing than the issues surrounding the overall long-term demand outlook for forest products: the long-term supply of wood and the most efficient utilization of wood. On the issues of long-term supply, there will be a paper by Sedjo on plantations and other papers focusing on the supply issues to be discussed later in the conference.

However, there is one particular issue in trade that is of immediate urgency, especially from the viewpoint of tropical hardwood-producing countries — namely, the issue of local processing of timber. The issue is urgent because tropical hardwood is a semirenewable resource. The exploitation of tropical hardwood today is destructive, and, although foresters worry a great deal about destruction of tropical forests, I, as a development economist, worry more about whether the producing countries are getting the maximum possible benefit from the resources.

Recent developments in the tropical hardwood sector in the Asia-Pacific region suggest that a wholesale restructuring of tropical hardwood trade is under way with global implications. In the last few years, three major traditional suppliers, i.e., Indonesia, Malaysia, and the Philippines, which together account for more than 80% of world exports of tropical hardwood logs, have taken decisive steps to reduce log exports. The measures involve export quotas (or outright bans) and increased government charges (royalties, export taxes, etc.) on log exports. The objec-

tives of the governments are to conserve the semirenewable resources, to collect maximum resource rents from their rich forest resources, and, most importantly, to secure benefits from increased local processing of logs.

Two important features of mechanical wood processing tend to favour the location of such activities in the hardwood-producing areas. These are that the activities are relatively unskilled and labour-intensive and that they reduce the bulk of the raw material and, hence, the transportation costs.

In terms of current policies, major hardwood-producing areas in the Asia-Pacific region are broadly divided into two groups: states attempting to increase local processing of logs and export of products (Philippines, Peninsular Malaysia, Sabah, and Indonesia) and states with liberal log-export policies (Sarawak, Papua New Guinea, and other Pacific islands). Increased processing increases the export value of the logs as well as the local employment opportunities. In contrast, policies to encourage log exports reap immediate foreign exchange.

In this context, I would like to stress that a distinction must be made between two sets of objectives — those for deriving benefits from local processing and those for deriving maximum resource rents from semirenewable resources. The latter set requires careful consideration of the long-term price increases and the long-term growth of standing trees.

A government choosing between the two sets of objectives has to consider the quality of its resources, the level of its technical development,

etc. For instance, Peninsular Malaysia and the Philippines have chosen a policy to phase out log exports completely and to take necessary steps to improve the cost competitiveness of their processing industries. Given their levels of technical development and the demand for their resources, these governments seem to have made an appropriate decision, even though the wood-processing industries in both places could be strengthened if the governments introduced more aggressive, outward-oriented industrial policies.

In contrast, Papua New Guinea (PNG) has chosen a liberal log-export policy, and this decision also seems appropriate because the country's timber resources are commercially not so attractive as those of the Philippines, Malaysia, and Indonesia (excluding West Irian). Therefore, this country needs to develop a market for its species.

In Sabah and Indonesia, policy options are more open than in Peninsular Malaysia and the Philippines or in Papua New Guinea. On the one hand, Sabah and Indonesia (excluding West Irian) happen to have the richest forest resources in terms of commercially attractive species per hectare. On the other hand, they have a number of short-run problems in realizing increased local processing. Attracting the necessary labour to Sabah or the outer islands of Indonesia is a problem. The infrastructure required for large-scale growth of the processing industries in these areas would be a heavy financial burden. Until processed products are exported in large quantities, transport costs work against such processing. Furthermore, the resource rents that could be collected from log exports are substantial but would have to be foregone if the governments opted to establish export-oriented processing industries. This could take several years, or possibly even a decade. Nevertheless, Sabah and Indonesia may consider it politically desirable to develop some kind of industries in their remote regions for the sake of regional development. This political objective would be well served by a policy to promote timber processing. Indeed, timber processing could be used as the core of a regional development strategy, along with agriculture.

The long-run economics are in favour of local processing in Sabah and Indonesia, and strong

measures to protect an infant processing industry may be justified, especially in the light of South Korean and Taiwanese experience. Adoption of an export-promotion strategy like South Korea's as the general development strategy should be carefully considered. More specific steps are to minimize the use of price ceilings and other interventions of the domestic market, to improve the efficiency of domestic transport (especially shipping) and port facilities, and to develop several wood-product terminals at strategic locations. To ensure an internationally acceptable quality of products and to secure market access, joint ventures with experienced foreign companies should also be considered at this stage of development.

Sarawak is a different case; there seems to be room for it to collect higher resource rents on log exports than it does now. The government of Sarawak may be foregoing both the resource rents on logs exported and the benefits of local processing.

One of the issues in plywood trade has been import duties. Industrialized countries have historically levied high import duties on tropical hardwood plywood. They have done so to protect their processing industries. The recent changes in the log-export policies of major log-producing countries have prompted many industrialized nations to reduce import barriers on veneers and sawn wood, which, of course, is a welcome trend. However, industrialized countries should reduce or eliminate import barriers on tropical hardwood plywood. The second-best solution in terms of maximizing world economic efficiency is for log-exporting countries to introduce a two-tiered pricing of logs based on higher government charges for export logs than for logs processed locally.

Plywood manufacturing should be the core of a development strategy to encourage local processing. If the development of a plywood industry were promoted successfully, it would automatically have the effect of promoting milling and other wood-based paneling, such as particle-board, because milling and wood-based panels are complementary to plywood manufacturing, improving the efficiency of raw material use.

The Northeast-Asian Market Economies' Response to Tighter Controls on Fish and Forest Resources

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The Northeast-Asian market economies (Hong Kong, Japan, South Korea, and Taiwan) depend heavily on imports from other countries for the raw materials to meet their demands for fish and forest products. Thus, they have been particularly vulnerable to changes in resource management within the exporting countries. Whereas many of the changes have been to promote conservation of renewable resources — a goal that benefits everyone in the long run — some have been the result of protectionist policies that may be viewed as globally counterproductive. Probably the most important change in fisheries has been the general acceptance of coastal states' rights of jurisdiction over the fish resources within 200 miles of their shores, whereas the most important change in forestry has been the greater involvement of resource-owning countries in manufacturing. The responses by the Northeast-Asian market economies reflect their differing industrial strategies. For example, South Korea's strategy in the fishing industry is to create foreign exchange through exports, whereas Japan's is to produce food for a majority of its people. Some of the positive side-effects of the tighter control on fish and forest resources are more intensive efforts in fish culture and in reforestation, especially in Japan and Southeast Asia.

L'économie de marché de l'Asie du Nord-Est — comprenant Hong Kong, le Japon, la Corée du Sud et Taiwan — dépend largement des importations pour la satisfaction des besoins de la région en produits forestiers et halieutiques. Ces pays ont par conséquent, été particulièrement vulnérables aux changements survenus dans la gestion des ressources chez les pays exportateurs. Plusieurs de ces changements ont été apportés dans le but d'assurer la conservation des ressources renouvelables, mesures qui à long terme, profitent à tous les intéressés, mais d'autres changements résultent de politiques protectionnistes qui peuvent être considérées dans l'ensemble comme anti-productives. Dans le domaine des pêches, le changement le plus important est peut-être l'établissement de la zone de 200 milles dont la juridiction relève des états riverains alors que dans le domaine des produits forestiers, la principale modification vient de ce que les pays propriétaires de forêts s'intéressent davantage au développement de leur industrie. La stratégie industrielle de protection mise au point par les pays de la région diffère d'une nation à l'autre. La Corée du Sud par exemple, cherche à établir un échange de produits halieutiques avec les pays étrangers en développant l'exportation alors que le Japon essaie d'augmenter la production alimentaire pour répondre aux besoins de la majorité de sa population. Cette situation provoque plusieurs effets secondaires dont les plus positifs sont l'exercice d'un contrôle plus serré sur les ressources forestières et halieutiques et de plus grands efforts de pisciculture et de reboisement, surtout au Japon et en Asie du Sud-Est.

In the last decade, changes in the availability of resources in forestry and fisheries have profoundly affected Northeast Asia. The countries in the region that are based on market economies — Hong Kong, Japan, South Korea, and Taiwan — are small and resource-poor. To offset their lack of natural resources, they have invested in industries for which the resources have been either available to all countries on an equal basis or

easily accessible and readily processed for added value. They have, therefore, developed their fishing fleets and wood-processing industries. Three of the four have distant-water fleets that have, in the past, enjoyed equal access to the resources of the sea. The introduction of the exclusive economic zones has been a major setback to these countries, as it has given preferred access to coastal nations. The wood-processing industries have

also been adversely affected by restrictions on access. Many resource-rich countries have limited their exports of logs and have begun investing in processing. The response of the Northeast-Asian countries deserves study.

Fish Resources and Trade

By international standards, people in North-east Asia eat more fish and other marine products than do people elsewhere, although there are some differences in diet even within the region. Japanese, for example, depend more on fish, especially raw fish, for their diet than do Koreans. Japan depended on the export of fish products in the early stage of its post-War economic development, using the revenue to finance the import of raw materials for industry. In the late 1960s, however, the nation became a net importer of fish products as its own industry lost comparative advantage while demand for these goods continued to grow. Despite the fact that Japan has the world's largest fisheries industry, it is also the largest importer of these products. In contrast, exports of fresh or frozen fish made up 3.3% of South Korea's total 1978 exports.

Although South Korea's fishing industry has suffered because of higher fuel prices and the growing number of established 200-mile economic zones, it still is in a more favourable position than Japan, for wage costs are lower. In fact, South Korean exports of fishery products caught up with those of Japan in 1977 (FAO 1977a). Japan is a promising market for Korean fishery products, bringing in U.S.\$443 million in 1980. (Taiwan, too, is important to Japan as a source of fishery products, but at times trade relations between the two countries have been strained. In 1980, for example, Japan imposed quantitative restrictions on imports of eel from Taiwan.)

For developing countries with poor natural-resource endowments, fishing is an important means to earn foreign exchange, for fishery technology is, in general, labour intensive. Working conditions are severe, and the industry tends to hold a comparatively disadvantageous position as economic growth advances because wage rates rise rapidly. This experience is observed in the stagnation of the Japanese fishing industry and in the continued growth of the industry in South Korea. In the years to come, the ASEAN industry will catch up to that of Northeast Asia (FAO 1980).

Northeast-Asian nations attempted to counter the movement in 1977 by major countries to establish 200-mile economic zones. Up to the

present, to avoid conflict, the market economies in the region have refrained from applying economic zoning among themselves. Japan introduced economic zoning to counter the Soviet zone, but there are no exclusive zones between Japan, South Korea, and China.

Forestry and Trade¹

No country in the region is self-sufficient in wood. Demand for lumber, pulp, and wood products has rapidly increased as residential construction and consumption of paper have expanded with economic growth. Although forests in Japan are to some extent cultivated for lumber harvest, self-sufficiency has decreased steadily in the past 15 years. The index stood at 71% (for lumber) in 1965, 64% in 1975, and 31% in 1978, and other countries in the region seem to be following similar trends. Production of lumber has an extremely long lead time, so it is expected that all market economies in the region will have large net imports of forestry products.

Lumber production, planting and forest management, and wood-manufacturing industries such as milling and plywood are all labour intensive and are suitable for a labour-affluent country. In Japan, the lumber-manufacturing industry developed as an important exporting sector selling lumber and plywood to industrial countries but is at present declining. Exports of plywood are still important in South Korea, amounting to 2.7% of total exports in 1978. The lumber-manufacturing industry is important in earning foreign exchange reserves, and this industry can easily be adopted by developing-country economies, especially those with both plentiful forests and an abundant labour supply. Time-series data on exports of lumber products suggest that ASEAN countries will become more important in the export of manufactured wood products. Thus, the Northeast-Asian market economies will find it necessary to consider tariff escalation, technology transfer, and capital investment in the industry as well as conservation of forests.

Market Response

Both the fishing and the forestry (more precisely the lumber-manufacturing) industries have life cycles that are closely related to overall economic development, and it will be the ASEAN

¹Statistics have been taken from FAO yearbooks of forest products unless otherwise indicated.

countries that develop these industries in the 1980s. Japanese distributors (trading houses and supermarkets) and fishing companies have responded to the trends by establishing joint ventures with entrepreneurs in almost all countries in the ASEAN region. Technical progress in freezing and cold storage in marine transport has favoured such undertakings. Some joint ventures in cultured fisheries, such as prawn breeding in Indonesia, have also begun, and the number of joint ventures is growing between Japanese trading houses or paper-manufacturing enterprises and lumber companies abroad. In response to regulations on log exports imposed by resource-owning countries, joint ventures, which may replace domestic producers in Japan, also have been established in the plywood industry. In fact, Japanese plywood manufacturers have occasionally requested protection against foreign competition, ultimately shifting to high quality, chemically coated plywood production. A few joint ventures are in experimental planting and reforestation. Japan has imported a growing quantity of lumber from Siberia, and this trade presents a political factor affecting government policy vis-à-vis the USSR.

Case Study: Japan

The fishing industry has been important to Japan for centuries. For instance, it played a major role in the early stages of Japan's post-War economic development by providing employment and earning foreign exchange through exports of canned fish and crustaceans. The industry originally grew up in response to domestic demand, which is high by Asian and world standards. Fish and other marine products are the main — and for some Japanese, the only — source of animal protein. This heavy demand combined with changes in the country's economic environment has turned Japan into a net importer of fishery products, although its fishing industry continues to be the largest in the world.

According to a fisheries census for 1979, 468 000 persons were engaged in fishing activities. Of these, 364 000 were small-scale fishing families (Norin Tokei Kyokai 1981) much like the small farmers in Japan. In 1979, fishing households owning their own vessels (*gyosen gyoka*) depended for 55% of their income on nonfishery work. As in agriculture, in which some 70% of Japanese farmers were classified in 1977 as depending for more than 50% of their income on nonagricultural work, fishery firms are in general

small, although some large corporations have developed.

As small farmers have formed a protectionistic interest group, so have fishing personnel. Many of these small operations are now claiming compensation for the damage caused by pollution of inshore fishing grounds, which occurred in the 1950s and 1960s when environmental protection measures were lacking.

Among the various categories of fisheries, pelagic and offshore fisheries expanded the most rapidly until the early 1970s. The first oil crisis in 1973, subsequently higher fuel prices, and the spread of 200-mile economic zones, however, combined to bring Japanese fisheries to stagnation. New trends include increased efforts in fish culture and joint ventures with resource-managing countries.

Major Changes on the Supply Side

Because the Japanese fishing industry was based on labour-intensive techniques, it lost its comparative advantage in the 1960s and 1970s when wages increased in response to improved economic conditions. Another factor that drastically affected Japanese fisheries was the rapid increase in fuel costs. Even in coastal fishing, fuel costs rose 6.5 times during 1970–78. Although inshore fishing consumes a relatively small quantity of oil, the proportion for fuel in the total costs rose from 6.5% in 1970 to 9.6% in 1978. Higher oil prices damaged the pelagic fishing operations even more severely (Norin Tokei Kyokai 1981). Labour costs for inshore operations increased 3.4 times during the same period, but the percentage of total costs contributed by labour dropped from 21 to 16.

Higher fuel and labour costs, reduced fish catch due to quotas, and licence fees all combined to reduce the supply of fish and raise the price. Thus, Japanese production of fish and other marine products declined after a peak in 1977–78 (Norin Tokei Kyokai 1981). Imports expanded rapidly, annually increasing 7.9% during 1970–75, whereas domestic production grew at an annual rate of only 2.4%.

The most seriously affected sector has been pelagic fishing, which is operated by large companies. Their response to the changing environment was to enlarge their trading departments to import fish from resource-owning countries. They also established joint ventures in these countries, selling technological know-how both in management and in fishing. According to Norin Tokei Kyokai (1981), sales of the trading departments of large fishery companies (with

paid-in capital of more than 1.0 billion yen) rose from 47% in 1970 to 70% in 1979. The share of fisheries itself declined from 34% to 15% during the same period.

Response on the Demand Side

How sensitive are Japanese consumers to the changes in relative prices between fish, crustaceans, and meat? The consumer price index rose by 121% between 1970 and 1979, whereas that for fresh fish, crustaceans, and molluscs increased by 201% and for meat by only 94%. Food consumption per household increased by 141% in the corresponding period, and the figures indicate that the Japanese reduced their real consumption of fresh marine products and increased that of meat. Substitution proved to be fairly responsive to changes in relative prices.

A new feature of the fishing industry is that uses of fish for products other than human food have rapidly increased. Thus, although demand for food use has leveled, total demand still continues to rise. The total demand for fish, crustaceans, and molluscs increased 2.5% annually in 1970-79, 2.0% for food use and 3.8% for nonfood use (Norin Tokei Kyokai 1981).

Trade in Fish, Crustaceans, and Molluscs

The major exporters of marine products to Japan are the U.S. (144 billion yen), South Korea (133 billion yen), Taiwan, Indonesia, Canada, India, Spain, China, and Australia. Development of fisheries has been rapid in ASEAN countries, and trade is promising even among the resource-deficient Northeast-Asian market economies, as indicated by the large exports of Korea and Taiwan to Japan.

Exports of fish have lost ground in Japan. In 1979 Japanese exports accounted for only 196 billion yen, whereas imports were as high as 931 billion yen. The most important export market is the U.S. where Japan sold 36 billion yen worth of products. Within the Northeast-Asia region, Taiwan (12 billion yen) and Hong Kong (11 billion yen) were the largest export markets for Japan, though still comparatively small.

Public Policy

The most important aspect of public policy is encouragement of favourable fishery agreements for fish catch. Japan has struck agreements with the USSR, Canada, and the U.S. in the North Pacific. In recent years, fishery agreements have been made with nations of the South Pacific, such as Australia, and these have increased in importance. A common complaint in Japan is

that smaller fishing quotas and higher licence fees in the North Pacific have combined to make the pelagic fishery increasingly less attractive (Norin Tokei Kyokai 1981). The Japanese are concerned that the fishing quotas in the 200-mile economic zones are sometimes used as leverage for other trade issues.

The government has declared that fisheries cooperation is one important form of assistance to developing countries, and it extended a 6.6 billion yen grant for fishery cooperation in the 1980 fiscal year. In addition, it sends Japanese experts for consultation and receives trainees from developing countries. As most technical progress in the industry has been promoted by public institutions, just as in agriculture, government-to-government cooperation holds the promise of technology transfer. Government organizations that specialize in these activities are Japan International Cooperation Agency (JICA) and the Overseas Fishery Cooperation Foundation (OFCF).

On the domestic front, Japanese fishery policies focus on assistance to small fisheries by means of subsidies and preferential financing. Fish manufacturing, enlargement of freezing and refrigeration equipment, and improved distribution efficiency are priorities for support. A new area of importance has been the protection of inshore fishing grounds and promotion of fish-culture activities.

Japanese foreign trade policy is a mixture of free trade and protectionism. To protect small inshore fisheries, it tends to restrict imports of competing products. In 1979, there were 27 items under residual import restrictions under the GATT (4-digit BTN classification), 22 of which were agriculture and fish products. Marine products include fresh, frozen, or salted herring, cod, yellowtail, mackerel, pike, etc. (BTN 03.01 and 03.02) and fresh, frozen, salted, or smoked scallops and squid, etc. (BTN 03.03). According to the Ministry of International Trade and Industry (MITI), the Japanese government has occasionally requested that South Korea voluntarily restrain exports (tuna in 1975 and seaweed in 1977) (Sekiguchi 1979).

Similar protectionism is found in the tariff structure. For instance, a 10% tariff for fresh fish is imposed on sardine and cod imports, which are subject to quantity restrictions. Quotas are introduced when domestic prices are higher than international prices plus tariffs (and transportation and other costs). The gap between domestic prices and tariffs plus international prices is attributed to importers as import premiums.

Tariffs are also used to protect the fish-processing sector. Canned herring, for example, has a tariff of 15%, although there is no limit on quantities imported. Tokyo Round agreements will produce a different picture when they have been implemented. Tariffs on marine commodities will decline by about 40% from the levels in 1979, i.e., 10% to 6%; 5% to 3.5%. Although the tariff reduction is substantial, tariffs will remain high, as is suggested by the fact that tariffs on smoked cuttlefish will decrease from 15% to 7.5% (Tokyo Round Study Group 1980).

The Japanese public seems convinced that price increases are inevitable because of higher oil prices and stricter fishing quotas. Debate on freer trade in fish products was rare in the 1970s.

Forestry and Trade in Wood Products

Japanese residential buildings have traditionally been largely constructed of wood. Rapid economic growth in the post-War period was followed by expanding housing construction as well as increased demand for paper, and demand for logs grew rapidly. The forested area of the country is limited, although the government worked to promote replanting of forests soon after the War. Trees planted in the late 1940s, however, are still comparatively young. Thus, the ever-expanding demand for lumber has largely been met by imports. Japan has depended on the U.S., the USSR, and New Zealand for coniferous lumber and on ASEAN countries for deciduous lumber.

The national forests have supplied an important proportion of the total domestic wood production and have been critical in environmental protection. In fact, national and municipal forests supplied 41% of total domestic log production. As the Japanese islands are mountainous with much steep terrain, forests are important not only for lumber production but for prevention of landslides, flooding, and soil erosion. The latter is especially important because rivers are short and steep, and water tends to flow quickly to the sea.

Most private forests are owned and managed by wealthy farmers, but, as wage rates rapidly increased, the production of logs has expanded while forestation has stagnated. Adding to these difficulties is the fact that lumber producers have seldom been an influential pressure group, for lumber users make up a much more numerous and stronger interest group.

Sawing and secondary processing of lumber are carried out by small firms. In 1977, 207 000 persons were engaged in sawmills, 62 000 in plywood manufacturing, and 150 000 in furniture

making. All firms are small, and, occasionally, they demand protectionistic measures. Plywood manufacturers, especially, face serious difficulties from foreign competition. Some have shifted to high quality, chemically coated plywood, and others who stay with the product lines of ordinary plywood have been allowed to form depression cartels to prevent price decline (Sekiguchi 1979).

Domestic production of logs was $51.8 \times 10^6 \text{ m}^3$ in 1967, $34.2 \times 10^6 \text{ m}^3$ in 1975, and $33.3 \times 10^6 \text{ m}^3$ in 1979. In recent years, the level has been stable at some $33 \times 10^6 \text{ m}^3$, $20 \times 10^6 \text{ m}^3$ from private forests and $13 \times 10^6 \text{ m}^3$ from either national or municipal forests (Japan Forestry Association 1981).

Log imports were $35.7 \times 10^6 \text{ m}^3$ in 1975 and $37.5 \times 10^6 \text{ m}^3$ in 1980. The fluctuations in imports mostly reflect ups and downs in domestic businesses in which housing investment plays an important role. Japan has been the world's largest importer of logs for many years, accounting for some 55% of world trade in 1978 (UN 1978:63). Major source countries for Japan's log imports are the U.S. ($10.8 \times 10^6 \text{ m}^3$ in 1980), the USSR ($6.2 \times 10^6 \text{ m}^3$), ASEAN countries ($19.1 \times 10^6 \text{ m}^3$), and New Zealand ($0.7 \times 10^6 \text{ m}^3$) (Japan Forestry Association 1981). In 1979, Japan's rate of self-sufficiency in lumber was only 44.6% (Japan Forestry Association 1981).

Among ASEAN countries, Indonesia and Malaysia are the largest exporters of logs to Japan, both at $8.9 \times 10^6 \text{ m}^3$ in 1980. The Philippines, because of an embargo on the export of logs in the mid-1970s, exported only $1.1 \times 10^6 \text{ m}^3$ in 1980. Similar strategies are now followed by both Indonesia and Malaysia; the approach may have found impetus in the Southeast Asian Lumber Producers' Association (SEALPA), which was formed to develop, among other improvements, better marketing operations.

In the 1970s, Canada began actively to implement an export embargo on logs so that it has become extremely difficult for Japan to import logs. A similar trend has been observed in the U.S. where regulations on log exports are increasing at the federal as well as the state government levels. The revision of the Export Control Act in October 1979 threatens to ban exports of American cedar logs completely from October 1982. One positive development has been the formation of a U.S.-Japan Lumber Trade Promotion Committee by private individuals in both countries; the members met for the first time in November 1980.

Because of its enormous domestic demand for lumber, Japan has turned to the Soviet Union as

an important supplier. During 1975–79, 17.5×10^6 m³ logs and 0.9×10^6 m³ in milled lumber were imported from the USSR. The next contract, for 1981–86, was delayed by economic sanctions against the Soviet Union for its invasion of Afghanistan, but it was concluded in March 1981. Some other contracts exist for trade in pulpwood and wood chips. One problem is said to be less-than-punctual delivery, for the contract states that 80% of the cargo will be carried by Soviet carriers. In the three prefectures where the majority of wood supplies depend on the USSR (Fukushima, Niigata, and Toyama), wood manufacturers are naturally enthusiastic promoters of trade with that country.

According to FAO statistics, Japan's imports of roundwood expanded from 27.8×10^6 m³ in 1967, to 45.9×10^6 m³ in 1970, and to 53.5×10^6 m³ in 1978. Although Japanese demand for lumber continues to rise, the restrictions by resource owners on their exports have meant that imports into Japan have not kept pace with demand. In 1979, Japan's total demand for lumber was 109.8×10^6 m³, 55% for milling, 29% for pulp production, 13% for plywood manufacture, and 3% for other uses (Japan Forestry Association 1981).

Most of the wood demand, therefore, is for construction, especially for residences. By 1980 housing investment seemed to have reached a peak. Nevertheless, the demand for lumber continues to increase as the size of families becomes smaller, and progressive urbanization leads to demands for better houses. Demand for pulpwood will also expand along with that for paper.

Another notable feature of Japanese import demand for lumber is its drastic fluctuation. Because of Japan's large share of worldwide lumber trade, its demand fluctuations have had a strong impact on international prices. On the Japanese domestic front, lumber prices were stable in 1977–78 as the yen exchange rates rose. In 1979–80, the declining value of the yen accelerated the price increase, which was twice that of the previous year.

Because of the serious impact of price fluctuations not only on the importers' but on the exporters' economies, a buffer stock scheme was established in October 1974. The size is not yet large enough, however, and price fluctuations are still great.

The government recognized in the early post-War economic development that Japan would inevitably be dependent on imports for most of its raw materials and worked to promote resource development projects. Among these was

the establishment of the Alasca Pulp Co. with government support in 1953.

In the early 1970s, the government more actively encouraged private investment in resource development. In 1971, it created a special fund to redress losses incurred by natural-resource development investment (Tennen Shigen Kaihatsu Sonshitsu Junbikin). It allowed firms to deduct a certain percentage of foreign investment for exploration and extraction in their calculation of taxes. The reserve is to be used up equally in 5 years after a 5-year period. Lumber was the only renewable natural resource covered by this scheme. The system reduced the risks firms faced and had an effect of postponing the payment of corporate income taxes (Krause 1976).

In addition, the government subsidized research and development in the utilization of South-Pacific woods. These efforts were directly addressed to the interests of Japan as an importer. The Japanese government was concerned about resource conservation, and any strategy for securing lumber supplies for Japan naturally depended on cooperation with the conservation policies of resource-owning countries.

Among governmental cooperation measures in this area are programs for education and training of persons from abroad and provision of Japanese experts abroad as consultants. A non-profit corporation, called the Kaigai Ringyō Konsalutanto Kyōkai (Association of Consultants in Forestry Overseas) has been engaged in consulting not only in lumber production but in reforestation as well. This organization is subsidized by the government, and to date quantitative data have not been published on its activities.

The Japanese government faces difficulties in trade policies for manufactured lumber products. If lumber standards for building are accepted among all nations, exporters can realign products without risking local demand. Still, many small-scale manufacturers operate in this area in Japan, and they demand protection from import competition. For this reason, tariffs in manufactured lumber products are fairly steep. Since implementation of the Tokyo Round agreements, the tariffs will be reduced one-half or two-thirds. For plywood, the tariff will be reduced less than for other products primarily because there are no preferential tariffs for the industry.

Policy Implications

Northeast-Asian market economies are all deficient in two important renewable natural

resources — marine (including crustaceans, molluscs, etc.) and forest products. They, thus, face serious difficulties when exporting countries decide to impose mechanisms of direct control, such as embargoes. Resource-owning countries should strengthen conservation policies, but they should ensure that new policies do not discriminate against any particular nation — that is, that higher prices of scarce or limited resources should be borne by all users, both domestic and foreign.

Increasing fishery licence fees has the effect of transferring income from the poor to the wealthier nations because rich countries impose the burden on developing countries. This effect occurs in fisheries because the industry is growing in developing countries and is labour-intensive. A constructive way to absorb excess licence fees would be to direct the funds toward resource studies and regional consultation as well as public relations activities on resource management.

Both fisheries and lumber-manufacturing industries in Northeast-Asian market economies are in transition. These industries, aided by an abundant labour force, have played an important role in earning foreign exchange early in economic development. Because ASEAN countries will be developing these industries in the coming decades, it is desirable that the Northeast-Asian market economies, especially Japan, reduce tariffs in trade in manufactures in this area. If these precautions are taken, the export revenues of ASEAN countries will increase and price increases in importing countries will be moderate. Importing countries' difficulties in making these adjustments arise because of the significant number of small-scale firms who face adjustment problems. In this context, a freer trade policy cannot be realized without assistance from governments. Increased supply security, too, will be essential to removing protectionist measures. The growing number of joint ventures in fisheries and wood processing will work as a counterweight to protectionist pressure in importing countries.

As new technology, both in fisheries and forestry, has been encouraged and undertaken by many governments, the future of government-to-government technical cooperation is promising. Such cooperation should not be limited to fishing and wood milling but should include cultured fish farming and conservation techniques. Especially with regard to forestry, all the Northeast-Asian economies share the benefits of increased cooperation. In fisheries, the intraregional market is large. For example, Japan is a major net importer and South Korea, a large net exporter. Development of the South Korean economy, it appears, will make the industry less competitive with Japan, and Korean fishing companies, too, will begin to establish joint ventures in ASEAN countries. Development of the fishing industry in Asia will benefit not only traders in the region but each nation by increasing its fish-protein intake.

Price fluctuation is a matter of serious concern for producers and consumers. In the lumber trade, private buffer stocks (Beigic and Hager 1974) with government support will be the principal method of improving the situation, although the effectiveness largely depends on how the cost of storing can be reduced by technical progress.

One factor makes trade in lumber dominant at a certain stage of processing. Industrial standards and building standards vary among countries. Thus, producers face increased risks if they manufacture lumber for specific uses, as the products will not sell in other markets. Furthermore, the further downstream the processing, the more important is local taste, as in the case of furniture. Downstream industries survive in importing countries regardless of tariffs. Information exchange and consultation in establishing international standards will remove some of the risks for developing countries moving to higher stages of manufacturing. The governments in the Pacific basin countries must work together in this endeavour, for, although social and cultural factors do differentiate building standards among countries, the potential for cooperation should be explored.

Discussion

Helen Hughes: Professor Sekiguchi has analyzed the principal renewable resource issues from the resource-poor countries' point of view

with his usual perspicacity and thoroughness. He has indicated the special characteristics of renewable resources, the trade and location of process-

ing questions arising from those characteristics, and the ensuing policy options. His analysis might have, however, been even more illuminating if he had made a clearer distinction between what might be called the "mining" and "farming" phases of renewable-resource exploitation.

When a renewable resource is initially exploited from the "virgin" state in which it has developed over many (sometimes hundreds or even thousands) of years, it may be said to be in its mining phase. During this phase, stocks are reduced, and considerable resource rents, akin to those accruing to depletable mineral resources, are reaped by the public and private owners of timber and fisheries. After a time, policy choices have to be made about the use of land on which the timber stands — whether to continue to plant it with timber, to use it for tree crops, grazing, or annual agricultural crops. Fish, seaweed, and other marine stocks have to be managed to attain stable yields, with consequent direct or indirect farming costs. The returns accruing in this phase are those accruing to land or sea and to complementary capital and labour (and other factors of production).

During the mining period, the production decisions are mainly concerned with rates of depletion and the division of resource rents among the private and public natural resource owners, primary exploiters, traders, and processors. A tendency to limit production to increase the income from rents is common. However, once the farming stage is reached and the resource rents are depleted, returns are more likely to increase as a result of an increase in the volume of production. Differences between private and social costs and returns generally continue to be important because of environmental and common-property questions. They may, however, diminish — for example, in timber farming in small competitive woodlots.

The experience of resource-poor countries reflects these phases. Initially, they often benefited from a share in resource and monopoly rents by dominating extraction, trading, or processing or more than one of these phases. These activities were extremely profitable, often permitting the relatively small or inefficient units that are typical of the early stages of natural-

resource exploitation, trade, and processing to continue in production. But, as the limited domestic natural resources became exhausted and as developing countries gained political and economic strength and reduced the purchasing countries' share of natural resource rents, these activities became less profitable. Where rates of exploitation began to be limited by resource-owning countries, supplies became or were thought to be becoming precarious.

The long-run outlook, as farming replaces mining is, of course, favourable, even for resource-poor countries. As tropical hardwoods become scarce, it will be profitable to plant (or otherwise produce) substitutes. Once fisheries are subject to conservation practices and technological improvements, their output will rise.

The transition period, which is occurring, is, however, difficult. The formulation and implementation of appropriate policies is no easier in renewable resources than in other sectors, and in fisheries it is complicated by common-property rights in open seas. In the supplying countries, new policies are required to manage the shift to farming-type production, with appropriate regard for the social as well as private costs and benefits. The shift often, though not always, means a move to local processing if labour costs are low. In the importing countries the loss of resource rents, particularly if accompanied by rising labour costs, should lead to shifts from the affected industries. Unfortunately, usually for short-term social reasons, the affected enterprises are often permitted to stay in the industry by protectionist policies, as Sekiguchi implies in his comment that Japanese foreign trade policy is a mixture of free trade and protectionism; Taiwan and South Korea have been highly protectionist until recently. Protection becomes harder to remove as the protected industries become less competitive. Sekiguchi identifies the problem accurately with regard to Japanese protectionism in timber processing and in fisheries. He perhaps places too much stress on the formal tariff barriers to trade and processing, not giving enough emphasis to administrative controls exercised by various government agencies to protect small producers, and to the intricacies of the Japanese distribution system that is inherently highly protectionist.

*Resources of the Eastern USSR*¹

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East of the Ural Mountains in Siberia, the Soviet Union has vast resources — 85% of all its fuel and energy resources are located in the region. Forests, oil, natural gas, and hydropower are all abundant and, with changes in transportation, are increasingly being exploited. At present, Pacific markets are easier for Siberia to reach with its products than are major population centres in the Soviet Union, and trade flows, especially toward Japan, are expanding. However, plans for improved trans-Siberian rail links may have a strong impact on the direction of the flow eastward.

L'Union soviétique possède des richesses considérables à l'est des monts Oural, en Sibérie : c'est dans cette région que se trouvent 85 % des combustibles et des ressources énergétiques et pétrolifères. On y trouve en abondance des forêts, du gaz naturel, du pétrole et de l'eau qui sont de plus en plus exploités à mesure que se développent les moyens de transport. La Russie atteint aujourd'hui les marchés du Pacifique plus facilement que ses grands centres peuplés et le commerce prend de l'expansion surtout avec le Japon. Le plan d'amélioration du réseau ferroviaire trans-sibérien pourrait produire un impact considérable sur l'avenir du commerce.

The part of the Soviet Union that lies east of the Ural Mountains is usually divided into three economic regions: western Siberia, eastern Siberia, and the far eastern USSR. These three regions cover an area of 11.7×10^6 km² (50.9% of the Soviet Union) compared with 9.9×10^6 km² for Canada. On 1 January 1980, the population of these three regions was 26.6 million and, for the entire USSR, 264.5 million compared with 23.8 million for Canada.

These three regions account for 85.7% of the overall fuel and energy resources of the USSR — 87.2% of mineral fuel resources and 62.5% of the hydro resources (Krushchev 1979: 189). They also have 81.8×10^9 m³ (74.8%) of the USSR's timber stands but account for only 33.5% (3.88×10^8 m³) of the volume of logging and 27% (1.16×10^8 m³) of lumber production (Krushchev 1979: 302).

The three regions are linked with the Pacific basin by trans-Siberian railroad, by air, and by the Northern Sea route, which has been function-

ing for increasing periods through the construction and use of heavy-duty, nuclear-powered and diesel ice breakers.

Each of the three regions owes its development to the availability of fuel and energy resources, and each one is endowed with a different resource.

The relationship between the three regions and the Pacific basin is primarily determined by geographical location.

Western Siberia lies the furthest from the Pacific basin, and, although it is the most important of the three regions for the USSR, it is probably least important at present for the Pacific-basin countries.

The region lies in the basin of the Ob' and its tributary the Irtysh. The Ob' is the first of the three large rivers east of the Ural Mountains flowing from south to north.

Western Siberia owes its present importance to the oil and gas industries, developed during the past decade and a half. As late as 1960, no significant amount of oil was produced here. In 1965, western Siberia still accounted for only 0.4% of the national oil output; in 1970 for 8.8%; in 1975

¹These comments were prepared at the request of the conference organizers when the invited participant from the Soviet Union was unable to attend.

for 30.1% (Shniper 1980); in 1980 for 51.74% (312 Mt) (*Ekonomicheskaja Gazeta* 1981b). In 1981, western Siberia is to produce 59.3% of the USSR's output of oil. Although the output of oil in the country as a whole is to drop in 1981 by 57.8 Mt, it is to increase in western Siberia by 11.5 Mt.

The region experienced similar development of the natural gas industry. Its share in the national output increased from 0.3% in 1965 to 4.9% in 1970 when total national output was 1.98×10^{11} m³, 13.3% in 1975 (Shniper 1980), to 35% in 1980 (national output, 4.35×10^{11} m³). By 1985, this percentage is to reach 55–58 (*Ekonomicheskaja Gazeta* 1981a). Oil and gas pipelines are currently being built to link western Siberian reserves with the Ural and the European USSR. Should such pipelines be built to the Pacific coast, the new supplies may have a considerable effect on the availability of oil and gas to the Pacific-rim countries.

The development of the oil and gas industries has triggered similar expansion in transportation, forestry, agriculture, and even fisheries through fish breeding in the numerous lakes of the region and in coastal waters. However, because of the proximity of the region to the Urals and to European USSR, western Siberia has gravitated westward rather than to the Pacific basin.

Western Siberia has 12.6% of the country's timber stand but accounts only for 8.1% of the logging operations and 7.2% of the lumber produced. Although there are possibilities for a substantial increase in both logging and processing, such expansion is not likely to have much effect on the Pacific-rim countries' trade in wood-based commodities because of the long distances and the high costs of transportation. This finding applies equally to the fishing industry.

Of the three regions, western Siberia is the smallest (2.4×10^6 km²), but has the largest population (13 million).

To the east of western Siberia lies eastern Siberia, occupying the basin of the Yenisei and its tributary the Angara. The Yenisei is the middle one of the three great Siberian rivers. The territory of the region amounts to 3.7×10^6 km², and the population numbers 8.2 million.

If western Siberia, with its oil and gas resources, is the region of today, eastern Siberia is a region of yesterday and tomorrow. The main resource is hydropower, which the Soviet Union has been developing since the mid-1950s. There are four important hydro projects on the Yenisei and four on the Angara, completed, currently under construction, or planned. Using this

hydroelectric power, wood processing and wood chemical industries have been developed in the region.

The main industrial centres are in Irkutsk, which is an important machine-building centre for the mining industry of the region and the far east and also an important transportation centre. Bratsk is the first giant hydropower station in eastern Siberia (4.5 MkW installed capacity) and is also the site of a large lumber-producing and wood-processing plant (*Ekonomicheskaja Gazeta* 1980). Bratsk stands on the banks of the Angara, which is the only river flowing out of Lake Baikal. It is the largest tributary of the Yenisei. More than 300 rivers flow into Lake Baikal. In other words, Lake Baikal is a huge natural reservoir, and a result is that the volume of water flowing in the Angara does not vary much from season to season.

Ust Ilimsk hydroelectric-power plant, also on the Angara (4.3 MkW installed capacity) is currently nearing completion. Here is also being built a collection of plants to produce wood products. Ust Ilimsk is also a site of a joint project, which is being built by the East European countries and the USSR to produce pulp and paper. The last of the three giant power stations on the Angara is to be at Boguchany, which is down the river from Ust Ilimsk. Work is just beginning on the construction of the 3-MkW, installed-capacity power station, which will have attached to it another large wood-processing centre (*Ekonomicheskaja Gazeta* 1980). On the Yenisei, are Sayano-Shushenskaia hydroelectric-power station (6.4 MkW), which is currently under construction, Krasnoirskaia hydroelectric-power station (6.0 MkW), which is already in operation, and Sredne-Yeniseiskaia hydroelectric-power station (7.5 MkW), which is yet to be built (*Ekonomicheskaja Gazeta* 1980).

Besides these three large hydroelectric-power stations and the industrial centres attached to them, the region has a smaller hydroelectric station, as well as nonferrous metallurgy- and lumber-processing centres close to the mouth of the Yenisei and a scatter of small industrial towns around Lake Baikal.

Wood products from Bratsk and other processing plants on the Yenisei and the Angara are transported both east and west, either by rail or by oceangoing vessels through the port of Dudinka on the Yenisei and through the Northern Sea route.

Located further away from the European USSR, eastern Siberia naturally gravitates more to the Pacific basin than does western Siberia. Nevertheless, distances to the Pacific are still

great, and transportation costs are a factor in determining the commodities that enter Pacific-basin markets.

To improve transportation facilities from eastern Siberia and the far eastern USSR to the Pacific, the Soviet Union is currently building Baikalsk-Amurskaia trunkline, which is the continuation of the existing branch line from Taishet on the trans-Siberian railroad to Bratsk and then to Ust Kut. From here, the newly planned railroad will run to Nizhneangarsk on the northern tip of Lake Baikal, then to Tynda — the halfway point — where it will intersect the north-south railway running from the trans-Siberian railroad to Berkakit. From Tynda, the new line will run to Komsomolsk on the Amur and then to the Pacific coast at Sovetskaia Gavan in Tartar Straits between the mainland and the Sakhalin Island, or to Vladivostok and Nakhodka in the Sea of Japan.

The construction of the railroad was announced without warning in mid-1974. The part to be newly constructed is 3145 km. The railway will cross seven mountain ranges, will require construction of 142 bridges and 25.3 km of tunnels, one of which is to be 15 km. Twenty thousand comsomol members were directed to volunteer for the project. The total labour force working on the project is close to half a million. The estimated cost is U.S.\$10 billion.

Apart from providing the USSR with an alternative rail communication link with the Pacific (because the trans-Siberian railroad along this sector runs dangerously close to the Chinese border), the new railroad will provide access to massive resources in the far eastern region (coal in south Yakutia, to Udokan copper deposits, and to some 5×10^6 m³ of lumber annually). The railway was to have been completed by 1982 but will probably be ready sometime between 1985 and 1990.

The availability in eastern Siberia of the huge reserves of hydropower and also of various inputs for nonferrous metallurgy, chemical, wood-processing, and machine-building industries promises significant development in the future in the region. The main obstacles up to now have been the unwillingness on the part of the Soviet people to settle here and the lack of capital resources, which are currently going toward development of the oil industry in western Siberia.

The far eastern region is 5.5×10^6 km² and has a population of 5.3 million. It lies directly on the Pacific and, consequently, is the most likely of the three regions to influence the development and trade in the Pacific basin. Because of the

remoteness from the population centres of the USSR, the natural resources of the region, such as coal and wood, have been considered mainly as export commodities. Administratively, the region was recently increased at the expense of eastern Siberia when Yakut ASSR with its rich deposits of diamonds and coal and copper was incorporated into the far eastern region.

Except for the southern fringes, the region has remained underdeveloped because of the severity of the climate. However, local development of such valuable resources as gold, mica, and tin has been taking place. In the Lena basin are located deposits of diamonds as well as extensive deposits of coking coal and brown coal. Some oil and gas is also thought to be present. The Soviet Union expects to be able to export this coal to Japan and other countries in the Pacific basin once Baikalsk-Amurskaia trunkline has been completed. The other major resource is copper ore from the Udokan deposits, which are conveniently located south of the coal deposits. In the more distant future, the Soviet Union plans to develop in the region a chemical industry centre that will utilize brown coal unsuitable for export.

In the far eastern region, an important fishing industry exists and has important fish landing and processing bases, such as Vladivostok, Nakhodka, Petropavlovsk in Kamchatka, Okhotsk, and others (Solecki 1979). In 1970, the far eastern fishing administration was responsible for 33.6% of the Soviet fish landings and in 1975 for 34.9%, or 3.6 Mt. In 1975 Soviet catch in the north Pacific amounted to 3.4 Mt (Sysoev 1977: 317, 327). In spite of the high domestic demand, the USSR was able to export 162 million rubles (not freely convertible to U.S.\$, fixed arbitrarily; in September 1981 U.S.\$100 was R.76.30) worth of fish in 1975 and 124 million rubles in 1979, of which 10.2% went to Japan (Table 1). By volume, 1979 exports to Japan amounted to 77 624 t or 474 471 t or 16.4% (Statistika 1980).

The far eastern region has 226.3 Mha of the 637.4 Mha of forestland in the USSR, or 35.5%. It has 27.6% of the nation's stand, which indicates that the forest-covered areas are poorer than for the nation as a whole. Annual increment for the area is 2.01×10^8 m³, whereas the volume logged in 1977 was only 3.84×10^7 m³. The imbalance results from poor accessibility to and poor quality of the northern forest areas and inadequate utilization of stands in the south. But it shows that a substantial potential exists here for exports to the Pacific-basin countries.

Also, exports of forest products from the three regions east of the Ural Mountains will probably depend on the ability of the Soviet forest industry

Table 1. USSR exports of fish and fish products, 1967-79.

	Exports (million rubles)		Imports (million rubles)	
	Total	Fish products	Total	Fish products
1967	8687.1	68.4	7683.0	13.4
1968	9570.9	78.0	8469.0	9.7
1969	10490.0	80.0	9294.1	13.2
1970	11520.0	88.3	10565.1	14.9
1971	12425.0	90.6	11231.9	13.6
1972	12734.0	84.3	13309.2	14.0
1973	15802.0	97.5	15540.8	9.6
1974	20738.0	129.6	18829.2	17.1
1975	24030.0	162.7	26669.2	18.8
1976	28022.2	89.0	28730.7	20.3
1977	33256.3	80.7	30097.0	28.6
1978	35670.0	90.2	34554.1	29.9
1979	42426.3	123.8	37864.0	34.1

Source: Vneshnia Torgovla SSSR (USSR Foreign Trade) statistical yearbooks for the appropriate years, Moscow, USSR, Statistika, 1968-79.

to make use of larch. In all, 258.3 Mha of the forests in the USSR are larch. As this species appears almost exclusively in the three regions (Lesnaia Promyshlennost 1980), it accounts for almost exactly half of the forested area in them. The stands of larch amount to $2.6 \times 10^{10} \text{ m}^3$ or 45% of the total. Yet, as the Soviet economists admit, larch has not been utilized sufficiently.

An examination of the map of the USSR's forests shows that the new major wood processing centres, namely Bratsk, Ust Ilimsk, and Boguchany (currently under construction) are sited on the patches of pine stands. Baikalsk and Selenginsk are supplied from spruce and Siberian stone pine forests, and Komsomolsk on the Amur from spruce forests. As far as is known, no major plants have been sited on larch stands. Larch is difficult to transport by water and difficult to process, hence the unwillingness on the part of the Soviet industrial enterprises to use it. However, once scientists find a way to overcome these difficulties, the availability of larch-based forest products may have a significant effect on the Pacific-basin markets.

The allowable cut for the USSR as a whole in the accessible areas has been estimated at

$6.8 \times 10^8 \text{ m}^3$ of which 61.5% is in the conifer stands and 36% in soft-leaf forests. Hard-leaf stands account for only 2.5% of the allowable cut. Furthermore, 40.8% of the allowable cut is found in the European USSR.

Conclusion

An increase in the Soviet participation in the Pacific-rim markets can be expected with the completion of the Baikalsk-Amurskaia trunkline. More would be possible if there were a scientific breakthrough that would allow wide utilization of larch as an input for the production of export commodities. Some increase is likely simply because of the overall economic development of the far eastern region, entailing population increase and, with it, an increase in the demand for consumer and capital goods, some of which it will be more economic to buy from the Pacific-rim countries than to bring from the European USSR. Overall economic development of the three regions will depend to a considerable extent on the growth of the fuel and energy sectors of the three regions.



Forestry case studies



Forest Plantations, Production, and Trade in the Pacific Basin

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This paper describes the forest-project flows within the Pacific basin, discusses the transition from old-growth to plantation forests, and summarizes the results of another study that examines the comparative economic potential of plantations in several locations within the Pacific basin.

La présente communication décrit la circulation des produits forestiers dans la région en bordure du Pacifique, la transformation des anciennes forêts en plantations nouvelles et résume les résultats d'une autre étude comparée sur le potentiel économique de ces nouveaux peuplements dans divers endroits de la région.

The Pacific-basin countries are a major source of the world's industrial wood supply. Nature endowed the west coast of North America — Alaska, British Columbia, the Pacific northwest region of the United States, and California — with vast inventories of prime conifer timber. Across the Pacific, Indonesia, Malaysia, the Philippines, and to a lesser extent Papua New Guinea have similarly large stocks of high-quality tropical hardwood stands and have become the major world suppliers of these woods. Also, the Pacific region provides an outlet for the vast timber resources of Siberia. Certain other countries in the region, such as Chile and New Zealand, are becoming, or have the potential to become, important producers and exporters of wood and wood products.

Trade Flows

The Pacific coast of North America, particularly British Columbia and the U.S. Pacific northwest, is the origin for softwood products of all types, the most important being logs, lumber, and wood chips, newsprint, and pulpwood (Sedjo and Radcliffe 1981). Although these products flow to all parts of the globe, a substantial portion go to Pacific-basin countries, particularly Japan. The East Indian Archipelago is the origin of a massive flow of hardwood forest products (Takeuchi 1974). In this case, the principal

outflow is logs, with modest amounts of lumber and wood panels. The major final market is Japan, with the United States and Europe being lesser, but important, final markets. However, much of the processing (particularly of veneers and plywood) is done at an intermediate location, most commonly Taiwan and South Korea. The final major flow of trade consists almost exclusively of Siberian logs from the USSR moving to the Japanese market. The USSR supplies about 40% of Japan's substantial imports of softwood logs. In addition, relatively small, but substantial, flows of forest products, largely softwood logs, go from New Zealand and Chile to Japan, and small flows are from New Zealand to Australia and from Chile to non-Pacific-basin countries.

The flow of forest products within the Pacific basin is profoundly affected by Japan. Historically, Japan was heavily wooded and relied upon wood to provide a variety of its needs, especially construction. The post-World War II boom found the Japanese forest unable to provide for domestic needs. Part of the reason was forest overuse and neglect during the War, and part was the relatively low productivity of Japanese forests compared with the demands of the growing Japanese economy. However, the plentiful forests of Southeast Asia, initially the Philippines and Malaysia and later Indonesia, provided abundant, accessible forest resources at low

prices. The early 1950s saw the growth of Japanese imports of Southeast Asian tropical hardwood logs. Initially, the logs were processed in Japan into lumber and plywood, some of which was used for local consumption but much of which, especially the plywood, was exported to foreign markets, principally the United States. In the early 1960s, the Great Columbus Day Storm ravaged the forests of the Pacific northwest of the United States. The ensuing salvage operations generated large volumes of logs lacking available markets. The Japanese market was "discovered" as an outlet for the temporary glut. Once the benefits of such a trade pattern were recognized, U.S.-Japanese log trade continued to expand and grow until, by the 1970s, U.S. log-export earnings from Japan approached \$1 billion. Subsequently, the rapidly expanding domestic market has diverted domestic production of goods such as plywood from the export market into the domestic market. Furthermore, to meet domestic demand in Japan, imports of processed wood have increased, particularly hardwood plywood that is now being processed in countries such as South Korea and Taiwan.

This is not to suggest that Japan is entirely dependent upon external suppliers of wood. Japan has substantial domestic forests, some 24 Mha — of which about 10 Mha are artificial. However, the enormous wood requirement means that domestic production must be supplemented with vast forest-product imports.

Hence, Japan can be viewed as the hub of the great wheel called the Pacific basin, drawing a variety of forest products from all parts of the rim: softwood logs, wood chips, lumber, and some pulp and paper products from North America; hardwood logs and, increasingly, lumber and plywood from Southeast Asia; softwood logs from Siberia; and the recent modest flows, largely of logs, from New Zealand and Chile.

An interesting feature of Pacific-basin, forest-product trade is found in the unique set of commodities commonly traded. Logs and wood chips are not typically heavily traded products in non-Pacific-rim countries. Within the Pacific basin, however, these commodities are traded rather than the more highly processed lumber and wood pulp that tend to dominate trade flows elsewhere.

The Forest Transition

Forestry today is experiencing a transition similar to that which occurred in agriculture much earlier in human history. Like the transition from gathering and hunting to cropping and livestock raising, the current transition is from old-growth,

natural forests to planted, managed, and harvested forests. The decisions involved in modern agriculture about location, crop type, technological inputs, and management mode are similar for forestry.

Much of this transition can be examined in terms of a simple stock-adjustment model (Lyon 1981) that can be applied either to a particular forest (given qualifications) or to the global forest. In terms of this model, initially the actual stock of forest resources is greater than the desired stock. Thus, the economically rational policy is simply to draw the old growth (actual stock). In such a world, the initial price of stumpage would be very low, approaching zero, and there would be no economic incentive to invest in tree growing. In fact, the stumpage price was often negative, since the timber resources had no economic value but were merely an obstacle to alternative uses of the land. This situation existed until recently, for example, in much of North America. Gradually, however, an adjustment was occurring. Increases in demand, together with a reduction in old-growth stocks, brought desired and actual forest stocks into closer relationship. As this occurred, stumpage prices would be expected to exhibit real-price increases as has happened (Manthy 1978).

As increases in the real price of timber resources occur and expectations develop that such price increases will continue, the economic incentives are created to induce investments in industrial forest plantations. These increases for some types of timber resources, expectations of future real-price increases, and technological innovations that reduce the costs of forest plantation establishment and reduce the real costs of transportation to major markets all contribute to an environment in which the incentives for investments in plantations are continuously improving.

In this environment, the role of plantations as a supplier of industrial wood could be expected to increase gradually. Simultaneously, the old-growth forests will gradually supply relatively lesser amounts as the high-quality accessible stands gradually give way to lower-quality, less accessible old growth.

Another important feature of the transition should be noted. There is no reason to expect that the regions that have large and valuable stands of old growth will necessarily be the regions that are the most prolific and profitable timber growers. The economics of harvesting an inventory of old growth that has grown over several hundred years are quite different from the economics of timber growing. The latter will depend upon such features as the establishment costs, the biologic

rate of growth, the rotation period, alternative land use, etc. Thus, it is quite possible, if not probable, that some regions with high-value, high-quality old growth will not lend themselves to economically profitable plantations. Also, some regions that never have had extensive high-quality forests may, because of the introduction of exotic species, become dynamic and profitable timber-growing regions, e.g., Venezuela.

Perhaps the principal economic advantage of a previously forested region in the process of timber growing is the probable existence of an infrastructure that was created to facilitate the harvest of the old growth. Much of this infrastructure can probably be used for timber-growing activities.

Industrial Forest Plantations

The transition from natural to plantation forests has, thus far, been very gradual. Typically, plantations have been established to replace the harvested natural forest. This is particularly true in regions such as Europe and much of North America, where the process of natural regeneration is increasingly being displaced by artificial regeneration.

In the tropics and the southern hemisphere, the introduction of industrial forest plantations proceeded slowly. Before World War II some local plantations were established, but, on a global scale, these activities were quite modest. Since World War II and particularly beginning in the 1960s, the tempo of forest plantation development has increased dramatically in regions of the tropics and the southern hemisphere. The preliminary successes of many of these plantations, the rapid biologic growth often achieved, and the vast land areas potentially available suggest the long-term possibility for meeting much of the world's increasing requirement for wood and wood fibre with increased production from the forest plantations of the tropics and the southern hemisphere.

Plantation Types

Three major plantation types can be characterized as occurring currently across the world. First, in temperate regions that traditionally produced the majority of the world's industrial wood — northern Europe and North America — plantations utilizing indigenous species have typically replaced cutover natural forests. Second, other temperate regions that have not traditionally produced major industrial wood supplies are commonly introducing in their plantations exotic temperate-climate species (largely North American) that exhibit rapid growth and

desired marketability. Third, certain tropical regions are introducing exotic species (tropical pines, eucalyptus, and gmelina) that exhibit desirable growth and marketability from other tropical regions. Although experience with exotic plantations in the tropics is limited, results thus far are so dramatic that some knowledgeable observers maintain that tropical regions will eventually become dominant wood suppliers.

Although plantations are a small fraction of the world's total forested area, the current land areas involved belie their true potential. Industrial potential is the result not only of more land being converted into forest plantations but also of the volume of output per land unit. These volumes are likely to be large for plantations because the location is usually determined, at least partially, by considerations of high biologic growth and also because the management practices usually increase usable growth. Thus, fast-growing forest plantations offer the potential of meeting a major share of the world's timber requirements from relatively small areas.

Global Trends in Forest Plantations

Although data on the extent and status of forest plantations are extremely sketchy, a recent FAO study (FAO 1978b) provides some perspective on the global extent of forest plantations. Total area regenerated by artificial means was about 90 Mha in the mid-1970s. This is roughly 3% of the area of closed-canopy forest and includes all areas regenerated by artificial means including conventional afforestation and reforestation techniques. These plantations were, for the most part, located in the traditional wood-producing temperate regions of Europe, North America, and the USSR. Conifers are generally the preferred species, although large areas of eucalyptus and gmelina have been established in Latin America, particularly in Brazil.

Although most forest plantations are situated in the northern hemisphere temperate regions, attention has increased recently in plantation activities in the tropics and subtropics and in the southern hemisphere temperate regions. Lanly and Clement (1979) estimated that the tropic and subtropic regions of Central and South America, Africa, and Asia had about 11.8 Mha of plantation forest in the mid-1970s. Of this, about 6.7 Mha were industrial forest plantations. By 1980, only 5 years later, the industrial forest plantations were projected (FAO 1978) to increase by 36% to 9.1 Mha, and projections for the year 2000 were that the industrial plantations in that region would reach over 21 Mha. Although these figures include slow-growing specialty woods such as

teak, most of the present and projected tropic and subtropic industrial plantations consist of fast-growing conifers and hardwoods designated for ordinary solid wood and fibre production.

Plantation Activity

Within the Pacific basin, major forest plantation activities have taken place in several regions. Historically, the Pacific northwest of North America relied upon natural regeneration. Recently, beginning in perhaps the mid-1960s, however, greater attention has been paid to plantation forestry and to planting, growing, and research activities, e.g., to genetic improvement of trees. Large areas are now being artificially reforested with indigenous species and managed for their commercial values.

Plantations with exotic species have been developed in Chile since about 1900. Today, about 700 000 ha of plantation forest exist, much of it monterey pine, which originated in North America. In recent years, Chile has increased the rate of plantation creation to almost 80 000 ha/year. New Zealand currently has about 1 Mha of exotic plantations and is adding about 50 000 ha/year. As in Chile, most of New Zealand's plantations are monterey pine. The fertile soils of New Zealand and the long growing season result in extremely rapid rates of growth. Given the plantation age distribution, New Zealand expects that its plantation output will increase severalfold between now and the first decade of the 21st century. Similar activities are under way in Australia, although at a somewhat more modest level.

Within Indonesia, forest plantations of teak and other expensive specialty woods have been in place for a considerable time. However, plantations with fast-growing exotics are quite new and still experimental. Nevertheless, the rapid growth and low opportunity costs of some of the land suggest good economic potential.

In China, 30-40 Mha of plantation forest have been created since the revolution. However, much of this forest is designated for protection and fuelwood, and, therefore, the industrial potential is limited. Korea, like China, has reforested large areas, about 4 Mha. However, as with China, much of the reforestation is intended for protection and fuelwood purposes.

In Japan, about 10 Mha of its 24 Mha of forest are artificial. Predominantly local species were used, and the output is directed at the specialized local markets. In addition to these countries, Costa Rica, Colombia, Fiji, Australia, Malaysia, and the Philippines all have plantation forests.

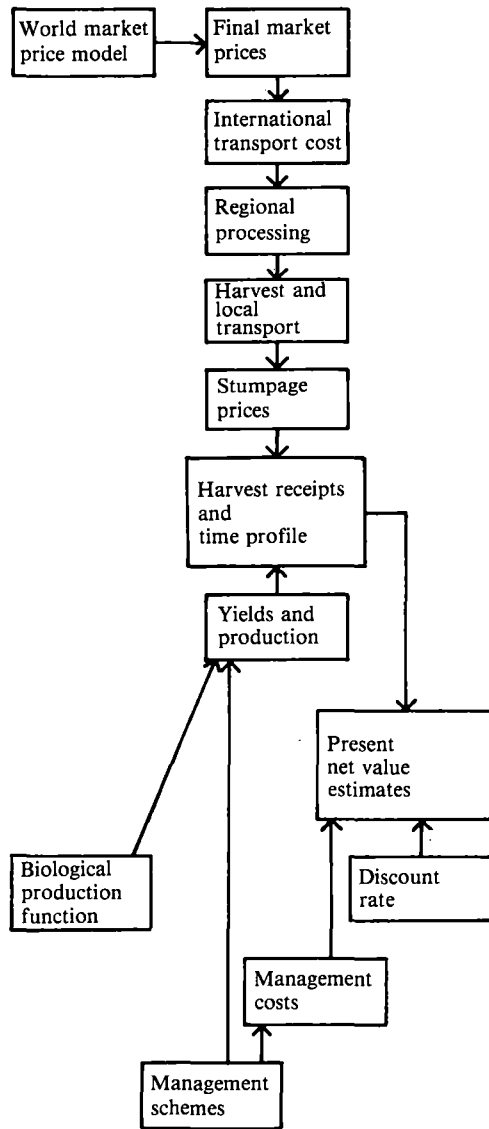


Fig. 1. Conceptual approach to forest plantations.

Comparative Economics

Resources for the Future recently undertook a study of the comparative economics of plantation forestry in 12 regions of the world (Sedjo 1980) using a conceptual approach (Fig. 1). The regions chosen either had large-scale plantation activities already or were thought to have substantial economic potential on the basis of growth rates, wood quality, and location vis-à-vis world markets. In each case, the analysis was

Table 1. Pacific-basin international plantations: present net values (at 5% discount rate for 1979 constant prices in perpetuity and internal rate of return in 1979 US.\$/ha).

Case/species	Present net values		Internal rate of return	
	Pulpwood	Sawtimber ^a	Pulpwood	Sawtimber
North America				
^b U.S. south/loblolly pine	1748	2474	12.02	12.45
^b U.S. south/loblolly pine/high site	2830	3742	13.91	14.12
Pacific northwest/douglas-fir	- 34	336	4.87	5.92
Pacific northwest/douglas-fir/high site	- 44	1236	4.83	7.51
South America				
Chile/radiata pine	3649	4509	23.39	17.50
Oceania				
Australia/radiata pine	2005	2141	10.68	10.06
New Zealand/radiata pine	2903	4118	11.90	13.11
Europe				
^b Nordic/Norway spruce	- 100	154	4.61	5.57
Asia				
Borneo/pine	1851	2364	12.94	14.73

^aIntegrated to use residues in pulping.

^bFor comparison purposes.

based upon the country's ability to export to major world markets — Japan, the eastern United States, and northern Europe. Of the 12 regions selected, 5 were in the Pacific basin — Kalimantan (Indonesia), Australia, New Zealand, Chile, and the Pacific northwest region of North America.

The following presents the basic results briefly, without indicating the degree to which these would be sensitive to changing assumptions or conditions.

The model

The preliminary findings of the formal model are shown as estimates of present net values and internal rates of return for the Pacific-basin countries. The present net value and internal rate of return investment criteria related receipts from the wood outputs to the direct costs of forest stand establishment and the costs of subsequent management. Neither land acquisition costs nor development costs enter into these calculations. In the absence of development costs and given an efficient market, the present net value calculated in this manner is an estimate of the per-hectare market price of the land (Table 1).

It should be stressed that, for these quantitative results, no provision is made for political risks and uncertainties that may affect an investment's viability. Also, the quantitative results should not be viewed as definitive but rather only as preliminary and partial indications of economic viability.

The plantations of New Zealand, Chile, Australia, and Borneo performed quite well using

either of the quantitative measures. Chile and New Zealand did particularly well. The Pacific northwest's performance, although the poorest within the Pacific basin, was still adequate to justify plantation investments; the long rotation cycle clearly reduces the economic attractiveness of plantations in this region vis-à-vis others examined.

Development costs

A more complete evaluation requires that development costs, risk, and alternative land opportunities all be introduced into the analysis. These can be introduced qualitatively. Development costs are those necessary to provide the physical base to undertake forest-plantation activities. They would include the provision of required infrastructure, both within the plantation boundaries and also of access to the sea. These costs are likely to vary considerably across regions. These costs are generally likely to be small for the U.S., Australia, New Zealand, and Chile due to the location of the plantations and the general level of infrastructure development.

In the areas examined, one would expect these costs to be highest in Borneo and, generally, in the area of Southeast Asia that has the vast inventories of old-growth hardwoods. The process of logging the old growth, if properly done, could provide a basic infrastructure for the establishment of plantation forests.

Summary and Conclusions

The Pacific-basin countries are a major source of the world's industrial wood supply. Much of

the international trade in forest products within the basin moves from producing regions along the Pacific rim to Japanese markets.

As the world's old-growth forests have gradually been used as an industrial wood resource, future forest requirements are increasingly being met by forest plantations. Rising real prices for the wood resource have provided economic incentives to undertake investments in industrial

plantations. The choice of location for new forest plantations is not confined to regions that have traditionally been important producers; it includes regions that have particularly favourable biologic or locational features. A simulation study has indicated that the economics are quite favourable for plantation investments in many countries in the Pacific basin, including some that have not been traditional producers.

Discussion

K. Hemmi: The Sedjo paper is excellent, although I must confess that the results of the analysis are so abbreviated that I could not judge the legitimacy of the figures in Table 1. For example, costs in developing a plantation forest may be huge and could change the figures dramatically. My impression, however, is that high rates of growth, wood quality, and location vis-à-vis world markets are main determinants of the competitiveness of the plantations. I agree with Sedjo that the introduction of *Pinus radiata* into New Zealand and Chile opened a new dimension for industrial plantation forests.

This paper complements Darr's because regions that Darr examines are in the Pacific basin, and the comparative economics among them would decide the competitiveness of each wood-producing region. Each of these wood-producing regions is in the forest transition detailed by Sedjo.

Sedjo's projections for the year 2000 that industrial plantations in the tropics and subtropics will be more than 21 Mha suggest that the demand for wood will be met by the supply from the industrial plantation forests. If my understanding is correct, there will be no increase in the real price of wood, and competition among various locations will increase immensely.

Moreover, there will be increasing competition from nonrenewable, inexhaustible natural resources, such as iron, aluminum, and cement. As Darr states in his paper, management of the existing forests will be intensified. In my experience in managing the university forests of the University of Tokyo, selective logging can produce almost the same amount of wood yearly as do plantation forests.

I believe that the positive environmental effects of forests will be more and more appreciated in the future and that public funds will be increasingly invested in protection forests. If this thinking is correct, selective logging in protection forests will be more competitive than the industrial plantation forests, at least in areas where the climate is severe.

In my understanding, the reasons that industrial plantation forests have increased in the past are the increasing price of wood and the improved technology in plantation techniques, including management. If my judgment is correct and if there is no technical breakthrough in silviculture in the tropics and subtropics, or in extremely cold regions, the industrial plantation forest will be limited to temperate zones. In regions of severe climate the transition may be from the mining phase in forestry to selective logging and not to plantations.

Pacific Northwest Timberlands

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Because of a large inventory of high-quality, old-growth timber, the Pacific northwest has been in a unique position to respond to demand for timber in Japan during the past two decades. Competition in the Japanese market has linked the Pacific northwest also to Southeast Asia, Siberia, and the rest of the Pacific rim. Withdrawal of land from timber production and uncertainty about maintaining current harvest levels cast doubt on the ability of the Pacific-northwest region to meet any future growth in demand around the Pacific rim. Shifts in the competitive position of Pacific-northwest producers of softwood lumber and plywood in the U.S. domestic market may lead to increased efforts to sell in Pacific-rim markets. Although demand will continue to grow for pulp and paper in Japan, demand for softwood lumber and plywood may not grow as before. Countries in Southeast Asia that produce tropical hardwood logs may prohibit log exports, and softwood production in Siberia may not increase as in the past. From the standpoint of both demand and supply of timber resources around the Pacific rim, the Pacific northwest is at a turning point. Any number of scenarios can be drawn, depending upon assumptions about future interactions of markets around the Pacific rim.

Le nord-ouest du Pacifique, comprenant d'anciennes forêts composées d'un nombre considérable d'espèces de qualité supérieure, a pu depuis une vingtaine d'années répondre à la demande de bois du Japon. Mais la concurrence a forcé les producteurs de la région à trouver des débouchés sur les marchés de l'Asie du Sud-Est, de la Sibérie et des autres pays en bordure du Pacifique. Cependant, l'affectation des terrains forestiers à d'autres productions et l'incertitude relative au maintien du taux actuel d'exploitation laisse planer un doute quant à la possibilité de cette région de répondre à l'accroissement éventuel de la demande des régions de la côte Pacifique. Mais les changements survenus sur le marché domestique des États-Unis dans les rangs des concurrents producteurs de bois mou et de contre-plaqué du nord-ouest du Pacifique peuvent orienter les fournisseurs vers les marchés des pays en bordure du Pacifique. Pour cette catégorie de produits forestiers, on s'attend à un ralentissement de la demande du Japon mais à un accroissement dans le domaine des pâtes et papier. Les pays de l'Asie du Sud-Est qui produisent des rondins de bois dur pourraient en interdire l'exportation, et la production de résineux de la Sibérie pourrait ne pas s'accroître au même rythme que par le passé. Le nord-ouest du Pacifique est donc à un point tournant, au niveau de la demande aussi bien que de l'approvisionnement en produits forestiers. On pourrait prévoir divers scénarios selon les hypothèses fondées sur l'interaction éventuelle des marchés de la côte Pacifique.

During the 1960s and 1970s, the industrialized countries of Japan, Canada, and the United States experienced rapid rates of economic growth. The growing economies of these countries generated demands for increased output of timber products: lumber, pulpwood, pulp, and paper. The timberlands of the Pacific northwest were in a unique position to respond to these demands. Development of these timberlands,

however, has not been without its problems and issues. In many respects, the timberlands of the Pacific northwest are at a turning point: attitudes about the role of the timber resources in meeting the needs of the people are in a state of flux, there are concerns about the ability of the timber resource to support current harvest levels, and markets for timber products are changing. During the 1970s, the potential for economic devel-

opment of members of ASEAN (the Association of Southeast Asian Nations) and other countries became apparent. Developments in Australia, New Zealand, South America, and the rest of the Pacific rim, through links in timber markets, also have potential effects on the timberlands of the Pacific northwest, which, for the purposes of this paper, is defined as the states of Alaska, Oregon, and Washington and the Province of British Columbia.

Alaska

Commercial development of the Alaskan timber resource has been limited to southeastern Alaska. To date, interior Alaska's timber has been used by local people primarily for shelter and fuel or for rough lumber. Forested land covers about one-third of the 146.7 Mha that make up the state. Most of the commercial forestland is federally owned, but some federal lands will be transferred to state and private ownership. Of the total forestland (48.2 Mha), 9% is considered to be commercial (capable of growing 1.4 m³/ha annual harvest). Almost 62% of the commercial forestland is in southeastern Alaska, which has an average timber inventory of 386 m³/ha compared with 40 m³/ha in the interior of the state. Hemlock (67%) and spruce (23%) are the most important species in the southeastern Alaska softwood inventory of 1.1×10^9 m³. Spruce makes up the total inventory of 6.9×10^7 m³ of softwood timber in the interior of the state. The interior has frigid temperatures during winter, areas of permafrost, and large swamps and bogs. In contrast, southeastern Alaska has weather more characteristic of a marine climate. The areas contain old-growth timber; therefore, annual growth rates are low (0.69 m³/ha in interior Alaska and 0.25 m³/ha in the southeastern portion of the state).

Interest in the development of the timber resource for commercial purposes began in the early 1900s. However, the high costs associated with the remoteness of the area generally precluded successful enterprises. After World War II, the U.S. Forest Service attempted to encourage utilization of the timber resource of southeastern Alaska through the development of a pulp industry. The primary enticement was the availability of long-term (50-year) contracts that guaranteed timber. These efforts led to the construction of two pulp mills, one wholly owned by Japanese investors and the other owned by U.S. investors. The combined capacity of these two mills is 395 000 t/year. All output of the mill

owned by Japanese investors (capacity of 195 000 t) is shipped to Japan; the output of the U.S. mill is sold around the Pacific rim and other areas (Table 1).

Sawmills were constructed in conjunction with the two pulp mills; the rationale was that high-quality logs could be sawed into lumber and lower-quality logs used in the pulp mills. Almost all the output of these sawmills is exported to Japan in the form of large "cants." The volume exported grew during the 1960s, reaching a peak of 955 000 m³ in 1973 and declining to 657 000 m³ in 1979 (Table 2).

A variety of factors have contributed to the orientation toward the Japanese market (Darr et al. 1977). Industry personnel generally cite the the Jones Act¹ as the major factor limiting the shipment of forest products from Alaska to the lower 48 states. The Jones Act specifies that any cargo shipped between two U.S. ports must be transported on a ship constructed in the United States and operated by U.S. crews. This legislation has meant increased shipping costs and has made producers in Alaska less competitive in U.S. markets than producers in Canada, Washington, Oregon, and other states.

All federal agencies in Alaska have restrictions on the export of unprocessed logs from lands under their jurisdiction (Lindell 1978). These restrictions require processing of raw materials prior to export as a means to stimulate employment. Until the late 1970s, these restrictions applied to almost all commercial forestland within the state: private ownership amounts to 100 000 ha or 2% of commercial forestland.

Before the 1970s, issues revolving around the Alaskan timber resource generally centred on how to increase the development and the competitive ability of the timber industry in southeastern Alaska. The two pulp companies proved to be financially secure; in fact, other independent firms found it difficult to continue operations without eventually becoming involved with one of the pulp companies. During the 1970s, the issue of development versus preservation of resources came to the fore. This issue involved not only forestland but other undeveloped areas as well.

Two recent pieces of legislation have major consequences for the timber industry of Alaska — the Alaskan Native Claims Settlement Act (1971) and the Alaska National Interest Lands Conservation Act (1980). The former gave to the indigenous people of Alaska the right to

¹Section 27 of the Merchant Marine Act of 1920.

Table 1. Foreign shipments of selected timber products, 1980.

Destination	Softwood logs (1000 m ³)			Pulp chips (1000 t)			Softwood lumber (1000 m ³)		
	Washington and Oregon		British Columbia	Washington and Oregon		British Columbia	Washington and Oregon		British Columbia
	Alaska	Oregon	Columbia	Alaska	Oregon	Columbia	Alaska	Oregon	Columbia
United Kingdom	0	^a	0	0	0	0	0	93	1166
Other Common Market	0	4	0	0	0	0	0	450	1274
Other western Europe	0	11	0	0	0	0	0	62	30
Japan	708	10619	701	137	2824	453	576	898	2558
Australia–New Zealand	0	^a	0	0	^b	0	0	212	302
Other Asian Pacific rim	19	1269	^a	0	0	0	2	40	5
Other Pacific rim	0	1	0	0	0	0	0	41	2
United States	—	—	349	—	—	621	—	—	14936
Canada	0	4	—	0	4	—	0	351	—
Other	0	12	0	0	0	0	0	203	727

Destination	Softwood plywood (× 10 ⁶ m ²)			Wood pulp (1000 t)			Paper and board (1000 t)		
	Alaska	Oregon	British Columbia	Alaska	Oregon	British Columbia	Alaska	Oregon	British Columbia
United Kingdom	0	5.7	19.6	0	26	205	0	1	8
Other Common Market	0	15.6	29.6	^b	161	1207	0	13	2
Other western Europe	0	0.9	0.4	0	11	131	0	9	0
Japan	0	0.7	2.8	154	119	777	0	219	5
Australia–New Zealand	0	^c	^c	0	22	76	0	7	121
Other Asian Pacific rim	0	0.1	1	89	139	249	0	133	66
Other Pacific rim	0	1.5	^c	0	5	17	0	6	59
United States	—	—	0.7	—	—	855	—	—	949
Canada	0	0.6	—	0	22	—	0	13	—
Other	0	0.9	^c	14	71	72	0	10	23

^aLess than 500 m³.

^bLess than 500 t.

^cLess than 50 000 m².

Sources: Statistics Canada (1981); U.S. Department of Commerce, Bureau of the Census (1981).

Table 2. Exports (10^3 m³) of softwood lumber to selected destinations.

Year	Alaska		Washington and Oregon			British Columbia			
	Japan	Other	Japan	Canada	Other	United States	United Kingdom	Japan	Other
1960	165 ^a	0	257 ^a	30 ^a	409 ^a	6000	1250	0	1000
1965	373 ^a	0	50	120	627	9152	1760	528	1408
1970	744	1	71	104	792	10224	1329	1728	1224
1971	580	4	39	110	640	13032	986	991	1150
1972	795	8	56	166	737	15552	821	944	961
1973	953	2	362	209	1316	15159	1159	1456	1087
1974	854	1	486	299	914	11838	1322	1182	1394
1975	739	0	491	267	698	10056	550	963	788
1976	683	1	440	240	970	14641	1267	1496	1261
1977	579	11	343	180	773	18408	1187	1666	1289
1978	558	3	385	278	719	19951	961	1838	1442
1979	646	11	840	269	873	18240	1225	2393	1638
1980	593	13	855	377	1092	14936	1166	2558	2342

^aData are for the following year.

Sources: Ruderman (1981); Statistics Canada (1981).

select up to 18.6 Mha of land. The natives, organized into corporations, opted for forestlands that were managed as part of the national forests of southeastern Alaska. The intent of most native corporations with respect to forestland is to export roundwood logs, primarily to Japan. Because these lands are considered to be privately owned, restrictions on log exports do not apply. Land selection is still under way, and it is not yet clear just how much land and timber will revert to native ownership. The volume of logs exported may reach 1.8×10^6 m³/year during the 1980s. This volume may eventually threaten the viability of the lumber mills that process timber from national forestland. This would happen if the volume of logs exported from native lands were to lower prices for Sitka spruce and hemlock cants in Japan to the extent that processing is no longer economically feasible in Alaska (Darr 1978).

The Alaska National Interest Lands Conservation Act (Alaskan Lands Bill) of 1980 was concerned primarily with the allocation of lands owned by the federal government in Alaska. The issue concerned the potential for development of minerals, timber, and other resources on these lands versus preservation of the areas. After much debate, significant areas of commercial forestland were reserved from development. The remaining federally owned forestland open to timber management in southeastern Alaska is believed to be capable of providing at least 2×10^6 m³ timber annually on a sustained basis. This is roughly equivalent to the volume of timber necessary to support the existing timber industry in the area.

The timberlands of Alaska have gone from a period when development of any type was encouraged to the current debate over preservation versus development of huge areas of land. The outcome of this debate has generally been to limit the expansion potential of the existing timber industry that is dependent upon federal timber in southeastern Alaska. Interactions between the existing industry and developments on land transferred to native corporations may further dampen the role of the timber resource of Alaska in Pacific-rim markets for timber products.

Washington and Oregon

About 55% of the State of Washington (17.2 Mha) is forested. The commercial forestland (7.3 Mha) makes up about 78% of all forestland. Forestland covers 49% of the State of Oregon (24.8 Mha). Commercial forestland accounts for 9.8 Mha or 81% of the forested area. As much as 40% of the economy of the two states is dependent upon timber (Maki and Schweitzer 1973). The timber industry is the sole supporter of many small, isolated communities.

Climate and topography have combined to make the eastern portions of the two states different, in many respects, from the western portions. The Cascade Mountain Range is the dividing line. To the west, the forest resource consists of 2.7×10^9 m³ of timber with an inventory of 49% douglas-fir, 22% western hemlock, and 29% other species. The volume of timber amounts to 280 m³/ha. The forest is dependent upon rainfall from a coastal climate. About 51% of commercial

forestland and 32% of the timber inventory are privately owned.

The timber resource to the east of the Cascades consists of 1.1×10^9 m³ of timber. Pine is 45% of the timber inventory; douglas-fir, 23%; and other species, 32%. The Cascades are a barrier to rainfall from the coastal climate, and the area can best be described as a high mountain plateau. Timber growth is concentrated on the slopes of the Cascades and on mountain ranges within the area. Timber constitutes an average of 146 m³/ha of commercial forestland. About 31% of commercial forestland and 22% of the timber inventory are privately owned.

Washington and Oregon have long been major producers of timber: first softwood lumber; then lumber and pulp; and, finally, lumber, plywood, and pulp. Logging of the timber resource began on privately owned lands located near tidewater and gradually moved into less accessible land in mountainous areas of the Cascade and Coastal mountain ranges. National forests and other public lands were generally the least accessible and the last areas to be actively managed for timber production. Total harvest in western Washington peaked in 1929 and in western Oregon in 1952 (Wall 1972). Harvests on private lands in western Oregon and western Washington also peaked in 1952. Overall production was maintained, however, through increased harvest on public lands (Table 3). Although significant inventories of old-growth timber still exist on private lands, average volumes per hectare on national forestlands (454 m³/ha) versus lands that are privately owned (177 m³/ha) reflect the historical pattern of harvesting. In recent years, national forest-

lands have accounted for about 28% of the harvest in Washington and Oregon; other public lands, 19%; and private lands, 53%. Although the extent of the increase is difficult to measure, during the 1960s and 1970s, forest management on public and private lands generally became more intensive. Even with intensification of management, however, second-growth stands of timber will not produce the heavy volumes per hectare that characterize old-growth forests. Current inventories on forest industry lands cannot support current harvest rates. Several studies (Gedney et al. 1975; Beuter et al. 1976; Haynes and Adams 1979) have suggested that harvests will decline on lands owned by the forest industry. The rationale for a decline in harvests on industry lands is generally accepted, but there is no consensus as to how severe the decline will be or when it will begin. On private lands, timber inventories are generally building: growth exceeds harvest. This, in part, reflects historical harvest patterns: these lands were the first to be harvested. As in other parts of the United States, there are questions about the timber supply potential from privately owned, nonindustrial lands (Sedjo and Ostermeier 1977). In general, individual holdings are small, and owners may have objectives other than timber management. There has also been gradual erosion of the privately owned forestland base as areas are enveloped in urban expansion, road construction, and other development.

The possibility of a decline in harvest following liquidation of old-growth timber was generally recognized for public lands in the late 1960s. The response was to institutionalize a policy of "non-

Table 3. Timber harvest (10⁶ m³), 1950-78.

Year	British Columbia			Alaska	Washington and Oregon		
	Coast	Interior	National forest		Other public	Private	
1950	16.4	5.6	na ^a	8.9	4.6	43.9	
1955	18.6	10.7	na	12.2	8.6	45.0	
1960	19.9	14.1	0.3	15.8	7.6	36.0	
1965	24.3	19.1	0.4	24.9	12.7	34.5	
1970	28.8	25.9	2.8	19.1	16.8	35.9	
1971	28.3	28.0	2.6	20.2	12.9	37.0	
1972	24.7	31.8	2.7	24.6	15.2	35.9	
1973	32.7	37.4	3.0	24.7	15.3	37.8	
1974	27.8	32.3	2.8	20.2	11.8	37.0	
1975	21.4	28.7	2.0	17.0	8.9	35.5	
1976	32.2	37.3	2.3	19.9	12.5	36.1	
1977	28.6	41.4	2.2	18.5	12.3	34.7	
1978	32.4	42.8	2.0	20.4	na	na	

^ana = not available.

Source: Ruderman (1981).

declining even flow" timber harvest on lands managed by federal agencies. Other public lands, generally, also have some policy for sustained timber yield. Such a policy places a maximum on the level of harvest from national forestlands. It also limits the feasibility of departures from current harvest levels. Departures are not feasible if they would eventually lead to a decline in harvest. The National Forest Management Act of 1976 (16 U.S.C. — United States Congress) directed the U.S. Forest Service to update management plans for each national forest. In this planning process, consideration is to be given to conditions that might facilitate departures from the even-flow policy in individual forests. Planning is to be completed by 1985.

Throughout most of the 1960s, there were few open conflicts regarding the management of national forestlands in Washington and Oregon, and the volume harvested annually increased throughout the late 1960s. The Multiple-Use Sustained Yield Act of 1960 (Act of 12 June 1960; 74 Statute 215, as amended; 16 U.S.C., 528–531) institutionalized the concept of management of national forestlands for a variety of uses and products. Beginning in the late 1960s and extending throughout the 1970s, conflicts in management became more frequent, particularly as harvesting began to take place in previously inaccessible areas. Interest groups became organized, often applying political pressure and appealing to the courts to question allocations of land and the propriety of management practices such as the use of chemicals to control forest pests and unwanted vegetation.

In part, the conflicts led to a review by the U.S. Forest Service of all undeveloped land under its management. The review process identified land to be retained primarily as wilderness. Some of the recommendations resulting from this review have been challenged and currently await implementation. The U.S. Congress must approve the designation of forestland as wilderness.

In summary, timber harvests will likely decline on industry lands, while public lands continue to have high volumes of inventory per hectare — a setting that will probably mean continued conflict among interest groups regarding the management of public lands within Washington and Oregon.

The capacity to process timber in Washington and Oregon has evolved, partly in response to the characteristics of the timber resource. Some firms are almost independent of open-market purchases of timber to meet the requirements of their mills, whereas others are completely

dependent. Prices for timber have increased rapidly in the last 10 years, going from U.S.\$4.88/m³ in 1960 to U.S.\$5.89/m³ in 1970 and U.S.\$58.72/m³ in 1980 (Ruderman 1981). A side effect of the rise in price has been improved utilization: more of the log is being recovered as lumber and plywood and as by-products to be used in pulp manufacture. Better utilization is also a reflection of innovations in logging and processing technology, although many firms still are operating mills with the technology of the 1950s and 1960s. These firms are ill-prepared to handle the small, second-growth logs that are now common; thus, they will have the most trouble competing for timber supplies in the 1980s.

Nature endowed Washington and Oregon with a softwood-timber resource with unique properties. Douglas-fir has many desirable characteristics as a construction material, and the old-growth trees yield clear, large timbers. Since the 1800s, the two states have shipped large timbers and specialty items throughout the world. The bulk of softwood lumber, however, supplies the U.S. domestic market. Since World War II, annual production of softwood lumber in Washington and Oregon has been reasonably stable (Table 4). The distribution of shipments within the United States has changed considerably, however, particularly during the 1970s. Water-borne shipments from Washington and Oregon to the U.S. east coast stopped in the early 1970s, partly because of competition from producers in British Columbia who were not bound by the terms of the Jones Act (Austin and Darr 1975). In the 1970s, rail-freight costs from Washington and Oregon to the U.S. midwest and northeast increased markedly in the wake of escalating energy costs. Also during the late 1970s and early 1980s, there was a gradual devaluation of the Canadian dollar relative to the U.S. dollar, which further enhanced the competitiveness of Canadian producers in U.S. markets. There was also some increase in competition from producers in the southern United States. By 1980, about 68% of the lumber produced in western Washington and western Oregon was sold in the west, up from 47% in 1972.

Increased demand in California, Arizona, and other western states has eased some of the transition in markets for the output of softwood lumber from Washington and Oregon. The erosion of the competitive position of producers of softwood lumber in Washington and Oregon for domestic U.S. markets in the 1970s increased the interest of these producers in foreign sales, particularly to Japan and other Pacific-rim markets.

Table 4. Production of softwood lumber, softwood plywood, pulp, and paper and paperboard, 1950–79.

Year	Softwood lumber (10 ⁶ m ³)			Softwood plywood (10 ⁶ m ²) ^a			Pulp (1000 t)			Paper and paperboard ^a (1000 t)	
	Alaska	Washington and Oregon	British Columbia (coast)	British Columbia (interior)	Washington and Oregon	British Columbia	Alaska	Washington and Oregon	British Columbia	Washington and Oregon	British Columbia ^d
1950	na	25.5 ^c	5.9	2.4	218	na	na	2213 ^b	705	1370 ^b	347
1955	na	29.0	6.5	5.1	412	72	na	2879 ^b	1237	2046 ^b	503
1960	0.2 ^b	25.4	6.7	5.8	613	105	242 ^b	3367	1928	2627	777
1965	0.4 ^b	26.5	8.6	9.0	937	145	344	4496	2971	3421	1100
1970	0.8	23.3	8.9	9.4	859	161	318	5494	4101	4431	1192
1971	0.7	25.7	9.9	11.3	949	173	366	4770	4409	4246	1738
1972	1.0	27.6	9.4	3.0	1011	186	358	5139	4576	4712	1776
1973	1.2	27.9	10.4	14.2	999	205	412	5559	5337	4961	1334
1974	0.9	24.1	8.0	12.7	828	164	372	5573	5268	4908	1948
1975	0.7	22.3	5.9	11.7	804	162	311	5130	3998	4518	1051
1976	0.7	26.0	9.4	16.0	911	199	384	5518	5320	4860	1327
1977	0.6	27.2	10.6	17.8	940	218	360	5964	4831	5329	1288
1978	0.6	27.3	11.3	18.3	958	237	296	5118	5426	4782	1379
1979	0.7	26.3	11.0	18.6	897	264	360	—	5324	—	—

^aNo production of softwood plywood or paper and paperboard occurred in Alaska during this period.

^bData are for the following year.

^cData for 1947.

^dNewsprint only.

Sources: Canadian Pulp and Paper Association (1981); Ruderman (1981).

Offshore sales of softwood lumber from Washington and Oregon fluctuated between 1 and 2×10^6 m³ in the 1970s, and markets were worldwide (Table 2). The worldwide sales pattern reflected the specialty nature of the products. The United States and Canada are the only two industrialized countries that use the so-called platform-frame construction technique as the standard means of home construction. Also, these two countries have yet to convert to metric sizes for construction materials; U.S. grades and standards for both lumber and plywood differ from those in Japan and western Europe, and U.S. distribution and sales methods differ from those in offshore markets. This lack of familiarity with offshore markets, plus tariff and nontariff trade barriers, has limited the development of offshore sales from both the United States and Canada. Promotion efforts in both Japan and western Europe on the part of North American industry began on a sustained basis in the late 1970s. North American producers are optimistic that sales will improve in the future. In 1979, offshore sales of softwood lumber from Washington and Oregon amounted to 1.7×10^6 m³, up from 1.1×10^6 m³ in 1978 and 900 000 m³ in 1970. Much of the increase in sales went to Japan, which purchased 840 000 m³ in 1979, up from 385 000 m³ in 1978 and 71 000 m³ in 1970. Other Pacific-rim markets accounted for 293 000 m³ in 1980.

In Japan, U.S. producers of softwood lumber compete with their counterparts from around the world (Table 5). Timber harvest in Japan declined from 5.2×10^7 m³ in 1967 to a low of 3.4×10^7 m³ in 1975. In the late 1970s, imports of timber products of all types accounted for about two-thirds of Japanese consumption, up from

one-third in the early 1960s. The decline in harvest in Japan occurred at a time of rapid increases in Japanese demand, particularly for home construction.

From the United States, the export of softwood logs to Japan was initially an outlet for hemlock and other species with limited domestic markets and an outlet for logs salvaged after a devastating windstorm in the early 1960s. Recently, however, the volume of exports has grown and has engendered considerable controversy (Darr et al. 1980). The volume of exports from Washington and Oregon grew to 1.2×10^7 m³ in 1973, declined in 1974-75, and reached a record high of 1.5×10^7 m³ in 1979 (Table 6). The two states account for about 94% of log exports from the west coast, most of which go to Japan. In the late 1970s, log exports amounted to about 22% of the total timber harvest in western Washington and western Oregon and had a total annual value of about U.S.\$1.4 billion. There have been continuing negotiations between the Japanese and U.S. governments on the feasibility of expanding U.S. exports of softwood lumber to Japan at the expense of softwood logs. The controversy over softwood log exports over the years has led to restrictions on the export of roundwood logs from lands managed by the State of Oregon and lands managed by federal agencies (Lindell 1978).

The export of pulpwood chips to Japan from the United States began in 1965, from Oregon. Subsequently, the volume grew rapidly, Washington and Alaska also contributing (Table 6). The volume from Washington and Oregon reached a peak of 3.2 Mt in 1974, declined in 1975, and rose again to 3.1 Mt in 1979. With the exception of isolated shipments, chip exports

Table 5. Japanese imports of selected timber products, 1979.

Origin	Logs (10 ⁶ m ³)		Lumber (10 ⁶ m ³)		Pulp chips (1000 t)	Plywood (10 ⁶ m ²)	Wood pulp (1000 t)	Paper and board (1000 t)
	Softwood	Hardwood	Softwood	Hardwood				
United States	12339	81	1139	12	3704	0.5	466	88
Australia-								
New Zealand	963	- ^a	29	1	2382	- ^b	233	4
Soviet Union	6648	87	134	1	317	0	9	0
Other Asian								
Pacific rim	466	22088	485	371	304	12.0	- ^c	6
Canada	335	7	1719	6	318	0.7	815	67
Other Pacific rim	213	213	42	22	82	- ^b	12	- ^c
Other	3	208	243	2	249	- ^b	323	35

^aLess than 500 m³.

^bLess than 50 000 m².

^cLess than 500 t.

Source: Japan Tariff Association (1980).

Table 6. Exports of pulp chips and softwood logs, 1965-80.

Year	Chips (1000 t)		Logs (10 ⁶ m ³)			
	Alaska	Washington and Oregon	Alaska		Washington and Oregon	
			Total	To Japan	Total	To Japan
1965	0	83	50	45	4081	3510
1970	0	1673	233	216	10039	9714
1971	18	1573	193	176	8322	7748
1972	18	2041	298	280	11946	10832
1973	0	2768	325	325	11956	11123
1974	32	3237	158	132	9918	8949
1975	29	2506	131	110	10081	9125
1976	98	3029	119	94	12399	11538
1977	97	2879	237	212	11577	10638
1978	29	2676	308	261	12899	11424
1979	76	3149	583	547	14648	13408
1980	137	2831	727	708	11922	10620

Source: Ruderman (1981).

from Washington and Oregon went to Japan. In the 1970s, Japan developed chip supply sources in Australia, South Africa, and other countries (Table 5).

Most of the chips directed toward the pulp industry and export markets consist of by-products from the manufacture of lumber and plywood; to date, chipping of roundwood on a sustained basis has not proved economically feasible because supplies of chip by-products have generally been in balance with demand. However, in 1980, a decrease in production of lumber and plywood occurred at the same time as an increase in pulp production, and the result was a doubling of the price of chips in a matter of months. The projected decline in timber harvest with coincident declines in lumber and plywood production may make roundwood chipping more viable.

After increasing rapidly in the 1960s, the manufacture of pulp in Washington and Oregon was relatively stable in the 1970s (Table 4). Expansion at existing sites in the 1970s was offset by the closure of obsolete mills in the Puget Sound area. The primary offshore markets for pulp from Washington and Oregon are Japan, other Asian Pacific-rim countries, and the Common Market (Table 1). The remainder is consumed primarily in the manufacture of paper and board within Washington and Oregon and in the sale of market pulp to the California area.

The manufacture of paper and paperboard generally parallels the pattern of pulp manufacture in Washington and Oregon (Table 4). Newsprint and writing paper are major items of export to Japan and other Asian Pacific-rim countries (Table 1). Most of the remaining production is

consumed on the U.S. west coast. In Japan, U.S. producers of pulp, paper, and paperboard face competition from Canadian mills and from domestic mills in Japan (Table 5).

Technological innovations, spurred by the rising costs of lumber in home construction, led to the rapid development of the softwood plywood industry in Washington and Oregon (Table 4). Production increased from 2.18×10^8 m² in 1950 to a high of 1.01×10^9 m² in 1972. Output in the late 1970s was relatively stable. Technological innovations also led to the development of softwood plywood based on the utilization of southern pines. The manufacture of southern-pine plywood began in 1964, and southern mills, with an advantage over western producers because of lower costs for wood and transportation to markets in the east, captured most of the growth in U.S. consumption during the 1960s and early 1970s. In the mid- and late 1970s, annual U.S. plywood production was about 1.8×10^9 m².

Until the mid- and late 1970s, the U.S. plywood industry was oriented almost entirely toward domestic markets. Promotion efforts of U.S. industry in the 1970s led to some increase in sales to offshore markets, primarily to western Europe (Table 7). Producers in Washington and Oregon account for about 90% of U.S. sales to foreign markets. In western Europe, the main competition for U.S. producers comes from Canada and from mills within western Europe. In Europe, U.S. plywood is used mainly for concrete form material and other specialty items. Grades, standards, and building codes have limited the success of efforts to promote the utilization of U.S. plywood in the home construction industry.

Table 7. Exports of softwood plywood (10^6 m²), 1970-80.

Year	Washington and Oregon	British Columbia
1970	8.4	55.6
1971	6.6	33.7
1972	11.4	41.6
1973	26.5	45.1
1974	26.4	33.5
1975	37.8	26.1
1976	49.5	22.0
1977	21.7	38.1
1978	22.5	49.2
1979	30.7	47.2
1980	26.0	53.1

Sources: Ruderman (1981); Statistics Canada (1981).

Exports of softwood plywood from Washington and Oregon to Japan have been minimal. Grades, codes, and standards have limited the acceptance of softwood plywood from the United States and Canada. The rapid growth in Japanese consumption of plywood in the 1960s and early 1970s was based on the importation and processing of tropical hardwood logs from Southeast Asia. Relatively low costs for this plywood plus consumer acceptance of the product contributed to the increase in consumption.

There are many factors operating that will affect the softwood plywood industry of Washington and Oregon in the 1980s and 1990s. In addition to competition from softwood plywood producers in the southern U.S. for domestic markets, technologies for various types of fiberboard have been developed. These technologies are being adopted to process the so-called soft hardwoods such as aspen in the northern U.S. and the prairie provinces of Canada. These fibre products are competitive in price with solid plywood and may be used as a substitute for softwood plywood in sheathing and other applications in home construction. Log export restrictions in Southeast Asia will affect tropical hardwood log exports to Japan and may spur development of trade in softwood plywood between North America and Japan. Even then, however, U.S. producers must meet potential competition from Canadian producers and from the manufacture of plywood from veneer imported into Japan from Southeast Asia and other sources.

In summary, there are many issues and uncertainties at both the resource and end-product levels concerning the forestland and timber industry of Washington and Oregon. Private lands that supported the bulk of timber harvest

during the earlier decades of this century no longer have the timber inventory to support the current rates of timber harvest. Major questions of land use and timber flow policies on public lands add to the uncertainty about future supplies of timber. Competition from Canada and the southern U.S. has eroded the Pacific northwest's markets in the major consuming areas of the midwest and northeast U.S. Looming in the future is competition for solid-wood products from fibre products. Efforts to promote offshore sales have met with only limited success. Individual firms have met some or all of these problems with improved technology and responsive marketing efforts. On the whole, however, the timber resource and timber industry of Washington and Oregon are at a turning point. Log export policies, timber flow policies on public lands, and developments in offshore markets will all play a part in their future development.

British Columbia

The Province of British Columbia has an area of 93.1 Mha, 56% of which is forested (Bowen 1978). There are 48.2 Mha of productive, forested land capable of producing a merchantable stand within a reasonable period and not withdrawn from timber production. There is a total inventory of 7.6×10^9 m³ of timber on the productive forestland (about twice the volume of Washington and Oregon). Spruce accounts for 23% of the timber inventory; hemlock, 23%; and balsam fir, 19%.

The coast of British Columbia has a timber resource base different, in many respects, from the interior of the province. For example, in the Vancouver area (southwestern British Columbia and Vancouver Island), hemlock (40%) and cedar (26%) are the most important species; in the Kamloops area (southern interior), spruce (28%) and lodgepole pine (24%) are the most important species. Trees are smaller in diameter in the interior, and the volume per hectare is smaller, e.g., 120 m³/ha in the Kamloops area and 243 m³/ha in the Vancouver area (Province of British Columbia, Ministry of Forests 1980).

With the exception of about 5% of the total area of productive forestland, the Province of British Columbia owns and has ultimate responsibility for management of the forestlands of British Columbia. Other lands are mainly privately owned and located on Vancouver Island.

Directly or indirectly, roughly one in four people employed in British Columbia depends upon the timber resource for a job (British Columbia Forest Service 1975).

Until 1950, development of the sawmill industry was concentrated on the coast and involved the manufacture of lumber for foreign markets. Through links with other members of the Commonwealth, British Columbia has long been an exporter of softwood lumber to offshore markets. Following World War II, improvement of the transportation system in the interior, technological innovations in processing timber, government timber-sale policies, and increased demand in the United States all contributed toward rapid expansion of lumber production in the interior (Table 6). During the 1960s and 1970s, British Columbia became increasingly dependent upon the United States for a market. Coastal British Columbia in the 1970s dominated water-borne shipments of lumber from the west coast of North America to the east coast.

Total production of softwood lumber in British Columbia increased to 2.46×10^7 m³ in 1973, declined in 1974–75, and jumped to a record high of 2.96×10^7 m³ in 1978. In the late 1970s, shipments of lumber from British Columbia to the United States amounted to 20% of U.S. consumption, and the United States accounted for 80% of total exports from British Columbia. By the late 1970s, Japan had displaced the United Kingdom as the second most important foreign market for British Columbia producers (Table 1). In part, the increased sales to Japan reflect the efforts of industry and government in British Columbia in promoting the sale of softwood lumber. Devaluation of the Canadian dollar relative to Japanese and U.S. currencies has also enhanced the competitive position of British Columbia producers in both the Japanese and U.S. markets.

The pulp-and-paper industry of British Columbia grew gradually on the coast until after World War II. Output went mainly to foreign markets and products consisted of both pulp and newsprint. In 1960, the first pulp mill was established in the interior of the province and was quickly followed by others. The availability of relatively inexpensive hydroelectric power in the interior of the province contributed to the growth of the pulp industry during the 1960s. Development was also facilitated by government timber-sale policies aimed at matching additional capacity with the availability of by-products from the emerging sawmill industry. These policies also intended to improve utilization of low-quality roundwood timber that was not suitable for the manufacture of lumber.

During the 1960s and 1970s, there was some expansion of capacity at existing sites on the coast. By the 1970s, pulp production was about 5

Mt. About 68% of the pulp mill capacity is on the coast and the remainder in the interior.

The primary products of the pulp-and-paper industry of British Columbia continue to be market pulp and newsprint. About 40% of the pulp that is produced is processed domestically, the remainder going primarily to the United States, Japan, and the United Kingdom (Table 1). In the United States, most of the pulp and newsprint from British Columbia goes to the west coast. Producers in the United States and Japan are the primary sources of competition for British Columbia producers in the Japanese market (Table 5).

Technological innovations in the manufacture of softwood plywood led to an expansion of production in British Columbia in the 1950s and 1960s, first on the coast and then in the interior (Table 4). In the late 1970s, production exceeded 2.25×10^8 m². About 80% of the output is consumed within Canada. The remaining 20% is shipped primarily to the United Kingdom and other countries in the European Economic Community (Table 1). There is no pattern of sustained shipments of softwood plywood to countries around the Pacific rim. In general, offshore shipments of softwood plywood from British Columbia have been limited by tariffs, codes, standards, and other factors that have also limited U.S. sales.

British Columbia has restrictions on the export of roundwood logs dating from 1906. Restrictions on chip exports were liberalized in the late 1970s. The restrictions permitted exceptions but practically eliminated British Columbia as a source of unprocessed timber in world markets.

Attitudes toward the forest resources of British Columbia have evolved during the past century. Prior to 1912, there was little concern over management and disposition of the timber resource. The forest was sometimes viewed as an impediment to other development, such as agriculture, and the forest seemed inexhaustible. In 1910, the Fulton Commission concluded that large-scale alienation of timber-cutting rights should be stopped and remaining reserves of timber should be left undeveloped. After 1912, policies were implemented that slowed development of the timber resource. The Sloan Report, in 1945, established the concept of sustained yield harvesting and management of forests. This view was reinforced by a second Sloan Report in 1956. The rapid development of the timber resource in the 1960s and early 1970s raised concerns over tenure systems, forest management, uses of the forest other than timber production, and other

matters. These concerns led to a review by the Pearse Commission in 1976 (Pearse 1976).

The findings and recommendations of the Pearse Commission were responsible, in part, for the passage of a new Forest Act in 1978. Among other directives, the act mandates an analysis of forest and range resources every 10 years. The first of these analyses, published in 1980, found that, under existing management, current harvest rates cannot be maintained in some areas of the province. The response of the British Columbia Forest Service was to propose a 5-year program with the intent of intensifying forest management so as to enhance harvest opportunities (Province of British Columbia, Ministry of Forests 1980). Pending detailed examination of the province's forest resources and harvesting rates, the timber harvesting program will be continued at about the present level from 1980 through 1985. Thus, an effect of the program will be to limit the responsiveness of the British Columbia timber industry to significant, sustained increases in demands for timber products in the 1980s. Shifts in shipment patterns between the United States and offshore markets are still possible, however.

There are many parallels between the development of the timber resource in British Columbia and that of the public lands in Washington and Oregon. In both areas, the forest was viewed initially as a resource to be exploited and later as one to be managed for perpetual yield of timber. A key difference between the province and the two states is the relative importance of private ownership of forestland in Washington and Oregon. The structure of the processing industry, social infrastructure, and other aspects of the economy developed according to the pattern of harvest of timber; harvest patterns on private land have differed from those on public land. The mixture of private and public ownership has resulted in the creation of a large number of interest groups. The differing objectives of these groups have set the stage for continuing debates over policies affecting the timber resource.

Another difference between the Province of British Columbia and the states of Washington and Oregon is the policy for the sale of the rights to the timber resource on public lands. Various tenure arrangements in British Columbia have long-time horizons, with the purchaser having at least some assurance of long-term timber supply: stumpage fees are only one consideration in the marketing of timber from public land. In Washington and Oregon, stumpage on public land is sold to the highest bidder, and harvesting rights are limited to specified volumes in specified areas. A purchaser may need several sales under

contract at any time to ensure a stable supply of raw materials. The auction method has contributed to high stumpage prices in Washington and Oregon compared with those in British Columbia (Haley 1980). Uncertainty about the availability of timber from public land probably contributes to the instability of operations for individual firms in Washington and Oregon.

Future Prospects

Japan is the focal point of Pacific-rim trade in timber products and provides the links between the timberlands of the Pacific northwest and the remainder of the Pacific rim. For example, the volume of trade between British Columbia and Japan affects trade between British Columbia and the United States, the United States and Japan, the Soviet Union and Japan, New Zealand and Japan, etc. Competition among supply areas in the Japanese market will likely intensify in the future, particularly in the area of solid-wood products: softwood logs and softwood lumber. In contrast with a history of a growing market for softwood construction materials tied to demand for housing in Japan, future demand may be stable or declining (Ueda and Darr 1980). Under these conditions, shipments from any one supply source can increase only at the expense of shipments from other sources.

Demand in Japan is expected to grow for fibre-based products, such as pulp, newsprint, and paperboard (Ministry of Agriculture, Forestry and Fisheries, Government of Japan 1980). This growth in demand will likely be met with increased shipments of pulp, chips, and finished products from the Pacific northwest, Australia, New Zealand, and other areas around the Pacific rim (Yasu 1981).

In addition to the historical pattern of competition between producers in the Pacific northwest and domestic Japanese producers, there may be competition from New Zealand, Chile, and the countries of Southeast Asia. New Zealand has the potential to become a major exporter of pulp to world markets (Cavana and O'Dea 1979). As log-export restrictions are initiated in Malaysia, the Philippines, and Indonesia and as proposed development plans come to fruition, these countries may become exporters of hardwood lumber, veneer, and plywood.

The People's Republic of China has initiated purchases of forest products from the Pacific northwest. The future market potential is unknown at present, but this country could become a major influence in the pattern of trade for timber products around the Pacific rim.

Pulp-and-paper manufacturers in Washington and Oregon have limited potential to increase production and respond to the expected increases in demands around the Pacific rim, given the current pattern of reliance upon the by-products of lumber and plywood manufacture. Increased consumption of roundwood and decreased chip exports are two possibilities for expanding wood supplies for domestic pulp manufacture. Even the potential of these options is dampened, however, by an expected decline in timber harvest.

The Alaska Lands Bill mandates for the timber industry — dependent upon federal land in southeast Alaska — a minimum of 2×10^6 m³/year to maintain its processing capacity. In addition, lands transferred to native ownership have the potential to support, at least for several decades, annual exports of as much as 1.8×10^6 m³ of softwood logs. If intensive management of national forestlands and improved utilization succeed in increasing timber harvest potential, the industry will have more than 2×10^6 m³ available for use. In the 1980s, the processing sector of the timber industry in Alaska will be constrained in its interactions with Pacific-rim markets.

Recent analysis indicates that the post-World War II pattern of rapid expansion of output of timber products in British Columbia cannot be

maintained. Any future expansion of output will be tied more to programs designed to intensify forest management than to the availability of untapped reserves of timber. Government policies affecting timber appraisals and timber sales, the value of the Canadian dollar relative to other currencies, and competition from eastern Canada and the southern U.S. for the U.S. eastern market will all affect future sales patterns for British Columbia producers. The availability of timber resources may place a ceiling on production in British Columbia. In Pacific-rim markets, British Columbia producers will face competition from U.S. mills, producers in Japan, and, possibly, from new developments in New Zealand, Southeast Asia, and other areas.

Uncertainties about the resource situations in Alaska, British Columbia, Washington, and Oregon; demand in Japan, the People's Republic of China, and Southeast Asia; and supply potentials of New Zealand, Chile, and other countries suggest that the 1980s and 1990s will be different, in many respects, from the 1960s and 1970s. Interactions of markets will intensify around the Pacific rim. Shifts in markets will present new problems and opportunities. The challenge to the owners, managers, and processors of timber from forestlands in the Pacific northwest is to convert into opportunities situations that currently may be perceived as problems.

Discussion

Wontack Hong: Darr argues that, if the volume of logs exported from native lands in Alaska expands radically, the resultant reduction in the price of logs sold to Japan would make timber processing in Alaska unviable (economically infeasible). However, unless there has been log-price discrimination between lumber mills in Alaska and those in Japan and unless the extent of price discrimination is proportional to the export price of logs, fluctuations in log price will not influence timber processing in Alaska or in Japan. The location of processing is not usually determined by the price level of the tradable intermediate products.

The question is whether the entire line of wood processing — manufacturing of lumber, veneer, plywood, fiberboard, chips, pulp, paper, or paperboard — should be located at the source of raw material or whether there is room for distant

processors to specialize, using imported logs or imported intermediate inputs.

In the past, South Korea imported hardwood logs from the ASEAN and, on the basis of low-cost labour, became a major exporter of hardwood lumber, veneer, and plywood. The U.S. and Japan have been major importers of South Korean plywood. However, as log-export restrictions are initiated in Malaysia, the Philippines, and Indonesia, South Korea has either to find alternative sources of log supply or to shift its processing line into high-quality end-products based on imported, semiprocessed wood products, such as veneer.

Darr says that exports of softwood plywood from Washington and Oregon to Japan have been minimal and argues that grades, building codes, and standards have limited the Japanese acceptance of softwood plywood imported from

the U.S. and Canada. However, I believe that the nonacceptance needs to be explained in terms of the labour-intensity of the manufacturing process and the labour costs in each country.

B.C. prohibits export of unprocessed timber. The U.S. also restricts exports of softwood logs but encourages the export of softwood lumber or softwood plywood. One should question whether such restrictions reflect comparative advantage or protectionism. In other words, do the production technology, the capital- or land-intensive nature of the processing, and the labour costs give these areas a comparative advantage over areas elsewhere? If the answer is no, then a self-respecting economist would condemn the protectionist policy or tolerate it on the basis of political excuses. Darr should have examined several aspects more systematically. For instance, he should have analyzed what determines the ideal location of the pulp industry and what is the significance of available processing technology, pollution, or labour costs in determining the location of each processing activity.

In analyzing the controversy over softwood log exports from the U.S., Darr puts stumpage owners on the one hand and processors and consumers of end-products together on the other hand. However, he should have separated the timber processors from the consumers to examine the protectionist nature of the problem and conflicting interests between these two groups.

Although the untapped reserves of timber in the Pacific northwest have rapidly been reduced, forestry management now seems to be reasonably optimal, ensuring a perpetual stream of

nondeclining timber harvests rather than a gradual depletion of timber resources in the region.

I believe Darr has overemphasized the uncertainties in timber resources deriving from the transfer of Alaskan forestland to native corporations. The uncertainties can hardly be attributed to the likelihood that the real price of timber will decrease. Timber does not seem to have low income elasticities of demand, the world demand likely continuing to increase and to raise the real price continuously. The only uncertainty in this regard is the speed of the price increases. The uncertainties to which Darr refers may result from possible shifts in markets and trade patterns, reflecting shifts in labour costs in each timber-processing country, progress in labour-saving techniques, technical progress in timber processing, lower costs for transportation, or the location of mass-consumption areas for final wood products. However, whatever the shifts in trade patterns, so long as these shifts are not the result of protectionist policies but are a reflection of the underlying market forces, they are a sign of more efficient use of a scarce resource, that is timber.

Essentially, there seems to be nothing extremely serious for us, as economists, to worry about in the future of timber resources of the Pacific northwest. Of course, if we consider the problem of management of timber resources in other regions (such as Southeast Asia or Latin America) or the feasibility of substantially increasing the global timber supply in the future, we may have a host of worries. Maybe what we need is comparative studies on forestry management worldwide.

Development Prospects for Forestry in Indonesia

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In this paper, I describe the forestry resource base, production pattern, and export economy in Indonesia; assess the implications of international trade on forestry development; and discuss investment prospects in forestry.

Ce document porte sur le potentiel des ressources forestières en Indonésie, les modèles de production et l'économie de l'exportation de ce pays; l'auteur évalue l'impact du marché international sur l'aménagement du secteur forestier et expose divers types d'investissements dans ce domaine.

It was estimated that supply of South-Sea logs from the Pacific region during the 1980s would continuously fall short of the demand in the international market. An estimated deficit of 1.1×10^6 m³ in 1980 would increase to a deficit of 4.3×10^6 m³ in 1990, corresponding to 3.3% and 21.7% of the demand. About half of the South-Sea log supply comes from Indonesia.

Forestry has contributed substantially to the foreign exchange earnings of Indonesia, producing the largest foreign exchange after oil. Forestry development has, therefore, been one of the major programs in the overall economic development policy. The program includes public efforts in reforestation, afforestation, and forestland rehabilitation, as well as measures to stimulate private investments in forest exploitation.

Forestry Resource Base

Throughout Indonesia, forestland covers around 122 Mha or roughly 60% of the land total. In 1979, almost 75% was rain forest. The second largest forest types — secondary or idle forest and swamp forest — occupied less than 15% of the total forest area. The remaining four types — coastal, peat, deciduous, and mangrove — each covered around 1% of the total forestland. The predominance of rain forest is not surprising because the country is an archipelago within the monsoon rainbelt.

Between 1972 and 1973, forest exploitation jumped by nine times to reach 63.1 Mha (Table 1); similarly protection forest increased by 23%; and nature conservation forest more than doubled. These increases were possible because the area of reserved forest was reduced by more than 60%. The changing structure of the export market, with decreasing supply from the Philippines, produced a tremendous demand, resulting in the rapid growth of forest exploitation. In terms of geographic distribution (Table 2), more than 90% of the total forestland is in Sumatra, Kalimantan, and Irian Jaya. However, the forest uses differ among the various provinces.

In 1978, 7.8 Mha of land was considered to be critical (Table 3) — the soil has been seriously degraded. Of this area about 60% is within the forest area. Reforestation and afforestation are a major concern of the economic development policy and the areas of reforestation and afforestation.

Table 1. Forest areas (Mha) by function in 1972 and 1979.

Forest function	1972	1979	Change in %
Protection	11.5	14.2	23
Production	11.1	63.1	468
Nature conservation	3.5	7.9	26
Reserved	96.1	37.0	-62

Source: Directorate General of Forestry.

Table 2. Forest areas (Mha) by function in each island, 1979.

Province	Forest type			
	Protection	Production	Nature conservation	Reserved
Sumatra	4.7	18.1	2.2	3.4
Jawa	0.6	1.8	0.4	0.1
Bali and Nusa Tenggara	1.2	0.2	0.2	0.4
Kalimantan	2.7	32.7	0.8	5.2
Sulawesi	2.9	4.2	0.9	1.9
Maluku	2.0	3.9	0.1	0.1
Irian Jaya	0.1	2.3	3.3	25.9

Source: Directorate General of Forestry.

Table 3. Areas (Mha) of critical land by region, 1978.

Region	Outside forest area	Inside forest area
Sumatra	1.4	0.5
Jawa	0.9	0.3
Bali	0.2	0.1
West Nusa Tenggara	0.1	0.1
East Nusa Tenggara	1.0	0.3
Kalimantan	0.4	0.9
Sulawesi	0.6	1.1
Irian Jaya	0.1	0.1

Source: Directorate General of Forestry.

tion have generally increased in the last 10 years (Table 4). However, it has not yet been possible to rehabilitate all the critical lands.

Production and Exports

In 1981, Indonesia produced 2.46×10^7 m³ of timber, in which 2.12×10^7 m³ were logs and 3.4×10^6 m³ were sawn timber. Both the composition and total production have changed since 1970 (Table 5). Log production increased twofold, whereas sawn timber production expanded more

Table 4. Areas ('000 ha) of reforestation and afforestation in Indonesia.

Year	Reforestation	Afforestation
1970-71	26.8	71.9
1971-72	22.1	80.9
1972-73	82.7	42.3
1973-74	78.8	40.0
1974-75	84.3	57.0
1975-76	25.3	37.8
1976-77	162.8	302.6
1977-78	149.4	511.6
1978-79	292.6	651.9
1979-80	301.3	680.1

Source: Directorate General of Forestry.

Table 5. Timber production (10⁶ m³) in Indonesia, 1970-79.

Year	Log	Conversion/sawn
1970	10.4	0.2
1971	13.7	0.4
1972	16.9	0.8
1973	25.8	1.3
1974	20.9	0.9
1975	14.6	1.7
1976	20.8	0.6
1977	22.4	0.6
1978	24.8	1.5
1979	21.2	3.4

Source: Directorate General of Forestry.

than 10 times. In general, increasing amounts of processed forest commodities were produced (Table 6).

In 1980, forestry exports amounted to U.S. \$1.8 billion and were more than 10 times that of 1970 (Table 7). In terms of volume, exports had doubled. The general upward trend of export prices indicated the increasing gap of demand over supply. However, major constraints to the development of exports of forest products have been inadequate harbour facilities, high shipping costs, poor quality control, and lack of trade skill and management.

Between 1969 and 1980, timber exports varied between about 60% and 85% of total production. The period when a high percentage of total production was exported, 1975-1977, was followed by a decline. Apparently, with increasing incomes, the domestic market is able to use more of the output, particularly of processed wood products.

International Perspectives

Because of insignificant replanting of felled trees in the supplying countries of Asia and the Pacific, log exports in the region are expected to

Table 6. Production of forest and processed forest commodities, 1973 and 1977.

Commodity	1973	1977	Increase in % annually
Logs (10 ⁶ m ³)	25.8	22.4	-1.0
Sawn timber (10 ⁶ m ³)	0.25	0.92	61.7
Plywood ('000 t)	1.37	9.18	65.1
Paper ('000 t)	47	83	13.4
Corrugated board ('000 t)	14	31	31.9

Source: Directorate General of Forestry.

decrease by about 50% between 1980 and 1990. Even with the emergence of fast-growing tropical trees, this situation is unlikely to change in this century. Equally, the planned local processing of logs into manufactured products in Indonesia, Sabah, Sarawak, and Papua New Guinea will accentuate the decline.

The historical preference of the Japanese market for unprocessed material is likely to continue as is the depletion of forest resources to meet the demand. The exports to Japan mean that there is unlikely to be enough resources to supply mills in developing countries for worthwhile investment periods. The average price movements for dipterocarp hardwood logs in 1979-80 from Southeast Asia continued to hold at about twice the level for 1976-78. There is little evidence that this situation will change because Japan purchased 60-70% of the total supply available.

Increasing demand for wood products has come from China for construction purposes, coal mining, railway sleepers, and paper manufacture.

Table 7. Volume, value, and average price of timber exports, 1969-80.

Year	Volume (10 ⁶ m ³)	Value (U.S.\$, millions)	Average price ^a (U.S.\$/m ³)
1969	3.6	26.5	7.36
1970	7.6	86.7	11.36
1971	10.8	168.6	15.67
1972	13.9	230.3	16.58
1973	19.4	583.4	30.02
1974	18.1	725.6	40.13
1975	13.9	500.0	35.91
1976	18.5	781.8	42.21
1977	19.8	951.3	48.03
1978	20.2	995.1	49.26
1979	19.5	1786.6	91.67
1980	14.3	1805.7	126.24

^aAverage price of export equals the value of export divided by the volume of export.

Source: Directorate General of Forestry.

The massive afforestation campaigns of the 1950s and 1960s in that country are unlikely to provide this raw material in the quantities required.

Proposals for increased pulp- and paper-manufacturing plant installations are made at frequent intervals in Asian countries. However, the viability of such plants depends upon government support for the proposals and the adequacy of raw-material supplies. At the moment, initiatives by public and private sector organizations are actively encouraged in various ways in the Philippines, South Korea, Taiwan, Malaysia, Thailand, and Indonesia.

The marked rise in the value of wood as a commodity in the Pacific area has occurred because of the supply and demand in the 1980s, the interest in wood as a renewable energy resource, and the emergence of South Korea, Taiwan, and China as significant purchasers. This may stimulate governments and investors to channel their resources of capital, land, and personnel into a belated, but still necessary, effective afforestation effort.

Investment is needed in permanent forests managed for specific needs and uses. However, with the relatively long payback period and current high interest rates, it is difficult to convince investors of the desirability of such investment. The impetus must come from governments who will either invest in forests themselves or, through fiscal and other appropriate measures, encourage companies and individuals to do so.

Investment Prospects

Today, in Indonesia, there are 525 firms holding forestry concessions with a total invested capital of about U.S. \$1.5 billion. Of these, 430 firms are operating under domestic investment facilities and 95 under foreign investment facilities. During the past decade, more and more firms have applied for domestic investment facilities and fewer foreign investors have entered the market.

The government has encouraged the firms to produce more processed wood and fewer logs. In 1980, a new regulation was issued under which firms could export no more than 50% of their logs and were required to process 50% locally. A few months later, the requirement was increased so that an export permit would be issued for one unit of logs if the firm could produce evidence that it had sold, for local manufacturing, two units.

From an international perspective, it seems likely that Indonesia will become a producer of plywood and other manufactured goods. The

major constraint would be the availability of managerial skill.

Special plans are being considered to encourage the establishment of timber manufacturing. Under these plans, no new forest concessions will be granted to applicants who do not submit plans for establishing a wood-processing plant.

Equally, existing forest concession holders are advised to merge among themselves to establish a viable wood-manufacturing plant.

The demand for forestry products in the Asia and Pacific markets suggests that extended investment activity in forestry in Indonesia is promising.

Discussion

R.N. Byron: Birowo's paper is extremely useful as a review of the current resource base on trade flows in Indonesia. The change in the area classified as production forest (from 11.1 Mha in 1972 to 63.1 Mha in 1979) is indicative of both past expansion of logging operations and plans for future logging operations. The classification of 7.8 Mha as critical land is also noteworthy. My impression is, however, that the paper has too many "teasers" — the data are presented, but few of the interesting implications are analyzed. For example, I would have liked to have known what is being done about critical lands and to have found much more discussion on the development and upsurge in the logging industry.

Indonesia's policy to encourage local processing through restrictions on the ratio of log exports/logs domestically processed produced dramatic reductions in log exports. The reductions are a reflection of the lack either of domestic processing capacity or of export markets for processed wood. The massive reduction in Indonesian log exports would probably have led to increased log exports from Sarawak — not a member of the Southeast Asian Log Producers' Association — and Sabah, the major suppliers of similar-quality logs, if the three states had not agreed in advance to contract log exports. (Before the agreement, each country had planned to expand log exports over the coming decade.)

The result of the agreement was increased prices for log exports, and, hence, the bonus to the log-exporting states, from a policy basically deriving from the objectives of increased local employment and value-added, was conservation or attenuation of the natural resource.

The constraints on the expansion of domestic processing industries are deficiencies in infrastructure; the foreign exchange costs of new machinery; complex bureaucratic procedures; low levels of labour productivity that at least partially offset low-wage rates; and inexperience

in producing commodities to international specifications. These constraints, however, should all be overcome during this decade. Indonesia could become a major supplier of plywood (and, on the same basis, of dowel, doors, mouldings, or parquet flooring).

Birowo implies that the Japanese preference for hardwood logs somehow could be blamed if Indonesia ran short of logs, and this suggestion is perplexing. Surely if Indonesia fears future scarcity of logs, it must slow the harvest of the old-growth forest stock. Increased log prices, increased domestic processing, and increased substitution of oil for log exports are all ways to collect the same amount of foreign exchange from reduced logging operations.

Indonesia has established a modest pulp-and-paper industry assisted by high (nominal) tariffs and governmental technical and financial aid. Production is costly compared with such operations elsewhere partly because of the mismatch between the large-scale plants and the small local markets for a wide range of products and partly because of technical problems. In 1979, Indonesia imported about 116 000 t of pulp — mainly long-fibred, for production of, for example, cement bags — and 20 000 t of waste paper. The Indonesian Pulp and Paper Industry Association (APKI) has predicted greatly increased production to 88% of projected consumption by 1985, but FAO forecasts huge deficits (presumably based on an assumption of constant real prices) of 267 000 t in 1986–90 and 1 Mt in 1996–2000. A recent FAO study identified, evaluated, and recommended 10 new pulp-and-paper projects within the ASEAN region, for 1986–2000. The total cost was estimated at U.S.\$6718 million, and the output would build up to 5.4 Mt/year, adding \$150 million per year to GNP and saving \$2200 million in foreign exchange. Some of these projects may never materialize, however, because of investments in pulp-and-paper production

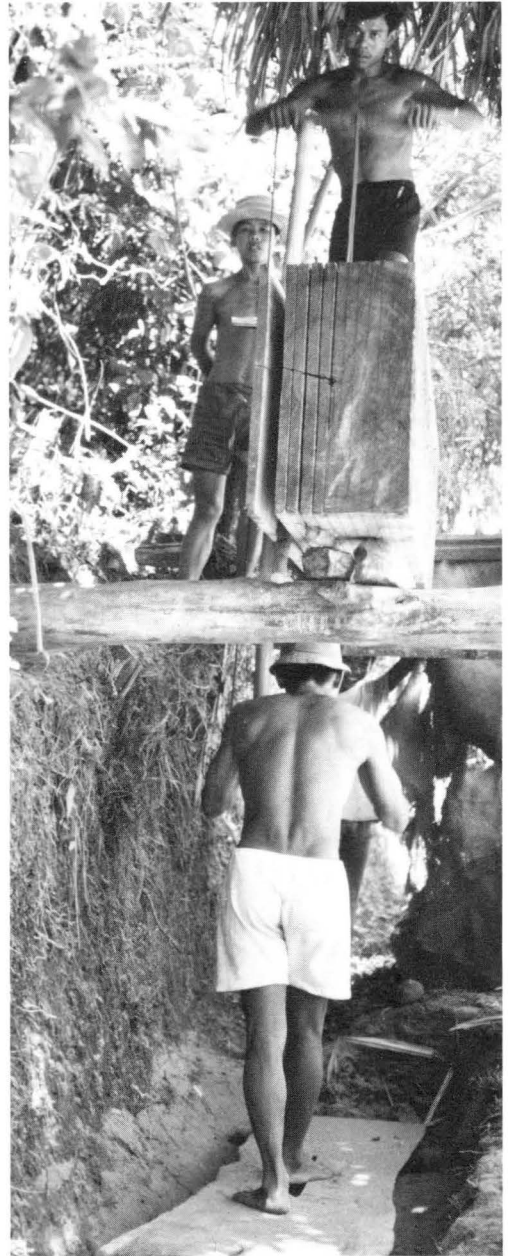
elsewhere; a lack of technical assistance in establishing the proposed plants; or an inability of the ASEAN to cooperate sufficiently to agree on how each country should specialize in particular paper types to exploit scale economies.

Unless the search for an intermediate technology in pulping is successful, pulp-and-paper mills will be large, capital-intensive, and highly specialized; they will, therefore, produce more for export markets than for local consumption and, so, will be quite probably either joint ventures or foreign-owned operations.

Birowo's assessment of China's potential as an importer of forest products is, to say the least, highly debatable. In the short run, it may depend on a maze of political and macroeconomic factors, e.g., the priorities for spending foreign exchange. Over the longer term and at a technical level, there are equally authoritative, contradictory views on the success of China's afforestation programs. Of course, even if China were to become a major importer of wood products, the implications for Indonesia may only be indirect — many other potential wood exporters are also eager to develop such trade links with China.

As to the important question of reforestation policy, perhaps there are impediments to investment in forestry, but I do not believe they are intrinsic. Perhaps the removal of certain government disincentives or their replacement by incentives would lead to much greater private interest in private tree farming. In this regard, much of what Chan says, in his paper about policies to encourage establishment of tree crops, could be applied to afforestation in Indonesia. After all, an industrial forest plantation is just another tree crop, producing wood as the primary product rather than fruit, oils, or rubber. The increased emphasis in developing cultural techniques either for multipurpose trees that produce fuel, fodder, and fruit as well as industrial wood or for intercropping cash crops in timber-producing plantations provides opportunities for afforestation while maintaining short-term income flows.

But I also suspect that part of the explanation for the "lack of reforestation" lies in the absence of property rights for the bulk of forestland under discussion and that part is simply economic rationality because of competing claims for scarce resources. The future extent, type, and location of forests are more a function of the opportunity costs of land than of either capital or labour (because afforestation may be either capital- or labour-intensive) and are subject to long-run political goals, e.g., increased food self-sufficiency or, conversely, increased export earn-



Increasing local processing is the aim of government initiatives in Indonesia.

ings and employment levels in the forestry sector. Indonesia faces basically the same investment decisions as any other country in this regard, and the decisions have to be based on assessments of costs, productivity, potential markets, and, consequently, potential profitability. As in Sedjo's excess-supply model, it seems at least plausible

that interest in replacing forests in Indonesia will remain limited as long as there is (or, more importantly, is imagined to be) a vast old-growth resource still waiting to be depleted.

My final comment concerns whether the experience of tremendous expansion in the forestry sector in Indonesia coincides with economic development. Despite some views to the contrary, it seems to me that growth in industrial output and increased national income are not synonymous with development, which has both

efficiency and equity elements. Unlike the case in some countries where pushing the forestry sector has failed on both grounds — i.e., has meant misallocation of resources plus inequitable distributional consequences — Indonesia has at least succeeded on the first count. Further, if the current policies are successfully pursued, one should expect development to follow from industrialization and output growth, as the number of, and intensity of, backward and forward links with the forestry sector increase.

Tree Crops in Malaysia

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This paper examines the experience of Malaysia in tree-crop cultivation before and after the formation of the Federation of Malaysia in 1963. It focuses on four major issues: the short-term export instability of tree crops; the long-term resource immobility of tree crops; the ecological and environmental impact of tree crops on the tropical rain forests; and the position of smallholders in tree-crop cultivation compared with that of the large estates. The analysis leads to four conclusions. First, tree-crop dominance in Malaysia has declined significantly in many respects except in percentage of agricultural land use and agricultural employment. Second, the long-term prospects of the major tree crops range from hopeful for oil palm and cocoa to bright for natural rubber. Third, tree crops are, relative to nontree crops, more profitable and less detrimental to the ecological balance in tropical rain-forest environments, although the competition between tree crops and forestry in land use may have reached a critical point. Fourth, the competitiveness of smallholders in tree crops, as significant new techniques in production and processing become available, will be reduced, and, therefore, they may require outside assistance, especially from the state.

Ce document expose les expériences d'agrosylviculture que la Malaisie a réalisées avant et après la constitution de la Fédération en 1963. Quatre points majeurs ont été traités : l'instabilité à court terme de l'exportation des récoltes forestières; à long terme, les ressources immobilisées dans ces plantations; l'impact écologique et environnemental de ces plantations sur les forêts tropicales humides; et l'étude comparée de la situation des petites et des grandes plantations. Cette analyse débouche sur quatre conclusions. Premièrement, l'importance de l'agrosylviculture en Malaisie a considérablement diminué à plusieurs égards, sauf en ce qui concerne le pourcentage des terres consacrées à l'agriculture et des emplois agricoles. Deuxièmement, les perspectives à long terme des quatre principales espèces d'arbres cultivés sont encourageantes pour le palmier à huile et le cacaoyer et remarquables pour l'arbre à caoutchouc. Troisièmement, les plantations forestières sont plus profitables et moins nuisibles à l'équilibre écologique des forêts tropicales humides que les autres cultures bien que la concurrence entre les deux semble avoir atteint un point critique. Quatrièmement, la compétitivité des petits agrosylviculteurs ne pouvant que souffrir de l'accès à de nouvelles techniques de traitement et de production, il leur faudra peut-être recourir à l'aide de l'État.

More than 77% of Malaysia is forested, and, of the 12% devoted to agriculture, about 80% is under tree crops — mainly rubber (52%), oil palm (19%), and coconut (8%) (Table 1). In Peninsular Malaysia, the total forested area (9.44 Mha) includes 4.66 Mha of virgin forest. Of the total forested areas (6.16 Mha and 9.72 Mha) in Sabah and Sarawak, virgin forest accounts for 4.66 Mha and 8.51 Mha respectively (Malaysia 1976). Recent trends in land development show that the proportion under tree crops is likely to rise as increasing numbers of farms incorporate tree

crops such as oil palm and cocoa, especially in Sabah and Sarawak.

Most of the tree crops are grown for the export market — less than 5% of raw natural rubber and less than 4% of palm oil were for domestic consumption in 1964–73 (Khera 1976).

As tree crops are notoriously price inelastic in supply as well as in demand, violent price fluctuations have often occurred, resulting in corresponding fluctuations in export earnings. Thus, extreme dependence on tree-crop export is clearly dangerous — a fact that was pointed out

Table 1. Agricultural land (Mha) use in Malaysia, 1976.

Land	Peninsular Malaysia	Sabah	Sarawak
Agriculture	3.14	0.38 ^a	0.35 ^b
Rubber	1.70	0.11	0.20
Oil palm	0.64	0.07	0.02
Coconut	0.24	0.05	0.04
Cocoa	0.02	0.01	—
Rice	0.36	0.05	0.04
Others	0.18	0.09 ^c	0.05 ^d
Suitable for agriculture	6.32	2.15	5.31

^aArea alienated for agriculture in 1975.

^bThis value would be 3.2 Mha if the area under shifting cultivation were included.

^cThis figure was estimated as residual.

^dThis value would be 2.9 Mha if area under shifting cultivation were included.

early in the 1960s by Clifton Wharton (1963a, b) for Southeast Asian countries in general and for Malaya (present day Peninsular Malaysia) in particular.

In 1960, rubber occupied 68% of total planted area, provided about 50% of employment in agriculture, and accounted for 63% of total Malayan export value and 18% of federal government revenue, as well as generating 26% of gross domestic product (GDP). This high degree of dependence on rubber posed two dangers: short-term economic instability transmitted from export instability and long-term resource immobility, which was especially ominous because of the emergent threat from synthetic rubber.

Many theoretical and empirical studies on the links between export instability and economic development have since been generated. The issues are obviously interesting and relevant to many developing countries.

Cultivation

Several features in tree-crop cultivation could give rise to problems. First is the long period (3–8 years) before most tree crops in Malaysia begin to produce (Wickizer 1951; Seftleben 1978). The loss on the investment during this period can be offset at times if the seedlings are intercropped with some short-term cash crops.

The long period of negative returns increases the cost of production and makes financing a problem, especially for smallholders. The Malaysian government has recognized this financial constraint, providing grants, initially for replanting but subsequently also for new planting of tree

crops. The amount was originally fixed at M\$988/ha to be paid over a 5-year period for rubber. The grant was calculated to help defray the costs incurred in felling and destruction (usually by burning) of old tree trunks, and for planting material, fertilizers, and other services. The grant has been increased several times and is M\$3705/ha for holdings equal to or less than 4.1 ha.

The second prominent feature is the long economic life of tree crops. It depends on such factors as rate of exploitation, level of upkeep, discount rate, and variety of species. A serious problem in this respect is that research on tree crops takes a long time, and the results may not be applied for many years. For example, in experimental work on breeding and selection of high-yielding planting material for rubber (*Hevea brasiliensis*), at least 25 years are needed from pollination to recommendation for large-scale planting. An additional period would usually be required to test for other desirable plant characteristics. For example, the clone RRIM 501 was originally bred in 1929 and was recommended for large-scale planting in 1947 but was withdrawn in 1959 because of high susceptibility to wind damage (Barlow 1978). Equally, a long time is needed for new planting materials to be widely disseminated. At an economic life of 33 years, a stand of rubber trees evenly spaced in age would be replaced at the rate of 3% a year. Thus it would take 33 years for the whole stand to be replanted unless the period of modernization is shortened, which would raise costs substantially.

The third important feature of tree crops is the short-term, and possibly also long-term, price inelasticity of supply. In the short term, this is expected for four reasons. First, productive capacity, as represented by the existing stand of mature trees, cannot be changed. Second, other inputs, especially labour, are difficult to vary either because of contractual arrangements or because of the absence of alternative employment opportunities. Third, there are physical or botanical limits to plant exploitation. Fourth, the effective variable cost is only a small proportion of the total cost of production. Some of these factors are more likely to be operative under estate conditions than under smallholding production so that estates are expected to be less price responsive. In the long term, price elasticity may still be low because it is costly to replace an existing stand with other crops or to expand productive capacity rapidly unless undeveloped land is easily available. Empirical studies tend to support these expectations (Askari and Cummings 1976).

Recent Developments

When Malaya gained political independence from the British in 1957, rural development was given high priority. The main objectives were to provide rural opportunities, to raise per-person output, protect living standards against the adverse effects of a possible decline in rubber prices, and to diversify the agricultural products from rubber. The three principal programs were replanting overaged rubber trees, improving drainage and irrigation to facilitate double-cropping of rice, and developing new land to create new employment and to relieve the pressure on existing agricultural land.

In the First Malaya Plan, rubber replanting was accorded the top priority followed by drainage and irrigation. In later plans, however, land development became progressively more dominant (Table 2) for several reasons. Rubber replanting is obviously limited by the age structure of the existing rubber area. Equally, the number of projects on drainage and irrigation is limited. In Peninsular Malaysia, few areas are suitable for this purpose, and, in Sabah and Sarawak, the constraint is low-population density and, hence, the low economic feasibility of irrigated rice cultivation.

Land development is the logical solution in Malaysia where substantial areas are still undeveloped. In Peninsular Malaysia, of the total 13.15 Mha, 48% (6.32 Mha) is suitable for agriculture; 60% (3.81 Mha) has been alienated. In Sabah and Sarawak, where the total land areas are 7.19 Mha and 12.45 Mha respectively, 30% (2.15 Mha) and 43% (5.31 Mha) are suitable for agriculture, 18% (0.38 Mha) and 51% (2.72 Mha) already having been alienated. Agricultural development can be used effectively to redress rural poverty, increase

agricultural production, and create rural employment for unskilled labour. Equally, it can provide the opportunity to modernize traditional communities and agricultural practices.

The desire for social transformation, especially the development of modern farm practices, is probably one of the reasons that land development in postindependence Malaysia has been in the form of publicly controlled land-development schemes. In this respect, it represents a dramatic departure from the pre-War colonial practice of leaving land development strictly to the private sector (Wan 1976).

The pace of development is reminiscent of the early days of rubber planting in Malaya. Between 1906 and 1930, the area planted to rubber increased by almost 1.0 Mha to about 1.3 Mha. Total land development in Malaysia between 1961 and 1980 amounted to 1.3 Mha, of which 0.5 Mha was developed by the Federal Land Development Authority (FELDA). The target for FELDA in 1981-85 is 0.15 Mha, whereas the total for the country is 0.54 Mha. The total public expenditure on land development between 1956 and 1980 amounted to M\$4343.3 million or 18% of the total public economic development expenditure, and another 16% has been allocated to land development under the current Fourth Malaysia Plan. Besides FELDA, many other state and federal land development agencies are involved; however, FELDA is clearly the major agency.

Tree crops, especially oil palm and rubber, are strongly preferred in land development projects. Thus, by the end of 1977, FELDA had allocated almost 93% of the 0.4 Mha it developed to oil palm (60.5%), rubber (31.7%), cocoa (0.5%), and coffee (0.2%). Data are not readily available on the choice of crops under the other schemes, but tree crops probably represent 75-80% of the expenditure.

Another important aspect of land-use development has been the massive effort at rubber replanting begun in 1952 and still being vigorously pursued. A total of M\$797 million was spent between 1956 and 1980 to assist mainly the smallholding rubber sector to replant old rubber stands either with high-yield rubber or with one of the approved crops — coconut, oil palm, coffee, cocoa, citrus fruits, and sago, as well as other nontree crops.

By 1975, about 94% of crops selected were also tree crops: rubber (85.4%), coconut (2.4%), oil palm (5.4%), and coffee (0.5%). Thus, when it was possible to replace existing tree crops, the choice made was predominantly another tree crop or the same tree crop (generally rubber).

Table 2. Public-development expenditure allocation, Malaysia, 1956-80.^a

	1956-60	1966-70	1976-80
Total economic expenditure (M\$ million)	759.9	2685.4	13570.8
Agriculture and rural development (M\$ million)	227.5	1114.1	4672.4
Rubber replanting (%)	67	15	4
Drainage and irrigation (%)	17	31	19
Land development (%)	7	33	59

^aExpenditures for 1956-80 are estimated expenditures implemented under plan.

. Sources: Various development plans of Malaya and Malaysia.

Table 3. Main crop areas (Mha) in Peninsular Malaysia, 1950-76.^a

Crops	1950	1960	1965	1976
Rubber	1.42 (67.0)	1.58 (65.9)	1.75 (66.3)	1.70 (54.2)
Oil palm	0.04 (1.8)	0.04 (1.9)	0.10 (3.7)	0.64 (20.3)
Coconut	0.20 (9.3)	0.21 (8.8)	0.21 (8.1)	0.24 (7.5)
Rice	0.31 (14.8)	0.38 (15.7)	0.38 (14.6)	0.36 (11.4)
Miscellaneous	0.15 (7.1)	0.18 (7.7)	0.19 (7.3)	0.20 (6.5)

^aFigures in parentheses are percent of total agricultural land.

Source: Selvadurai (1979) and government statistics published in Area of Miscellaneous Crops, 1978 and the Statistical Digest, 1976.

In other words, the commitment to tree crops in Malaysia has actually increased. Between 1960 and 1976, the share in total planted area of just three tree crops (rubber, oil palm, and coconut) increased from 77% to 82% in Peninsular Malaysia (Table 3). The actual share today is probably higher, as cocoa is beginning to find popularity throughout Malaysia, especially as an intercrop with coconut. Trends in Sabah and Sarawak have been similar (Table 4).

If, for Peninsular Malaysia, all potential agricultural land were planted according to the soil-capability classification scheme, perennial tree crops would occupy about 79% of all agricultural land compared with the 77% in 1970. However, land devoted to agriculture would constitute almost 49% of total land area compared with about 22% in 1970 (Selvadurai 1979: 10-11).

Export Instability and Economic Development

Export instability will affect economic development adversely if an economy depends heavily on the export commodities in such important aspects as employment, export earnings, contribution to GDP, and government revenue. Rubber was vitally important in Malaya in these respects in the early 1960s. Today, the position of rubber in these respects is not as critical. For example, the planted area of rubber has dropped from 68% to 52% but that of tree crops has probably increased throughout Malaysia due to the expansion of oil-palm cultivation.

About half the population of Peninsular Malaysia is employed in agriculture, and that statistic has remained fairly constant. However, the share of the labour force involved in production of rubber has fallen consistently from 1962 to 1976, whereas it has been an insignificant item in Sabah and Sarawak.

The most important change is in the share of tree crops in total export earnings in Peninsular Malaysia from a high of 63% for rubber alone to only 31% for both rubber and oil palm in 1976-80. The shares of oil palm and rubber in GDP and federal-government revenue have also dropped, and for all Malaysia the shares would be even smaller because rubber and oil palm are much less important in the economy of Sabah and Sarawak.

Thus, over two decades, the Malaysian economy has become much less dependent on tree crops in some important aspects. It has achieved a substantial degree of diversification both within the agricultural sector (away from rubber) and sectorally (toward manufacturing, commerce, and services as well as toward the exploitation of other natural resources such as forest products and petroleum).

These various trends toward a more diversified economy are basically healthy. Some are responses to changing marginal comparative advantage; for example, the estate sector responded to the challenge of synthetic rubber by replacing old rubber areas with oil palm when the latter was more suitable and profitable. Although total estate area remained almost constant, the

Table 4. Main crop areas (Mha) in Sabah and Sarawak, 1965-76.

Crop	1965		1970		1976	
	Sabah	Sarawak	Sabah	Sarawak	Sabah	Sarawak
Rubber	0.10	0.17	0.11	0.19	0.11	0.19
Oil palm	0.01	-	0.04	<0.01	0.07	0.02
Coconut	0.04	0.03	0.06	0.04	0.05	-
Padi	0.04	0.11	0.04	0.13	0.05	0.13

Sources: Various issues of the annual bulletins of statistics for Sabah and for Sarawak.

share of rubber dropped from 87% to 66% and that of oil palm increased from 8% to almost 31%. Equally, oil palm constituted about 61% compared with 32% for rubber in FELDA schemes up to 1977.

The increasing importance of the manufacturing sector is another example of the economy's responding to market forces. This can be seen in the increasing share in exports of manufactured products, which rose from an insignificant amount to about 15% of total exports between 1971 and 1975 and to 21% in 1980. In fact, it was second only to petroleum (25%) in 1980. Thus, the desirable degree of diversification has come about without sacrifice of economic gain or efficiency.

On this basis, the Malaysian economy has apparently overcome export instability, at least in the form of overdependence on rubber and tin. Export instability will continue to be a threat, however, not because of overdependence on a few export commodities but because the Malaysian economy is still, like that of most developing countries, highly susceptible to changes in the developed countries. The increased economic interdependence of the world and the emergent synchronization of business cycles pose serious problems to small open economies such as Malaysia, almost regardless of what they do. This becomes increasingly clear when the developed countries seem unable to control inflation and unemployment. However, in the absence of severe worldwide depression, the Malaysian economy will be increasingly less concerned with the problem of general export instability, much less to export instability from export proceeds of tree crops.

Although export instability adversely affected economic development in Malaysia, policy options that reduce the share of exports based on tree crops are likely to generate much lower, though possibly more stable, average return to investment in agriculture. In any case, the Malaysian economy seems to have experienced several episodes of severe export instability without apparent ill effects on overall economic development. The comprehensive study by Ariff (1972) found that built-in mechanisms in the economy helped to insulate it against the worst effects of export instability. Such built-in mechanisms are still in place and should cushion the impact of future export instability.

Resource Immobility

A more fundamental issue than export instability of tree crops is the potential danger of

resource immobility associated with tree crops. Diversification becomes urgent when the long-term prospects of tree crops are clouded and uncertain, as were those of natural rubber from the late 1950s.

The issue of diversification in Malaya has been raised on several occasions such as during the Great Depression and immediately after World War II. In both instances, the solution adopted was to encourage the largely subsistent Malay peasantry to be self-sufficient in rice while the government maintained a stockpile of rice equivalent to a 4-month supply for the so-called "ration population" (i.e., population minus the self-sufficient padi planters).

Even up to the early 1950s, many remained persuaded that natural rubber was still the crop for Malaya. They were supported in their belief by the rubber boom brought on by the Korean War and by the expectation that once the synthetic rubber plants set up by the U.S. government during the War were transferred to private hands, and hence ceased to receive government subsidy, the competitive strength of natural rubber would be evident. As it turned out, the synthetic industry under private enterprise after 1956 continued to make rapid progress and came up with several improved special types, some with technical superiority to natural rubber (Allen 1972). Only then did diversification become a serious issue.

The answer to the question of what crops should replace rubber is, however, not evident. For one thing, it is not clear that natural rubber has completely lost its comparative advantage in Peninsular Malaysia because of the substantial cost reduction through replanting with superior high-yield varieties that began to appear from the research effort of the Rubber Research Institute of Malaya. The increase in yield per unit of tapped area can be estimated from the ratio of average yield of high-yielding rubber to that of unselected rubber in the estate sector. The ratio increased from about 2.2:1 in 1953 to 3.6:1 in 1976. The ratio continues to increase as higher yielding lines are made available to producers.

The increase of output with little additional increase in cost through the use of these high-yield varieties keeps natural rubber cost-competitive against what Allen (1972) called the large-tonnage synthetic rubbers such as Styrene/butadiene copolymer (SBR) and polybutadiene rubber (BR). Synthetics managed to encroach on the share of natural rubber in world consumption, nonetheless, because the demand for all rubbers has increased much faster than natural

rubber producers have been able to expand their output. Thus, synthetics, which require 2–3 years to expand capacity compared with the 6–7 years for natural rubber, were able to fill the gap and thus increased their share of the world market. For example, the average rate of growth between 1951–76 for natural rubber was 3% compared with 13% for the synthetics (Chan 1978).

Second, the alternatives to rubber in Peninsular Malaysia were not easy to identify in the late 1950s or even now. The other tree crops were not doing well in international markets and might not suit the conditions in Peninsular Malaysia. The nontree crops seemed to be even less likely candidates because of marketing problems and considerations of suitability to soil and climate.

Even the experts invited to examine the problem of diversification agreed that the intention of the Malayan government to press ahead with rubber replanting with high-yield material was generally wise. For example, the Ford Foundation Survey Team (1963:43) recommended:

Continue but modify the rubber replanting scheme. The diversification team is convinced that the government's rubber replanting scheme is a wise one. The only safe economic strategy to meet the challenge of synthetic rubber is to increase efficiency and thereby reduce unit cost in the production of natural rubber.

Elsewhere, the team also observed:

... with the high rainfall, tropical climate, and rolling terrain of much of Malaya, potential crops for diversification have for the most part been perennial crops. Although perennial crops take time to become established and have high initial costs, they in effect replace the original jungle with alternative tree crops and thus continue to retard erosion, protect the notoriously volatile humus content of tropical soils and shade out weeds and bush.

Evidence of the continuing competitiveness of natural rubber is that all natural rubber produced has been taken up and usually sold at a substantial price premium over comparable synthetic rubber for most of the post-War years. For example, the price ratio of RSS3 (rubber smoked-sheet grade 3) to its comparable substitute (SBR) has been greater than one in most years since 1950.

Furthermore, many significant advances in natural rubber production and presentation have yet to be widely spread, especially to the smallholding producers and to producers outside Peninsular Malaysia. On the global level, smallholding rubber accounts for some 63% of total

world natural rubber and about 75% of all planted rubber area. Thus a huge technological gap waits to be filled. This is true even in Peninsular Malaysia where, in spite of huge government efforts and assistance, only 63% of planted area was high-yielding material in 1971 compared with 92% for the estates (Chan 1978).

More recently, the competitiveness of natural rubber compared with the synthetics received a most important boost when crude oil prices quadrupled in 1973 and continued to rise. In addition, a recent World Bank study came up with some findings that are "sweet music" to rubber producers. In examining the effect of the oil crisis on the competitive relation between natural and synthetic rubbers, the study concluded: "... the relative market position of natural rubber (NR) has improved substantially in the short term, but has improved even more in the longer term" (Grilli et al. 1980:55).

In the short term, even allowing for the appreciation of the Malaysian currency against the U.S. dollar by more than 25% between 1971 and 1974, Grilli et al. (1980) found "... the operating costs on estates and smallholdings apparently increased by about 65% between 1971 and 1974" compared with a 70–80% increase in the average direct cost of producing SBR-1500 over the same period. Thus the market share of natural rubber increased in the world market (excluding the centrally planned economies).

In the longer term in which changes in existing facilities are allowed, the analysis, based on the estimation of "full supply price" of natural rubber and SBR-1500, indicates that, at a real rate of return of 10%, investing in SBR-1500 would only be feasible if future expected real prices were at least U.S.\$0.88/kg (\$0.44/lb.). In contrast, "... investment in NR in Malaysia, at the same real rate of return of 10 percent, would ... have been possible in 1977 if a future real price of U.S.\$0.79/kg (\$0.36/lb.) (cif) in Europe had been expected" (Grilli et al. 1980:73).

The authors of the report went on to point out that this conclusion probably understates the competitive position of natural rubber because some assumptions used in the calculation tended to overstate the supply price of natural rubber and to understate that of SBR-1500. Furthermore, with each increase in the real price of petroleum, the competitive position of natural rubber is further enhanced.

Although the future prospects for natural rubber thus seem much less uncertain than they were in 1973, prospects for other tree crops in

Malaysia are harder to predict. For oil palm, Malaysia may have a strong competitive advantage over other oil-palm producers because production is predominantly organized in large-scale plantations that encourage central processing of the output and are in a good position to innovate and improve productivity. Thus, between 1952 and 1972, output per employee increased from about 3 t to 13 t, whereas the average area increased from about 3 ha to 7.5 ha (Khera 1976). Furthermore, most reported studies on the relative profitability of oil palm placed oil-palm cultivation above rubber and certainly over padi (Ng 1971; Wafa 1972; Khera 1976).

The main advantage of cocoa in Malaysia seems to be that it is ideal for intercropping with other crops such as coconut. Some evidence for this comes from the areas reported under "sole," "main," and "mixed" cropping of cocoa between 1958 and 1966. The area under "sole" crop stagnated at about 510 ha, the area under "main" crop dropped from 11 ha to insignificance, but the area under "mixed" crop increased from 106 ha to 627 ha. Thus, cocoa may have a place in Malaysia's future.

Tree Crops and the Humid Tropics

The land capability classification scheme prepared during the First Malaysia Plan specifically gives priority of land use to mining over agriculture and to agriculture over forestry. This order is justified on the basis of higher value-added by each use (Lee and Panton 1971). The use of value-added as the basis is, however, not an absolute recommendation because development decisions on the land use for a specific area presumably are taken only after careful evaluation of the economic, social, and ecological factors (Arshad 1979). The use of this basis in the case of mining versus other uses is not likely to lead to any serious consequences because the total area likely to be involved is only about 0.6% of total land. Past mining land has also been steadily reabsorbed by urban zones for housing, industrial, and recreational purposes or for market gardening, livestock farming, and fish farming (Lee and Panton 1971).

The application of the same principle to allocations of land to agriculture and forestry is more doubtful especially in Peninsular Malaysia where the past rate of land development is beginning to reduce the supply of land suitable for agriculture. There is now the fear that the forest is disappearing too fast and that rapid land development has led to wasteful use of forest resources. As revenue

from forestry is an important source for the state governments and land is a state matter under the federal constitution, excessive conversion of forestry to agricultural use is clearly a danger. According to the estimate of the Environment Assistance Mission, provided by the IBRD at the request of Malaysia in December 1974, the nation's lowland forest area would be consumed in the next 30 years at the current rate of forest conversion (IBRD 1975).

The issue of the proper and balanced use of the nation's land and forest resources was considered explicitly under the Third Malaysia Plan, which has just ended. At the urging of the IBRD mission, a National Environmental Policy has been developed and was incorporated into the Third Malaysia Plan. Among other things, that policy accounts for "... the critical importance of maintaining the quality of the environment relative to the needs of the population, particularly in regard to the productive capacity of the country's land resources in agriculture, forestry, fisheries and water" (Malaysia 1976:219).

Such a broad vision of land use in Malaysia is clearly needed as a replacement for both the federal development-oriented view and the state revenue-oriented view. It is to be hoped that it has not come too late for the forest resources of Peninsular Malaysia.

On the issue of the relative compatibility of tree and nontree crops to the humid tropical climate of Malaysia, I focus on Peninsular Malaysia, although the remarks are often relevant to Sabah and Sarawak.

The climate of Peninsular Malaysia results from the state's being in an equatorial region, but it is modified by the effects of the northeast and southwest monsoons. Annual rainfall is high (203–305 cm), as are humidity (85%) and temperature (26–28°C). Lying between 1° and 7°N with no point more than 170 km from the sea, and three quarters of the area below 304 m, the state never experiences excessively high temperatures, and the heavy cloud cover reduces the average sunshine to fewer than 7 hours/day. The maximal difference between the longest and the shortest day is only 37 minutes. The absence of seasonal variation in temperature is so marked that the daily temperature range is greater than the annual range. The main climatic difference results from seasonal rainfall distribution, with the northeast monsoons bringing rain to the eastern and northeastern coastal area and the weaker southwest monsoons bringing less rain to the western and southwestern plains (Ooi 1959, 1976; IBRD 1955).

The high annual temperature and precipitation have great significance in the problem of maintaining the fertility of the soil, for the choice of crops, and the technique of cultivation, as was noted by the Ford Foundation Survey Team (1980).

The high frequency of precipitation in the form of thunderstorms encourages rapid runoff and soil erosion of inadequately covered land. Heavy downpours within a short period increase the force of the impact on the ground, and the volume of accumulated water exceeds the absorptive capacity of the soil. The maximum absorptive rate of an average open soil in Peninsular Malaysia has been calculated to be 7.5 cm of water per hour. However, slightly more than 25% of showers in Kuala Lumpur were of a higher intensity — hence, the erosive force of tropical downpours (Ooi 1959).

An example of the serious consequence of the failure to account for this was reported by Bauer (1948) concerning the practice of clean weeding that European-owned rubber estates in Malaya used until 1930: the practice not only was expensive but also led to soil erosion and the loss of soil fertility. Because the high annual temperature works in conjunction with the high annual precipitation, leaching of uncovered soil, giving rise to low soil productivity, is greatly enhanced. The combination greatly speeds chemical reactions and weathering processes in the soils throughout the year. The high precipitation, in excess of the soil absorptive rate, leads to a continuous leaching from the surface of the soil downward. Organic matter and plant nutrients are washed out and are not replaced by compensating upward capillary action.

The high temperature has another significance. The higher the temperature, the more difficult it is for nitrogen to accumulate (Ooi 1959). In the natural equatorial forest, this destructive process of the climate is retarded by the heavy canopy of leaves that reduces the ground temperature to a level at which humus formation exceeds or keeps pace with the rate of destruction. It also counterbalances the rapid rotting of leaves, twigs, flowers, branches, and so on that fall on the ground and are quickly reabsorbed by the living plants. "A closed cycle is thus set up, in which the plant food is circulated from the top soil, taken up by the vegetation and then returned to the soil again to start the process anew" (Ooi 1959: 80). Because of the rapid turnover of the nutrient "capital," the tropical forests appear lush and luxuriant, and the appearance often gives rise to a false notion of the fertility of tropical soils.

The precarious equilibrium is maintained as long as the soil temperature is no higher than 25° C. Soil temperature under tropical forest fluctuates slightly because of the heavy shade and the high humidity of the air. However, if the heavy shade is removed, the equilibrium is upset and the cycle is broken. The tropical sun then raises the soil temperature, causing the rate of humus formation to slow and the rate of breakdown to accelerate. At the same time, "reinvestment" of the nutrient "capital" in the form of vegetative wastes is removed. The removal of the natural cover also facilitates the weathering process of the heavy downpours. Unless heavy applications of fertilizer are used, the result is the conversion of an arable land into one infested with obnoxious weeds and bushes.

Thus, tree crops clearly have several clear advantages over nontree crops because the tree crops better simulate the natural forest. In some situations, the higher value of some annual crops, such as vegetables cultivated close to urban centres, may be sufficient to pay for the fertilizers needed to maintain soil fertility. In general, nontree crops stand at a disadvantage relative to tree crops in terms of both protecting or preserving land quality and soil fertility and return to investment.

Smallholders

The stake of the smallholders in Malaysia varies widely among the three major tree crops (Table 5). Smallholders are distinguished from the estate sector in which holdings are more than 40 ha. Coconut is practically all on smallholdings, whereas oil palm is practically all on estates. Only in rubber is the distribution more balanced between estates and traditional smallholdings.

For rubber smallholders, the Rubber Industries Smallholder Development Authority (RISDA) schemes of replanting and the Federal Land Consolidation and Rehabilitation Authority (FELCRA) account for 65% of production. The FELCRA area consists mainly of rubber schemes that had originally been developed by state fringe alienation schemes and failed but were within commuting distance of existing settlements and were subsequently redeveloped under FELCRA.

The relative performance of the estates and smallholdings can be compared with some indicators. Between 1957 and 1971, the share of smallholdings (plus FELDA) devoted to rubber increased from 46% to 63%. In 1971, the average size of a farm under smallholding was 2.6 ha

Table 5. Distribution (%) of area in selected tree crops by type of organization, Malaysia, 1976.

	Peninsular Malaysia	Sabah	Sarawak	Malaysia
Rubber				
Estates	32	16	4 ^a	29
FELDA	7	—	—	6
Others	61	84	96	65
Total area ^b	1.70	0.11	0.19	2.00
Oil palm				
Estates	59	49	27	58
FELDA	34	51 ^c	69 ^a	36
Others	7	—	4	6
Total area ^b	0.64	0.07	0.02	0.72
Coconut				
Estates	7	6	—	6
FELDA	—	5 ^c	—	1
Others	93	89	100	93
Total area ^b	0.24	0.05	0.04	0.33

^aIncludes area under land-settlement schemes.

^bAreas in Mha.

^cMainly under Sabah land-development schemes.

Sources: Government statistics from Rubber Statistics Handbook, 1976; Oil Palm, Coconut, and Tea Statistics, 1976; and annual bulletins of statistics for Sabah and for Sarawak.

compared with 313.7 ha for estates. Between 1957 and 1971, the area under high-yield planting material increased from 15% to 63% for smallholdings compared with 48% rising to 92% for estates. The percentage of area replanted or newly planted was only 15% in 1957 for smallholdings compared with 33% for estates; this figure improved to 63% and 83% respectively. Smallholders were responsible for 42% of total production in 1957 and 48% in 1971. The yield of mature plantations was 456 kg/ha in 1957 on smallholdings compared with 578 kg/ha on estates, and these yields increased to 702 kg and 1239 kg, respectively.

The two sectors differ significantly (Table 6), even though the differences decreased consider-

ably from 1957 to 1971. Along with differences in area planted, the smallholdings have higher proportions of overaged trees and larger areas that are replanted with unimproved material than do the estates. They also use fewer modern techniques and produce lower grades of rubber than do the estates. A great deal of improvement in the smallholding sector came as a result of the vigorous state and federal schemes to encourage planting with high-yield material. In the smallholdings, the average rates of expansion (newly planted areas) were 0.5% between 1937 and 1952 and 1.2% from 1953 to 1972 and those of replacement (replanted areas) were 0.3% and 2.5% respectively. The corresponding figures for estates were 0.9% and 0.4% for expansion and

Table 6. Some aspects of smallholding and estate rubber-holding, Peninsular Malaysia, 1957 and 1971.

	Smallholding		Estate	
	1957	1971	1957	1971
Total planted rubber (1000 ha)	692.3	1086.9	818	631.8
Percentage of total area	46	63	64	37
Average size of farm (ha)	—	2.6	341.4	313.7
Percentage planted with high-yield material	15	63	48	92
Percentage replanted or newly planted since 1946	15	63	33	83
Average yield for mature area (kg/ha)	456	702	578	1239

Source: Department of Statistics, Malaysia, Rubber Statistics Handbook, Kuala Lumpur, Malaysia, various issues.

2.0% and 2.3% for replacement (Chan 1978). The government schemes for planting contributed substantially to the improvement and modernization of the smallholdings, being responsible for almost 100% of the replanted areas and 67% of the newly planted areas (Chan 1978).

Given the important and wide disparities between smallholdings and estates, it is relevant to examine the relative efficiency of the smallholders.

Historically, that is before World War II, it is probably true, as Bauer (1948) maintained, that the smallholders could compete successfully against the estates. Three factors seem to have worked in the smallholders' favour: the negligible cost of establishing a smallholding of rubber; the practical absence of technological breakthroughs in production in the rubber industry; and the lack of an effective substitute for natural rubber. However, with the release of high-yielding varieties and the development of synthetic rubber during and after the War, the picture changed drastically, and the poor quality of output of the smallholders became a severe disadvantage. In the meantime, the estate sector had adopted many of the improved methods that were developed by research institutions or by some of the big estate groups.

Under the changed conditions, the smallholders could not compete unless given some outside assistance. This came from the state and federal governments with incentives to help the smallholders to plant with improved high-yield planting varieties. In other functions, assistance has come from agencies that carry out specific roles for the benefit of the smallholders.

For example, the Rubber Research Institute of Malaya, since independence, has become more active in providing advisory services to the various schemes at project level. The Rubber Industry (Replanting) Board gave assistance in kind and cash for replanting. The Malaysian Rubber Development Corporation has been basically involved in the purchase of latex from the smallholders for the production of processed Standard Malaysian Rubber (SMR) to prescribed specifications for export. In 1972, RISDA was formed to centralize, coordinate, and integrate the various activities directed at the smallholding sector so as to help accelerate the development of the smallholders.

The key lesson from the Malaysian experience is that when technological changes, such as improved planting material and improved methods of processing, become available in tree

crops, cultivation in traditional smallholdings may not be efficient enough to compete with the estate-type organization unless supported by a strong institutional infrastructure. Support is needed especially to offset the estate sector's quicker access to and adoption of new techniques and innovations (Chan et al. 1973).

One should ask, however, whether the state and federal governments have been wise to have taken such active steps to encourage smallholders in tree-crop cultivation. The political gains are obvious, but there is a danger that the state then feels bound to intervene when the industry experiences, for example, a steep drop in commodity prices. This danger has proved to be real, for the decline in rubber price has led to an appeal by smallholders for the government to take steps to check the decline (Business Times 1981).

Similarly, the Malaysian government's active interest in pushing for an international-commodity agreement for natural rubber seems to be motivated by the desire to protect the interest and welfare of the rubber smallholders. As an efficient rubber producer, Malaysia may stand to gain little from such an attempt unless it is one aimed purely at price stabilization. Any attempt to maintain price upward would not be in the long-term interest of Malaysia or of the smallholders, especially when synthetics are readily available.

Conclusions

In conclusion, three points from the Malaysian experience may be stressed. First, of the twin problems of short-term export instability and long-term resource immobility, the latter poses a greater threat to the economic development and welfare of a country with a high degree of "perennial monocultural dominance" (Wharton's phrase).

Second, there is a strong tendency to prefer agriculture to forestry in land-use policies because of the emphasis on value-added or employment creation. This approach fails to give proper weight to the noneconomic, but equally fundamental, roles of the tropical forests. These roles often complement agriculture. Such neglect should be corrected and a more balanced approach adopted in land-use planning.

Third, and finally, the special problems of the smallholders in tree-crop cultivation, especially when new techniques for improved yield and processing of output become available, may require some form of state assistance, as the market solution to these problems is likely to be less than optimal.

Discussion

Mohamed Ariff: Let me, at the outset, compliment Chan for a stimulating, comprehensive, and well-written paper on tree crops in Malaysia. He addresses himself to four major issues, relating to short-term export instability, long-term resource rigidities, ecological and environmental implications, and finally the problems of smallholdings competing with estates. He concludes that the tree crops' dominance of the Malaysian economy is on the decline, that the long-term prospects of most tree crops are fairly good, that tree crops are ecologically less detrimental than nontree crops, and that the smallholders require external assistance to remain viable.

Although, generally speaking, I agree with him, I find that there are some gaps in his analysis. For example, it is well known that tree crops are generally price inelastic, especially in the short run, mainly because of the long lag between establishment and production and the long economic life span of most tree crops. However, Chan attributes price inelasticity not only to these factors but also to the low ratio of variable cost to total cost. This last I find difficult to digest, because a low ratio of variable to total cost would tend to make supply more responsive to changes in prices. Besides, labour cost accounts for as much as one-half of the total cost because rubber production is highly labour-intensive. In some estates, tapping charges account for 40% of the total expenditure.

I think the main explanation for short-term supply inelasticity lies in the physical or botanic limits of rubber. For example, one cannot expand rubber output by resorting to frequent tapping, as it would cause irreversible damage and would shorten the economic life span of the tree. Thus, age composition and stand composition have implications for supply elasticity. Rubber growers are more willing to do "slaughter" tapping on trees that are old and of a low-yielding variety than on trees that are young and of a high-yielding type. The presence of a large number of overaged and low-yielding trees on smallholdings is one reason that the smallholders are generally more responsive to price changes than are estates.

In Malaysia, the evidence of perverse supply responses, especially in the smallholding sector, is noteworthy. In an attempt to maintain their

income, smallholders increase output in the face of falling prices. This practice, of course, tends to further destabilize commodity prices.

As Chan has correctly observed, land development in Malaysia is largely controlled by the state. This fact appears inconsistent with the country's free-market economy and, to be properly understood, needs to be assessed in terms of the social, economic, and political context of plural Malaysian society. I, therefore, wish that Chan had added an appendix or at least a footnote clarifying the context. I also wish that he had analyzed the economics of government land-development schemes such as FELDA.

Chan has briefly discussed the role of tree crops in the diversification of the Malaysian economy. It is true that the share of tree crops in general, and that of rubber in particular, in total export earnings has fallen sharply. In absolute terms, however, export earnings from tree crops have continued to rise, and, in this sense, diversification has strengthened the role of tree crops in the Malaysian economy.

In this regard, Chan seems to be endorsing the conversion of rubber areas to oil palm. I am disappointed that he has not questioned the wisdom of this conversion, at least on such a large scale as has been witnessed in Malaysia. In retrospect, Malaysia may have overreacted to low rubber prices. Although recent studies (Thillainathan 1976; Chan 1980; Sahathavan 1980) have shown that the internal rate of return for oil palm is substantially higher than that for natural rubber, there are a number of other considerations that favour rubber over oil palm.

First, natural rubber exhibits greater price stability than palm oil; during 1970-79, the price instability index of 28.5 for natural rubber pales in comparison with that of 34.9 for palm oil (Chan 1980). India, which is the main market for palm oil, dips in and out of the market according to the availability of foreign exchange, and tariff barriers prevent the penetration of palm oil in the U.S. and other advanced countries. It is noteworthy that the U.S. has withdrawn duty-free treatment that had been given to palm oil under its GSP scheme in March 1978. Tariff rates under the GSP schemes of other advanced countries range from 10% in the European Economic Community (EEC) to 17.5% in Canada. In EEC a

4% tariff is applied to crude palm-oil imports, and a 12% tariff is imposed on refined palm-oil imports.

Second, natural rubber has greater externalities than does oil palm, as shown by the higher linkage coefficients. Based on 1970 inputs and outputs, Sahathavan (1980) has estimated the backward linkage coefficient for rubber to be in the order of 1.14, which compares favourably with the 0.36 for oil palm. Forward linkage effects are even stronger for natural rubber (4.78), compared with oil palm (0.85). Total linkage coefficients for natural rubber and oil palm are 2.54 and 0.37, respectively.

Third, the enormous possibilities for substitution in oils mean that the cross elasticity of demand for palm oil is high. Consequently, the prices of palm oil are highly sensitive to changes in supply not only of palm oil but also of vegetable, marine, and other animal oils. In this regard, natural rubber seems to be better off, now that synthetic rubber has been rendered less competitive by the rising costs in raw materials.

Fourth, recently a shortage of natural rubber has been forecast, with demand expected to outstrip supply in the 1980s, whereas a glut for palm oil has been indicated.

And fifth, rubber trees have been said to be more effective in nutrient cycling partially because of lower levels of nutrient removal from latex than oil palm in addition to producing a more protective canopy for the soil. Rubber forests are also possible sources of timber and

fuelwood for the future (Joseph 1980).

One gets the impression from Chan's paper that smallholdings cannot be viable without government assistance. However, several studies have suggested that smallholdings are more competitive and more efficient than are rubber estates. Because economies of scale are not important in the production of natural rubber, smallholdings are able to operate at relatively low cost. Although the problems faced by smallholders are real, the problem of low productivity is associated with the problem of rural poverty and is not related to the size of operation.

Chan speaks of the "danger" of the government's stepping in if the industry gets into trouble. This so-called danger is nothing new to the rubber industry in Malaysia. Historically, the powerful plantations were instrumental in pushing through a number of commodity-control schemes, especially in the pre-War years. The smallholders have always been more adaptable than their estate counterparts to volatile rubber prices. Therefore, one cannot ascribe the pressure for commodity controls entirely to the growing political influence of the smallholders. The past experience has been that the benefits of such commodity controls have not trickled down to the small operators. The smallholders now would like to see that they also have an equitable share of the benefits of any international rubber agreement. And there is nothing undesirable or dangerous about that, unless of course prices are artificially pushed up beyond the long-run equilibrium.



Fisheries case studies



The Economic Future of Alaska Groundfish under Extended Jurisdiction

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The groundfish resources of Alaska make a significant contribution to U.S. and world economic well-being. However, they are not likely to be the basis for an economically viable U.S. fishing industry, at least in the near or intermediate future. Fortunately, the capture of economic value from a natural resource does not necessarily require extensive participation by the owner (national or individual) in the extraction. At present, U.S. policymakers have to decide the most effective way of ensuring adequate compensation for access to the resource.

L'abondance des lieux de pêche de l'Alaska constitue une ressource susceptible d'apporter une contribution importante à la santé économique des États-Unis et du monde entier. Cependant, ces zones ne peuvent constituer, à court et à moyen terme la base d'une industrie de pêche rentable pour les Américains. Heureusement, la récupération des profits d'une ressource naturelle donnée ne dépend pas nécessairement de l'étendue de la participation du propriétaire (particulier ou État) à l'exploitation de cette ressource. Les autorités américaines étudient actuellement les moyens de fixer une compensation équitable pour la concession de l'accès à ces lieux de pêche.

The groundfish resources of Alaska consist of several demersal species that together sustained a 1980 harvest of 1.558 Mt (Table 1). The term groundfish reflects economic rather than biologic similarities within the species group. Virtually all the harvest is taken by trawlers that process their catch on board. Groundfish destined for U.S. or European markets are normally filleted and frozen individually or in blocks. Those in blocks are subsequently converted into fish sticks and other convenience foods. Oriental markets use groundfish in a variety of other forms, the quantitatively most significant being fish paste.

Until the extension of U.S. national jurisdiction in 1977, the groundfish resources of the Gulf of Alaska and Bering Sea were one of the world's largest international common-property fisheries, even though the U.S. fishing industry was almost totally unrepresented. The major players were Japan and the USSR.

Like those in most other coastal states, U.S. fisheries policymakers saw the new control as the first step in converting the international fishery into local industry. The Fisheries Conservation and Management Act of 1976 (FCMA) set the

development of domestic fisheries, particularly for Alaska groundfish, as a national policy objective. However, the extension of jurisdiction, alone, does not imply development of a domestic groundfish industry. The U.S. industry took no interest in Alaska groundfish resources when it had equal access to undepleted stocks during the 1950s and the early 1960s, although the country was rapidly becoming the world's largest consumer of frozen groundfish. But the extension of jurisdiction and other economic signals in 1977 apparently were interpreted as evidence that rapid development of the U.S. groundfish industry was imminent. The first signal was a substantial increase in the real (inflation-adjusted) prices of groundfish blocks and fillets on the world market, even though an examination of longer-term price trends would have raised the possibility that this was just an upswing in one of the industry's periodic price cycles. Second, 1977 was a boom year for fishing-vessel construction in the U.S., particularly the construction of large (>100-t) vessels, capable of groundfish trawling but primarily designed to exploit Alaska's king and tanner crab resources. Some purchasers of

Table 1. U.S. and foreign harvest of Alaska groundfish (t round weight).

	Pacific cod	Flounder and sole	Ocean perch and rockfish	Sablefish	Alaska pollack	Other species ^a
Foreign catch^b						
Federal Republic of Germany	552.5	15.4	15.1	15.9	5996.3	134.3
Taiwan	199.7	161.3	27.0	38.4	4973.7	107.9
Japan	60105.1	147369.2	21898.5	6713.1	870890.0 ^c	61687.2
Poland	681.8	844.3	93.5	152.2	59230.9	365.1
South Korea	8070.1	31554.2	1825.2	1241.2	138877.4	28409.2
USSR	1953.2	1848.8	1255.2	416.0	39157.2	13529.3
Canada	-	-	-	-	-	1177.6
U.S. catch						
U.S. processed	6213.2	263.5	522.2	1541.3	3298.0	490.7
Joint-venture processed	8922.0	12627.7	90.9	58.9	11787.7	995.3

^aIncludes Atka mackerel, herring, tanner crab, snails, halibut, other finfish, and squid and unclassified.

^bNinety-three percent of total U.S. fisheries allocations to foreigners in 1980 — 1.6 Mt.

^cExcludes tanner crab.

Sources: Foreign catch, U.S. National Marine Fisheries Service (1981); U.S. total catch, North Pacific Fisheries Management Council (1981); and joint-venture catch, French et al. (1981).

vessels did require special features for groundfish trawling on the premise that these would be expensive to install later.

An abrupt change occurred in mid-1979. Prices of king crab, and eventually of most Pacific-coast species, declined sharply. The immediate result was a halt in new orders for the large trawlers upon which hopes for domestic groundfish development had hinged. As early as mid-1977, the prices of frozen groundfish fillets and blocks had, in real terms, already begun the decline from which they have yet to recover. At the same time, fuel and investment capital became more expensive. The result has been modest growth in the domestic Alaska groundfish industry. Alaskan processors tried, with limited success, to fillet groundfish when their plants were not being used to process higher valued species. Similarly, groundfish catches were made by idle U.S. fishing vessels. However, the largest U.S. catches were, and continue to be, made as part of joint-venture arrangements with foreign-fishing interests. Of the total 1.558 Mt of Alaska groundfish harvested in 1980, 1.512 Mt (97%) were taken by foreign fishing vessels. Furthermore, 34 000 t of the 47 000 t U.S. harvest (72%) was processed on foreign factory ships participating in joint ventures.

Although one may regard 3 years as too short a time to conclude that early enthusiasm about a U.S. groundfish industry was unwarranted, other factors support this conclusion. One is the failure of several early groundfish processing ventures and subsequent withdrawal of their sponsoring

firms. Also, there has been virtually no new investment in groundfish-dedicated plants or vessels. The furthest the industry has ventured has been to refit existing vessels and processing plants with mechanisms for groundfish production during the off-seasons for higher valued species. Although such an approach makes economic sense as a low-risk way of testing economic conditions, it cannot be seen as the basis for a large-scale industry.

Thus, the market has spoken at least for the near future. But it has only said what will not happen. What will happen still requires speculation. In my view, there are four possibilities: two of them include development of a domestic groundfish industry, whereas the other two involve allocation of the resources among primarily foreign participants.

Market-Induced Development

The possibility that market forces will eventually lead to development of a U.S. groundfish industry in Alaska cannot be completely dismissed. Presumably, world groundfish demand will grow at least in proportion to population increases in the major consuming regions — the U.S., Europe, and Japan. Demand for frozen fish blocks will likely grow even faster, as the convenience foods produced from them exhibit a greater income elasticity than is typical of other fisheries products.

Supply may or may not keep pace at current prices. Most of the world's major groundfish

resources are already fully exploited, or overexploited, although some opportunities exist for new groundfish-resource development, particularly in the economic-resource zones of southern hemisphere nations like Argentina and South Africa. Also, if and when north Atlantic nations restrict their current catches to levels that permit the rebuilding of stocks, they will set in motion a process that should also lead to long-run supply increases.

If the demand outstrips both these possible sources of new supply, then the real price of frozen groundfish products could rise on the world market and, with it, the financial promise of an American groundfish industry in Alaska. Another factor that may lead to the same end is the recent rise in world petroleum prices. Much of the effect of post-1974 fuel-price increases on the world groundfish market may still be masked by the existence of a distant-water fishing fleet built under earlier economic conditions. The opportunity cost of deploying the fleet for the remainder of its economic life is low compared with that for rebuilding and operating subsequent generations of distant-water fishing vessels. The fleet can economically exploit world groundfish resources at real prices not significantly higher than those prevailing during the 1960s and early 1970s until new capital investments are required for replacement vessels. The world groundfish supply curve will then shift upward to reflect more fully the long-term effect of higher fuel costs, resulting presumably in higher real prices for frozen groundfish products.

Numerous groundfish feasibility studies (Scott 1980; Stokes and Offord 1981) have suggested the shape the industry would take if it were developed, beginning as a part-time operation providing off-season employment for personnel whose primary economic motive would be the harvest and processing of higher valued species. Eventually, the industry would shift to year-round operation to provide continuity of supply and to meet quality standards required for competition in U.S. and world groundfish markets.

One sector would comprise shore-based plants in Gulf of Alaska communities, processing the catch from medium-sized trawlers. Alongside this industry one might also find a limited hook-and-line fishery concentrating on higher valued species such as Pacific cod and rockfish; although its output would be small, it might become an important source of local employment.

The State of Alaska understandably favours development of such a shore-based groundfish industry. In fact, the state, and particularly the several communities bordering on the central and

southeast Gulf, regard groundfish as one of the most promising renewable resources in their economic base. However, the fact that the majority of Alaska groundfish are located well to the west of these communities along the Aleutian Islands and in the Bering Sea means that much of the resource will have to be harvested and processed offshore.

Immediate processing and freezing of products at sea offers economic advantages as well as independence from shoreside facilities. At present, there is one U.S. vessel with processing capacity operating in Alaska waters — the Arctic Trawler. Formerly, the Arctic Trawler was government owned. It was purchased and refitted by a Seattle-based group, now harvesting Pacific cod and pollack with apparent technical and economic success. However, this venture's economic performance cannot be easily duplicated, the reason being that no other such vessel is available in the U.S.-built fleet and to construct such a vessel at current U.S. shipbuilding costs is not now considered to be a sound investment.

Policy-Induced Development

It is possible that a domestic Alaska groundfish industry will develop as a result of policies adopted by the U.S. federal government or the State of Alaska. Both the federal government and the State of Alaska (Scott 1980) currently subsidize fisheries development. However, there have not been any significant new federal subsidy programs instituted since extension of jurisdiction, nor in the present fiscal climate are any expected. In contrast, the State of Alaska, with considerable revenues from the taxation of oil production, is able to embark on major economic-development programs independently of the federal government and has elected to use a significant share of its coffers to develop renewable-resource-based industries including a shore-based groundfish industry (Scott 1980).

American international trade policy could have a major effect on the rate of Alaska groundfish development. Restriction of groundfish imports could raise prices; pressure on foreign nations to reduce trade barriers could open foreign markets; and relaxation of restraints imposed by the U.S. on fishing-industry inputs could reduce costs.

On both U.S. coasts, people have long advocated tariff protection for the groundfish industry. The most recent effort was a 1979 petition to the International Trade Commission filed on behalf of Pacific-coast groundfish trawlers. However, the tariffs remain 0–2.5¢/lb.

(0–5.5¢/kg) (U.S. International Trade Commission 1980), whereas wholesale prices range from 75¢ to well over \$1/lb. (\$1.50–\$2.20/kg). Groundfish imports continue to enter the U.S. market free of significant trade restraints, and in 1980 U.S. groundfish demand was largely met by foreign sources (100% of groundfish blocks and 77% of fillets and steaks).

At the most recent groundfish-tariff hearings, fishing personnel argued that protection from foreign imports was essential if they were to penetrate the frozen groundfish market and even if they were to retain their current share of the U.S. fresh groundfish market. The “converters,” distributors, and processors of imported groundfish countered that the internal structure of the U.S. fishing industry presented the most significant impediment to U.S. industry growth. In particular, they claimed that U.S. suppliers could not meet the quality standards of foreign suppliers (U.S. International Trade Commission 1980). The converters also noted that raising tariffs or introducing quotas might be sufficient measures to make fishing for species such as cod and flatfish economic but would not be enough to tip the balance for pollack, the bulk of Alaska’s groundfish resource. Any stringent trade restrictions would have a serious effect on U.S. groundfish consumption, the lower priced cuts of beef (hamburger) as well as pork and poultry being substituted for frozen fish sticks, fillets, etc. Casual observation, industry experience, and formal demand studies all point to strong consumer substitution relationships between groundfish and these other products. If U.S. consumers were to shift from imported groundfish toward domestically produced beef, pork, and poultry, domestic groundfish producers would have to recapture the market later, a problem perhaps more difficult than competing with foreign suppliers.

The U.S. government has pressured foreign nations to reduce their trade barriers to groundfish imports. Specifically, it has linked Japanese access to U.S. groundfish resources with trade policy and U.S. access to the large Japanese groundfish market. In early 1980 after the USSR was expelled from U.S. fishing grounds, U.S. fisheries officials embarked on what was termed a campaign of “fish-and-chips diplomacy.” The purpose was to use a portion of the Soviets’ former allocation as an incentive to other nations to relax their trade restraints or to purchase U.S. fisheries products. This effect met with some success, and nations who responded favourably were rewarded with new or increased 1980 allocations. This approach has now been introduced into U.S. law as part of the 1980 revisions to FCMA.

Ironically, tariffs and trade restraints imposed on inputs used by the U.S. fishing industry are one factor that keeps U.S. groundfish above world prices. The most significant cost increases result from the Jones Act, which prohibits U.S. personnel to use foreign-built vessels in U.S. fisheries. When FCMA extended fisheries jurisdiction to 200 miles, the Jones Act still applied only to fishing within the 12-mile limit. People soon discovered they could acquire and use surplus foreign trawlers in Alaskan waters and that the prohibition inside 12 miles was not a major economic restriction because they could transfer their frozen fish to a U.S.-built transport vessel or land in a foreign port. American shipbuilders immediately sought legislation to close the “loophole” that permitted this practice. What is surprising is that they were supported by a significant share of the U.S. fishing industry and numerous fishery policymakers. The argument of these fisheries people was that people who bought foreign boats could compete unfairly with those who had already invested large sums in a U.S.-built groundfish trawling fleet. Because no such fleet has yet appeared or is under construction, one must assume that the vessels being referred to were the numerous crabber trawlers then being built.

This apparent misunderstanding illustrates the necessity for viewing Alaska groundfish development in the context of the rest of Alaska’s fisheries, particularly the crab fishery. At present, well over 200 vessels take the entire king crab quota in about 1 month, whereas historically far fewer vessels operated nearly year round.

King crab vessels, particularly the newer and larger ones, are the closest thing to a groundfish trawl fleet that currently operates in Alaskan waters. Many crabbers already harvest groundfish for U.S. and foreign joint-venture processors, and many others indicate an interest in doing so when, and if, groundfish harvesting becomes economically attractive: that is, whenever such an operation represents the most profitable employment of the crab vessel and its crew. By one estimate, the existing crab fleet could take 200 000–300 000 t of Alaska groundfish if all available crab vessels operated in the crab off-season. The adverse side effects when the season opens for king crab, and to some degree for tanner crab, are that groundfish processors shut down, crews are laid off, and deliveries are terminated until the close of the crab season. Then processors must rehire and retrain crews and work to reestablish markets for their products. Meantime, by contrast, their foreign competitors who harvest and process groundfish all year

maintain the skill levels of their workers by providing continuous employment and the good will of their customers by offering reliable supplies.

Continued Foreign Exploitation under Present Allocation Rules

Unless significant changes occur in economic conditions or in public policy, the domestic harvests of Alaska groundfish will fall far short of the harvestable total. Under FCMA, the U.S. commitment to full utilization requires continued allocations to foreigners. The recent revisions to FCMA have substantially changed the rules on how surpluses are allocated among competing foreign nations and how foreign fishing fees are assessed.

Under the original Fisheries Conservation and Management Act of 1976 the United States adopted a policy of allocating harvestable surpluses primarily on the basis of each nation's traditional participation in U.S. waters. A rather nominal fee for those allocations was based on U.S. government costs that could be attributed to foreign-fishing activities.

Amendments adopted in 1980 de-emphasized traditional participation and introduced a new criterion for allocation: the recipient nation's willingness to support U.S. fisheries development. The amendments also changed the language concerning foreign fishing fees.

Foreign fishery allocation determinations shall be made by the Secretary of State and the Secretary of Commerce on the basis of

- a. whether, and to what extent, such nations impose tariff barriers, or non-tariff barriers, on importation, or otherwise restrict, the market access of United States fish or fisheries products;
- b. whether, and to what extent, such nations are cooperating with the United States in the advancement of existing and new opportunities for fishery products from United States processors or United States fishermen; . . .;
- e. whether, and to what extent, such nations otherwise contribute to, or foster the growth of, a sound and economic United States fishing industry, including minimizing gear conflicts with fishing operations of United States fishermen, and transferring harvesting or processing technology which will benefit the United States fishing industry.

Fees imposed . . . shall be at least in an amount sufficient to return to the United States an amount which bears to the total cost of carrying out the provisions of this chapter (including but not limited to, fishery conservation and management, fisheries research, administration, and enforcement, but excluding costs for observers

covered by surcharges . . .) during each fiscal year the same ratio as the aggregate quantity of fish harvested by foreign fishing vessels within the fishery conservation zone during the preceding year bears to the aggregate quantity of fish harvested by both foreign and domestic fishing vessels within such zone and the territorial waters of the United States during such preceding year (U.S. Congress, Public Law 94-265, 94 stat. 3299).

Another significant recent development in allocation policy has been the growth of joint ventures, particularly between U.S. vessels and foreign processors. Groundfish in the round are delivered to the processor at sea, where they are converted to products aboard the foreign-flag vessel. Usually, the U.S. fishing vessel simply tows its trawl net to the vicinity of the processor vessel. There the cod end of the net is detached and tied to a buoy until the fish it contains can be processed.

Joint ventures were apparently not foreseen by the original drafters of FCMA nor are they explicitly dealt with in either the old or the new foreign allocation and fee provisions. The only reference FCMA makes to joint ventures is the so-called processor-preference amendment, which restricts them from direct competition with U.S. processors.

Regardless of how joint ventures are legally treated, their development is a natural economic outcome of U.S. policy concerning fisheries allocation. Given that the demand for foreign allocations exceeds the supply, one would expect foreigners to seek to increase their share of the total. FCMA provides no way for an increase in share except from American fishing vessels, which have not only an automatic preference over all foreigners but also the right to take groundfish without paying any significant fees. U.S. and foreign entrepreneurs have quickly discovered the obvious route to a marriage of interests.

Under current joint-venture arrangements, the foreign participants normally provide the labour and capital inputs required for processing. For these, they hold the advantages of paying lower wage rates and of having already acquired capital equipment. The U.S. vessels provide the fishing effort at a relatively low cost because most joint-venture fisheries operate during the crab off-season when economic alternatives are limited. However, the crucial contribution of the U.S. vessels is their access to the resource on a preferential, no-fee basis. The result, as recent experience has shown, has been a commercially profitable venture for both partners, accounting in 1980 for 72% of U.S. landings of Alaska groundfish.

Foreign Fishing Fees: an Allocation Device

That monetary fees have been given so little consideration as a tool in allocating U.S. fishery resources is a little puzzling. The federal government relies heavily on fees to allocate federally owned timber, petroleum, minerals, and other natural resources; and other coastal nations have included newly acquired fisheries resources among those they sell to foreign interests. Elsewhere, I (Stokes 1981) have dealt with the way that fees could be used to allocate U.S. fisheries resources.

Briefly, one method would be to set a fee and to observe whether the total demand for allocations exceeds or falls short of the allocable surplus. The response would indicate whether increases or reductions in the fee were needed. The fee would have to be adjusted as economic conditions change. Alternatively, the U.S. could take bids on appropriately defined units of fishery resources. Potential buyers would then determine the market-clearing fee by offering bids. The highest of these would be accepted by the U.S. until the available surplus was allocated.

A variety of factors other than the value of allocations to potential buyers would determine the actual level of revenues received by the U.S. Perhaps the most important of these would be the extent of competition among buyers. The economic theory of bidding indicates that only under competitive conditions will bids approach the net profit to be expected from the allocation.

In trying to sell Alaska groundfish, the U.S. would face a far from competitive market structure. Rather, the market would consist of one

dominant buyer, Japan (77% of the 1980 allocation), and a periphery of smaller competitors. The Japanese would presumably recognize and exploit this market power, and how the U.S. would counter in the resulting bilateral bargaining situation is not clear. However, the U.S. position would be strengthened by the existence of current or potential competition.

Hence, policies that restrict competition can be seen as weakening the U.S. hand when and if market allocation is ever adopted. Included among these policies would certainly be any residual allegiance to the traditional fisheries concept, which denies bidding rights to potential competitors simply because they have not historically fished in U.S. waters. The same would be true of the ban on fishing by the Soviet Union which, until its exclusion, was Japan's principal competitor for U.S. fisheries resources.

Conclusions

The options for the U.S. in effectively managing its groundfish resources do not exclude the development of a domestic capacity to exploit them; however, in the short and medium term, there are much more economically rational approaches. The first step is a rethinking of the policies on allocation of the resources. If policy-makers were to decide to maintain present allocation policies, then they would need to give much greater attention to joint ventures than they are currently. If they decided to change the policies on allocation, they could consider several means of obtaining fees that are commensurate with the value of the resource.

Discussion

Yoshiaki Matsuda: In contrast to early expectations, the domestic Alaska groundfish industry has developed little in the 3 years since FCMA was enacted. Realizing this fact, Stokes discusses possible alternative management schemes for resource use, including market-induced development, policy-induced development, continued foreign exploitation under present allocation rules and under a new schedule of fees. Each possibility has advantages and disadvantages. Market-induced development is favourable from the economic point of view but unfavourable from the social point of view; policy-induced development promotes balanced domestic fisher-

ies development but could be very expensive; continued foreign exploitation under present allocation rules encourages local development through joint ventures with foreigners but reduces the U.S. government's share of fee income; and foreign fishing fees provide fee income at low administrative cost but discourage domestic fisheries development. The options require that priorities be set and trade offs be made in accordance with the priorities.

I agree with Stokes' conclusion that the U.S. must avoid encouraging groundfish operations that could never survive on their own in the open market and would require permanent subsidy if

they were not to engender painful economic decline in the communities where they have been introduced.

However, I would like to comment particularly on his pessimistic evaluation of current Alaskan groundfish development. He notes that U.S. fishing operations harvested 47 400 t (3%) of Alaskan groundfish resources in 1981. He feels that this accomplishment is minor; however, I feel it is only low in comparison with U.S. expectations, which may have been too high.

Unlike development in construction, transportation, and communication, fisheries development is slow because of its complexity. Although the United States has discredited itself by using strong political pressures on foreign countries in its current policy of fish-and-chips diplomacy, it has a good start in developing the capacity to exploit its Alaska groundfish resources. The United States must understand the reality and limitations in developing such a fishery.

Stokes' paper has not mentioned anything about the Blow, Magnuson, and Weicker bills. However, the Japanese are concerned about the policies in these bills that seek to phase out foreign fishing, increase fishing fees, etc. In fact, these bills are an indication that U.S. policymakers have forgotten that foreigners have not always been bad for the United States. For

example, the Japanese have been willing not only to observe conservation measures but also to invest in many U.S. fisheries industries, such as salmon eggs, roe herring, herring-spawn-on-kelp, sea urchins, and oysters. In addition, they have provided the best market for U.S. fisheries products, absorbing more than 50% of the total U.S. fisheries exports.

Frankly speaking, I would like to ask whether Alaskan groundfish fisheries development (which pertains to dramatically underutilized low-valued species) by the U.S. fishing industry is advisable when the opportunity costs for this development seem to be very high. Now is the time to ask why the United States wants to develop a domestic industry to exploit Alaska groundfish and why it needs fish-purchasing missions from Japan to guide it in setting up facilities to cater to the Japanese market at Japanese expense. Normally, when a country wants to sell a product to another nation, the producers learn the language of the potential consumers and do market research at their own expense. In the Japanese people's eyes, the policymakers in the U.S. are not behaving responsibly. The United States should be examining past experiences and working toward new means of international cooperation that do not exploit others and that mutually benefit all the participants.

Canadian Regulation of Pacific Fisheries

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The rich fish stocks on Canada's west coast have been commercially exploited for a century and regulated by the Canadian government for many decades. The salmon, halibut, and roe herring fisheries are the most important, and the efforts to manage the stocks since the introduction of extended fisheries jurisdiction (EFJ) provide insights into the special requirements in managing migratory species (salmon) and fisheries, such as roe herring, that are dependent on export markets. The impact of EFJ is particularly clear for the halibut fishery. The history of regulation can be divided into two phases. Early efforts were based almost entirely on biologic considerations. Starting in the 1960s, limited entry programs were used in an attempt to reduce economic inefficiencies and to protect the stocks, but these failed because the economic incentives to remaining participants were unchanged. Landings taxes and transferable quotas have been proposed as means of rationalizing these fisheries, but any scheme that fails to address the crucial links — biologic, economic, and international — cannot succeed.

Le Canada exploite sur une base commerciale ses abondants stocks de poissons de la côte ouest depuis un siècle et le gouvernement exerce ses droits sur cette zone depuis plusieurs décennies. Les pêches les plus importantes comprennent le saumon, le flétan et le hareng. Les efforts de gestion des stocks halieutiques depuis l'extension de la juridiction sur les pêches ont mis en relief la nécessité de fixer des mesures spéciales pour la gestion rationnelle des espèces migratoires. L'impact de ces mesures est particulièrement évident dans le cas du flétan. L'histoire juridique de la gestion des pêches maritimes comprend deux étapes. Les premiers efforts réalisés s'appuyaient sur des considérations biologiques. Mais dès le début des années 60, des réglementations furent imposées pour lutter contre la surexploitation et protéger les populations mais ces moyens se sont avérés insuffisants, les rendements répartis entre les pêcheurs n'ayant pas été rajustés. D'autres formules telles que taxe par capture et quota de prise ont été proposées mais toute technique de lutte est vouée à un échec si elle ne comprend pas des paramètres fondamentaux à la fois biologiques, économiques et internationaux.

The wild stocks of fish on the northwest coast of North America were extraordinarily bountiful and productive in their natural state. The Pacific salmon especially has long been a highly prized fish and, along with the halibut and herring, provided the economic basis for a wealthy and stable coastal Indian culture. With the influx of settlers to British Columbia in the late 19th century, exploitation of these resources, especially those in the Gulf of Georgia, rapidly increased. The primary demand has been, and continues to be, from export markets. The United States, which provided the earliest export market, continues to be important, but Japan and the EEC nations (especially Great Britain) are importers of sub-

stantial amounts of fisheries products from the west coast.

Salmon occupies a preeminent position in the B.C. industry, accounting for up to 60% of total landed value (DFO 1980). The salmon fishery has always received a large share of public attention, particularly regulatory attention, as a result.

Regulation of west-coast fisheries in Canada is carried out exclusively by the federal government, as part of its constitutional jurisdiction over coastal fish and fisheries. Apart from limited jurisdiction over sport fish and shellfish, the provincial government has control of fish only after they have been landed on the dock. This arrangement has allowed the federal government to link

management of the stocks both to international trade in products and to international efforts at cooperation in fisheries stock management. In Canada's case, the latter has principally been with the United States but also included agreements with Japan.

Objectives

Unrestricted, open-access exploitation of fish stocks usually leads to several undesirable consequences (Gordon 1954; Scott 1955). One is that, if the market conditions are favourable and the available technology effective, the fish stock could shrink sufficiently to endanger its long-term survival. A second deleterious result is that the level of fishing effort (in the form of capital and labour inputs) typically exceeds that required to take the catch in an efficient, least-cost manner.

Those who have introduced administrative regulation of the fisheries off the west coast of Canada have not in general viewed the avoidance of the second consequence as a primary objective. The overriding goal, historically, has been protection of the fish stocks. For this reason, biologic management has until recently been the major organizing principle of the Department of Fisheries and Oceans. (This agency has undergone several name changes over the decades but will be referred to here as the DFO.) In particular, the biologic concept of maximum sustainable yield (MSY) was the typical expression of the goal of fisheries' policy over many decades, beginning early in the century. This goal is also enshrined in several international treaties relating to fisheries management to which Canada is a signatory (Logan 1974). The major regulatory tools applied were total-catch quotas, closed seasons, gear restrictions, and area regulations and closures. Effective biologic management does require protection of spawning areas and other such measures, but because salmon, for example, spawn only once, size restrictions have not always been used. Related to the biologic emphasis was the need to protect the distribution of the shrinking catch among traditional gear types and fishing groups.

The principal difficulty with the traditional approach to management was that it did not deal with the economic implications of the controls it instituted. Effort expanded in competition for the available catch (Sinclair 1978), returns to individuals were threatened, and the number of redundant inputs was enormous. As a result, open seasons were shortened over time. A demand thus existed by the 1960s for a revised

management scheme, but the programs that followed paid little explicit attention to the inefficiencies or costs of excessive effort, the one exception being the salmon management program.

Resources

Salmon

There are five major species of salmon on the west coast — sockeye, coho, pink, chinook (spring), and chum — all of which are commercially exploited. Salmon are "anadromous" fish; mature classes return from the ocean to spawn in the coastal rivers and streams in which they were spawned. The stocks available for exploitation are highly variable because time to maturity differs across the five species and because the run up a particular river is a mixture of runs from different species and genetically distinct subspecies, each making for its particular spawning ground. Specific substocks are highly vulnerable to overexploitation, owing to their habit of traveling in large schools once they move close to shore. They are easily taken by nets if they migrate when the fishing is "open."

The wide-ranging movement of the salmon during their early life, together with their high market value, makes them a subject for international debate. The two largest runs of British Columbia salmon are those returning to the Fraser and Skeena rivers. Together, these account for 50% of salmon caught in B.C. (Macdonald 1980), and both pass through U.S. territorial waters. Another significant run, bound for the Columbia River on the U.S. coast, passes through Canadian waters off the western coast of Vancouver Island. Commonly, one nation's fishing operations intercept the stocks returning to another nation's rivers.

Exploitation of the salmon resource was prompted by a strong export demand. The traditional export form was canned salmon, with the United Kingdom being the largest consumer of west-coast products. More recently, the canned salmon industry has become increasingly dependent on the domestic market, which is protected by a 7.5% tariff (Macdonald 1980). During 1966–74, roughly 47% of canned salmon was exported. Exports of frozen whole salmon have been increasing, largely in response to increasing Japanese demand since the mid-1970s. Over the same period, 75% of frozen salmon was exported (DFO 1979), with some recent years showing exports as high as 90% (Macdonald 1980). This strong international market has had predictable effects on the levels of effort devoted to salmon fishing.

Exploitation of the Fraser River sockeye stocks was well developed by the end of the 19th century, and fear for the stocks was expressed from the 1880s onward (Fraser 1977). A series of slides in the Fraser Canyon limited access to the spawning grounds, but Canada was reluctant either to invest in improvement to this access or to curb its own fleet, believing that the benefits of such actions would accrue largely to the American fleet that was fishing the same stocks as they moved through the Juan de Fuca Strait and the lower Gulf of Georgia.

Eventually, mutual concern for the stocks led to an agreement between the U.S. and Canada, a model for international cooperation in fisheries management. The Sockeye Salmon Fisheries Convention was signed by Canada and the U.S. in 1930, although it was not ratified until 1937. It created the International Pacific Salmon Fisheries Commission (IPSF), which was empowered to improve the Fraser River sockeye migratory route and to regulate the Fraser sockeye catch. In 1946, it began to regulate exploitation, and the Fraser pink salmon stocks were added to its purview in 1956 (Gardner 1980). The Commission set total allowable catches, mesh sizes, net lengths, area closures by gear type, and weekly limits on fishing days. The outstanding aspect of this convention, however, is the distributive and protective stipulation that the sockeye catch be split on a 50:50 basis between Canadian and U.S. fishing operations and that costs of Fraser River fish ladders, spawning-ground improvements, etc., be shared equally by the two countries. These features remain in force today. The Commission invested heavily in clearing the river, and the stocks have continued to be commercially exploited.

A second international agreement of great importance to salmon was the tripartite International Convention for the High Seas Fisheries of the North Pacific Ocean (Norpac Treaty), which was signed by Japan, Canada, and the U.S. in 1952. Japan agreed to abstain from fishing salmon (and halibut) east of 175° W (a line more or less through the middle of the Bering Sea). Previously Japan had been free to take salmon stocks while they were still in their immature, high-seas stage. An important caveat to this principle was that the domestic nations fully utilize their stocks. It later became a principle of the draft law of the sea treaty that anadromous stocks should not be intercepted by foreign fleets, but this earlier treaty was clearly an important preliminary step (Logan 1974).

Despite these unique attempts at maintaining stocks by international cooperation, domestic-

stock management became increasingly difficult. The number of days of salmon fishing allowed each week declined steadily, and open seasons became progressively shorter as the amount of effort grew larger and larger. After several years of discussion and study (Sinclair 1960), a Licence Limitation Program was implemented in 1969 in the B.C. salmon fishery. Because this program was an important breakthrough in fisheries management, it is worth stating its objectives in full. These were:

- To reduce the salmon-fishing fleet so that the remaining vessels would be more efficiently utilized.
- To reduce capitalization of the salmon-fishing fleet.
- To increase the net earnings of the personnel involved in salmon fishing.
- To provide the opportunity for government to obtain an economic rent from the salmon fishery.
- To provide the basis for improved conservation techniques (Sinclair 1978).

The underlying rationale was that a reduced fleet could take the catch at lower costs and have less need of new capital investment in gear and equipment, so that rents would emerge that could be shared by the fishing fleet and the government. At the same time, pressures on the stocks could be more easily controlled. These objectives would not be seriously questioned by most fisheries economists, but the program for achieving them was doomed to partial success.

The central features of the program were to be attained in four stages, only three of which were actually implemented. (Detailed analysis of the regulations can be found in Fraser 1977; Pearse and Wilen 1979; Sinclair 1979; and Macdonald 1980.) Under the first phase, the total number of vessels was to have been limited to its 1968 level. After an appeals process allowed the entry of several marginal participants, no new vessel licences were issued. All vessels that had engaged in salmon fishing in the previous 2 years were licenced to continue participation: "A" licences for vessels with catches above a certain limit in those years and "B" licences for all others. This distinction was aimed at restricting fishing to full-time participants: only "A" licences were transferable to replacement vessels. No gear stipulations were made, however, and only nominal fees were charged.

The second phase attempted a substantial decrease in fleet size by limiting the life of "B" licences to the period ending in 1981 (subsequently extended for 5 years) and, more importantly, by introducing a buy-back program.

Under the latter initiative, the government offered to buy any "A" vessels tendered to it and arranged for an attractive price as an incentive, i.e., the price was to be that determined by two independent evaluations, plus a 15% premium (Campbell 1974). These purchases were to be funded by licence-fee revenues, and the fees were increased.¹ The buy-back program started in 1971 but was eliminated in 1973, as a result of rising vessel costs and expected resistance to the higher licence fees that continuation would have required. Another stipulation was that "A" vessels could only be replaced by a vessel of equal or less tonnage. This was aimed at curbing the early practice of retiring small vessels and replacing them with much larger ones of greatly enhanced fishing power.

The third phase was in fact industry-wide and was concerned solely with vessel standards that affected the quality of fish landed. It started in 1973.

The fourth phase, which has yet to be implemented, is to relax the restrictions on time and area available for fishing. This phase was planned on the expectation that fishing power would decline as a result of the three earlier phases, but the necessary decline has yet to be observed.

The vessels that remained in the fishery after 1969 continued to invest in new equipment and even more sophisticated vessels to the extent that revenues exceeded costs, because the fish stock remained a common-property resource among those vested with licences. No legal or property limit was imposed on a vessel's potential catch, and, in fact, a desire to prosper in the race for fish during regulatory openings justified increased speed, storage, communications, and capacity. A slight decrease in the numbers of vessels (roughly 10%) was brought about, but real-capital growth has been noted in several studies. Pearse and Wilen (1979) estimated, for example, that real capital employed in the fishery (corrected for the value of the licence) grew at an average annual rate of 5.7% between 1957 and 1968, and continued to grow at 3.7% between 1969 and 1977, despite roughly constant real-fleet revenue over the full period.² Thus, although the difference in rates is statistically significant, implying that the program did have a limiting effect on capitalization, this success was only partial.

¹This schedule remained in place until the 1981 season, at which time fees in each category were doubled.

²Pearse and Wilen do point out that there may have been some quasi rents incorporated in their figures, but these would not likely have persisted over the fall period.

The growth in capital occurred in a variety of ways. Before the replacement rule on vessel weight, 76 vessels were replaced by vessels with a combined tonnage three times that of the previously licenced vessels (Macdonald 1980). A second method used after 1971 ("pyramiding") replaced several small vessels by a single large vessel of the same net tonnage but with a higher catch capacity than the smaller ones combined. The increment was especially large when a seine vessel (which uses a purse-seine net) replaced gillnet or troll vessels. Finally, any vessel could add another gear type to that already used. As Macdonald (1980) points out, however, the fact that many seiners became "combination" vessels over the 1970s also had much to do with the fact that those vessels began to participate in other fisheries as well.

Several subsequent salmon regulations were aimed at controlling or limiting this increase in fishing capacity. In 1977, seine vessels were allowed to replace seine vessels only. In 1978, vessels replacing a group of vessels were restricted to be less than 50 feet (15.3 m) long. In 1979, the tonne-for-tonne replacement rule was bolstered by a metre-for-metre rule. Finally, in 1980, the practice of pyramiding was prohibited outright. The DFO, as regulatory authority, had been forced to adjust the salmon-vessel limitation program to close loopholes in the regulations and will likely have to continue to do so. Indeed, it is now a standard conclusion in the literature that, to the extent that inputs are substitutable one for the other, effort cannot be restricted by simple input regulation (Pearse 1978).

In terms of its biologic objectives, the program has not been a major success, as is implied by the ongoing efforts to limit capacity. Fishery conservation managers, faced with the fleet's rising mobility and power, have been forced to introduce stricter area and time closures, with the openings reduced to portions of days in many areas. Troll vessels have not been subjected to such restrictions in their catching. This permissiveness exists at least in part for reasons related to international negotiation. A possible consequence was the reduced numbers of chinook, a traditional target of troll fishing, in 1980. This lack of control seems also to have led to the imposition of catch-retention limits on trolling for sockeye, pink, and chum — traditional net fish. (Technological innovation has blurred the old rule of thumb that net-fishing operations caught sockeye and pinks while trollers caught coho and spring.)

The major response to the threats to the salmon stocks has not been any further economic

rationalization of the fleet but rather an attempt to increase the stocks directly through the Salmon Enhancement Program. This initiative, which has counterparts in the U.S. and elsewhere, has as its long-run goal the restoration of salmon stocks to their "historic" levels by direct investment in spawning grounds and channels, hatcheries, rearing ponds, etc. The first phase (1977-84) envisions total expenditures of CA\$150 million, of which \$50 million had been spent by 1980 (Fraser and Friedlander 1980). The wisdom of such investments may well be apparent, viewed in isolation, but, because of the excess capacity that remains in the fishing fleet, reliance on this approach to guarantee the health of the stocks is questionable.

The most important developments currently facing the salmon fishery, aside from the possibility of a complete revamping of management and rights to access (a major inquiry is currently under way), are linked to the 200-mile economic zones declared by Canada and the U.S. in 1977. Interceptions are being carried out largely within formerly high-seas regions now subject to the jurisdiction of one country or the other. Other species are also involved (especially halibut), but the result in the case of salmon has been open conflict between Canada and the U.S. The IPSFC has been one focus of this debate, with Canada demanding a larger share of the Fraser sockeye and pink catch and also greater financial contributions by the U.S. for spawning-ground improvements. Joint management has been based on 1-year interim agreements, and a convention seems to be taking shape that would at least put a ceiling on levels of interception. This issue is important not merely on distributional grounds, however. The strategic demands of international negotiations, based as they often are in fisheries matters on past levels of participation, are having significant effects on Canada's domestic management. The relatively lax regulation of Canadian trolling (in comparison with the tight time and area restrictions placed on net vessels) is a consequence of these demands. The trollers have traditionally intercepted chinook and coho stocks returning to the Columbia River, and such interception is a crucial bargaining point in the ongoing discussions about interception of the large Fraser and Skeena stocks. Domestic difficulties have arisen, however, because new lures have allowed trollers to take sockeye, pink, and chum salmon so that the tight regulations on net fishing are not sufficient to protect the stocks. As a result, friction between fishing operations using different gear has worsened in recent years.

Halibut

The Pacific halibut is a demersal (bottom-feeding) fish and is the largest of all flat fishes: the average halibut at 20 years weighs more than 45 kg. It is a slow-maturing species, males reaching sexual maturity at 7-8 years and females at 12 years (Crutchfield 1980). Halibut are thus particularly vulnerable, the stocks being slow to recover from overexploitation. Crutchfield points out, however, that these characteristics imply that halibut is well suited as the basis for a stable, well-managed fishery. The west-coast stocks are truly transnational in nature, in contrast with the salmon; they are known to spawn at several places along the B.C. and Alaska coasts, and the various stocks mingle with one another constantly. They typically move into the open ocean in winter and return in heavier concentrations to coastal waters in the summer. There is also a tendency for larvae and immature fish to migrate to the north and west and for the mature fish to move east and south.

Halibut are taken by "longline" fixed gear (due to regulations). Although they could also be taken by bottom trawler along with most other groundfish, they are said to be far too valuable to be subjected to such an indiscriminate and often damaging fishing method. "Longlines" are lengths of line that lie on the ocean floor; attached at regular intervals along them are shorter lines with hooks. Buoys are attached to both ends of the lines, and they are typically retrieved by power drums.

The major market for Canadian halibut is the U.S. In the first 8 months of 1980, 98% of Canada's exports of fresh halibut went to the U.S., along with some two-thirds of frozen halibut exports. Another 20% in the latter category went to Japan (Statistics Canada 1980). Between 1972 and 1979, the real price of landed halibut tripled (Crutchfield 1980), but the rate of increase trailed off in 1978 and 1979. During 1980, the nominal price fell to about one-third its 1979 level.

Halibut fishing has a long history in Canada, paralleling that of salmon in that early fears were expressed for the long-term survival of the stocks. The current lack of effort aimed at exploitation of the south coast stocks may indicate that these fears were warranted. Vessels from both Canada and the U.S. were involved in the fishery, so management could be achieved only by cooperation. In 1923, Canada and the U.S. signed the Convention for the Preservation of Halibut Stocks, the "world's first international attempt at high seas conservation" (Logan 1974:43). The treaty was revised several times after 1930, with the most recent version having been in force from

1953. The International Pacific Halibut Commission (IPHC) was created in 1924 under the convention and given powers, to be exercised through the laws of the two countries, to regulate the total catch, gear type, and season and area openings. The Commission, whose objective has always been clearly understood to be the attainment of maximum sustainable yield, is a reasonably autonomous international fisheries authority, confining national government services to implementation and enforcement.

Halibut landings declined during the 1920s but recovered (as did catch per unit effort — a standard proxy for stock size) and increased steadily to a peak in 1962. (Although the Commission claimed success for its regulations, subsequent study has attributed this fluctuation in part to environmental factors as well.) In the years since 1962, however, stocks and landings have fallen dramatically — average landings during the 1970s by both countries were less than half those of the peak 1958–63 era (Crutchfield 1979a). The reasons for the decline are straightforward and demonstrate that the Commission has encountered the same problems employing regulatory methods as the salmon managers have. The three main reasons are the increased efficiency of the fleet, halibut fishing by boats from other fisheries (especially salmon and smaller “dayboats”), and incidental catches or by-catches by large foreign and domestic trawlers, working at some distance from shore.

The increase in the numbers of combination vessels can be explained partly by the rapidly rising halibut prices and partly by the steadily shrinking open seasons in all major west-coast fisheries. This trend toward combination vessels is certainly a result of traditional management methods, but it makes direct linking of fleets with stocks in rational management much more difficult because the fleets exploiting distinct species can no longer be treated as separate entities.

The problem of incidental catches of halibut is a quite different one, due to fishing technology, but it also imposes links between fisheries. The lower valued groundfish species such as hake, sablefish, pollack, lemon sole, etc. are taken by means of ground trawls, which literally scoop up everything on the ocean floor. Some halibut catch is inevitable with this method. Regulations on gear forced domestic trawlers to throw back halibut, with resultant mortality as high as 50% (Crutchfield 1979a). But the heavy exploitation, in the 1960s, of west-coast groundfish stocks by unregulated distant-water fleets of the Soviet Union and Japan has been regarded as the most

important element in the recent declines of stock (Crutchfield 1980).

With the advent of EFJ, exploitation by distant-water fleets has diminished, but other problems have arisen. Before 1976, the halibut resource on the west coast was managed as one entity, with vessels from the U.S. and Canada free to compete for all available stocks. The thrust of EFJ, which was toward the exploitation of domestic stocks by domestic fleets, made a change inevitable. In 1979, a protocol was signed between Canada and the U.S., under which fishing operations from one country were excluded from the waters of the other. This arrangement affects the Canadian fleet more than the American as the latter took only 2.5% of its catch in Canadian waters over the period 1969–79, whereas the former took some two-thirds of its catch over the same period from Alaskan waters. A special arrangement was eventually made for the IPHC's Area 2, which encompasses Alaskan and Canadian waters. The IPHC quota for that area is to be split, 60% going to the Canadian fleet and 40% to the American. The system worked poorly in 1979, the U.S. fleet taking more than 50% of the quota early in the season, but the difference is to be made up over several years.

The IPHC had no authority to initiate economic rationalization of the halibut fleet, and by 1979 the Canadian halibut fleet was far too large for the reduced stocks in Canadian waters. The DFO response was to initiate a limited-entry program for halibut in 1979, with licences to be issued only to vessels reporting landings above a given minimum in 1977 or 1978. The minimum was set so low, however, and the appeals criteria were so generous that the result was a reduction of only about 20% of fleet capacity. Eighty percent of the vessels are thus left to compete for perhaps 50% of the catch previously available to the full fleet. The stage is clearly set, therefore, for combination vessels within the halibut fishery to increase appreciably their levels of effort in fisheries other than halibut. Part of this redistribution of effort has been officially encouraged: holders of halibut licences were offered, in exchange for the halibut licences, gear-conversion grants and licences for sablefish, which have become available as a result of reduced foreign groundfishing effort. The advent of EFJ has thus affected many fisheries through this halibut connection and has served to highlight not only the international links in west-coast fisheries but also the links among domestic fisheries. The serious problems currently facing managers of the halibut stocks clearly need to be solved by cooperative means, and a thorough

understanding of the multiplied impacts of unilateral exclusionary actions is an important prerequisite.

Roe Herring

In 1971, a market for a new product, herring roe, began to open up, and a new phase of the herring industry was entered. The Pacific herring are shore spawners, and they move into coastal spawning grounds in dense schools in the early spring. Sixteen major spawning grounds have been identified, and the herring generally return to their own spawning grounds each spring (Wilén 1980).

The herring must be taken just before spawning occurs, the roe at this time being in the most desirable condition and at maximum weight. Once unloaded, the herring are brined or frozen, and the eggs are manually removed. The amount of roe recovered can vary from 10% to 16% of the total round weight of the female (Fraser 1980). The female carcasses and the males are subsequently used for fish meal, because they do not meet standards for human consumption.

The principal market for herring roe is Japan, where *Kazunoko* is a traditional seafood, now consumed mainly as part of the New Year's activities. Roughly 99% of Canadian roe exports go to Japan (Statistics Canada), and well over 90% of the value of the domestic herring catch is accounted for by herring-roe exports. Domestic Japanese supplies declined steadily over several decades (Fraser 1977), but tight import quotas were maintained on the product. In 1971, however, these restrictions were relaxed, and total imports to Japan of 8000–14000 t followed in each year between 1972 and 1977.

The impact of this new market on the B.C. herring fishery was explosive. In 1972, 196 seine vessels and 58 gillnet vessels took a total of 31 500 t of round roe herring (fish plus roe), with a landed value of CA\$2.1 million. In 1973, 161 seiners and 223 gillnetters took 50 400 t with a landed value of CA\$9.1 million (Wilén 1980). Although the season extends for 6 weeks at most, 1973 average vessel returns were \$56 400 for seine vessels and \$5700 for gillnet vessels (Sinclair 1979). The prospects for additional income for salmon seiners, and for anyone willing to invest \$5000 to bring a new gillnet vessel into the industry (Fraser 1980), were obvious, and thousands of vessels were expected to enter the fishery during the 1974 season. Excess capacity and effort had yet to develop but were clearly imminent. The time was right for a well-conceived management scheme that would prevent the problems experienced with other fish stocks.

Effective January 1974, a limited-entry licensing program was instituted for the roe-herring fishery. The stated objectives of the program were to control the fleet at a level that would not endanger the stocks, to guarantee returns above fishing costs, and to provide a source of revenue for the Crown (Fraser 1980). Because the fishery was new and because some new entry was still officially encouraged for employment reasons (Wilén 1980), the only criterion for gaining a licence was payment of a fee (\$2000 for seine vessels and \$200 for gillnet vessels). These fees were higher than those levied on salmon vessels but were low when measured against the potential returns. The licences were granted to individuals rather than to vessels and were made non-transferable (the inevitable result of this provision was that licences were leased for long periods). Entry continued to be open until January 1975, and the number of participants increased significantly; 250 seiners were licenced in 1974. A much larger jump in the number of gillnetters occurred, with 1579 licences issued. A significant number of these licences were left inactive, however, and some ultimately lapsed, so that there was clearly some speculative entry.

A series of shocks over subsequent years made the roe-herring industry into the second most important fishery on the west coast. The landed value of roe herring increased by an astounding 1000% during 1975–79, despite a 30% decline in the harvest (Fraser 1980). Two external developments initiated this trend. In 1974, the Chinese had supplied nearly 50% of Japan's import needs; Canada had 35% of the market. In 1975, the Chinese supply inexplicably dropped to 15% of its former level and, in 1977, dropped further to 5%. Canada was left in the position of dominant supplier, and its market share rose steadily from 54% in 1975 to 80% in 1979 (Fraser 1980; DFO 1979). Second, the yen appreciated by 40% against the Canadian dollar during 1977 and 1978. The harvest declined steadily from a peak of 78 300 t in 1976 to 37 000 t in 1979 (Fraser 1980) and contributed to the upward pull on price.

The result in terms of capital and effort devoted to the fishery was easy to predict. The two main focuses for new inputs have been increased gillnet capacity and enhanced vessel mobility among the various spawning grounds. These had dramatic effects on the primary method of biologic management: area openings for specified periods. Although an overall annual catch quota is set each year, the actual level of effort permitted is determined as a result of online management systems (Wilén 1980). In

brief, the system works as follows: local fisheries officers carry out random checks of the stock approaching the spawning grounds to determine both the size of the stocks (and thus the allowable catch) and the optimum time at which to open the fishery. When that moment is reached, the fishery is opened for the time that these officers estimate will be required for the number of vessels on hand to take the prescribed catch. The increasing capacity is causing severe problems for this system, however, in that if all vessels at an opening were allowed to participate, the entire stock might be taken almost instantaneously. Thus, 15-minute openings for the seine fleet have become rather common (Fraser 1980), this being the time required for one "set" of a purse-seine net. Openings are occasionally canceled altogether.

The present outlook for the roe-herring fishery is somewhat mixed. In 1980, the trend of declining catches accelerated, the total harvest amounting to some 18 000 t — one-half of the 1979 level and only one-quarter of the 1976 and 1977 catches. The significance of the 1980 catch is unclear.³ A large portion of the fleet was on strike at the time, and this fact may account for the small harvest. Nonunionized vessels did continue to fish, however, and as many as one-third of the usual number of seiners and one-sixth of the usual number of gillnetters were involved. This reduced fleet may have been sufficient to take the larger 1979 catch, but the 1981 catch recovered somewhat to about 28 800 t. The overall trend is clear, nonetheless, and there is some cause for alarm with respect to the health of the stocks.

A decline in landed price of about 50% in 1980 brought into question capital investments made on the expectation of prices' continuing at the 1979 level of nearly \$3000/t. Nevertheless, the 1980 price remains nearly twice the \$700/t paid in 1978 and four times that paid in 1977. Licence fees have remained at their 1974 levels (\$2000 and \$200), and gross returns in 1978 (before the quadrupling of price in 1979) were \$36 000 for gillnetters and \$74 000 for seiners. Thus, participants in the roe-herring fishery are continuing to earn significant rents, quite possibly at a level significantly above that justified by any government desire to "improve" their incomes.

³Some participants argue that recent stock declines are a reflection not of overfishing but of the methods of exploitation. In particular, they argue that the herring are being driven to less-productive spawning grounds and that the conditions are leading to reduced survival rates. This issue has yet to be adequately analyzed by biologists.

A rational approach to management of the fishery demands a reduction in effort on a scale that can only be achieved by a removal of some of the participants in it. In the 1981 season, vessels were required to nominate one of three areas to which their effort would be exclusively restricted; the areas are the Gulf of Georgia, the west coast of Vancouver Island, and the mainland coast north of Vancouver Island. This is useful only as a transitional measure, however, as is a proposed "vessel-pooling" scheme under which all vessels must pair off and only one vessel from any pair can attend a particular "major" opening, although both share in the catch.

In conclusion, the short history of the roe-herring fishery has demonstrated that inadequate control of the level of effort exerted in a fishery can lead to serious management and distributional problems when the industry is subjected to drastic shocks. The rapid escalation of effort and investment has been based on an assumption that the price rise recently observed will not be cyclical or temporary. The dominant position of the Canadian supplies in the Japanese market may well be eroded by external forces, unrelated to domestic stock difficulties. Alaska is expected to compete more heavily in this market and the previously dominant supplier, China, may reenter at any time. Although most of the seine fleet participates in the salmon and other fisheries, the gillnetters use equipment specially designed for roe herring (Fraser 1980) so that redundant capacity would represent a significant social waste. The fact that these problems have arisen from developments in an external market does not mean that they are unique to export-led resource development, of course. Instead, they simply draw attention to the fact that international markets can be volatile, especially from the point of view of a single player, and that inadequate or ad hoc stock, catch, and income management systems are particularly vulnerable to the shocks that external markets can produce.

Other Fisheries

Salmon, halibut, and herring roe account for nearly two-thirds of the landed value of the total catch in west-coast waters, but there are a number of smaller, thriving fisheries on the coast as well (DFO 1980b). A new approach has been taken with respect to the regulation of these fisheries over the past 5 years. During this period, six new limited-entry programs were initiated, and a seventh was begun earlier, in 1975. The common characteristic of these is that the licensing programs seem to have been set up in a manner that aimed at encouraging development

into major income sources, while maintaining at least some control over the pace of that development. Employment goals, and particularly distributional objectives, concerned with spreading the potential benefits from these resources among participants with limited employment opportunities, have been emphasized much more heavily in these programs than in others.

The fact that these programs followed almost immediately the introduction of EFJ in 1976 does not seem to have been a coincidence. One motivation was to exploit protected stocks in an orderly fashion. Another arose from the displacement of Canadian vessels from American waters, which was another result of EFJ. The principal example is the dislocated halibut fleet, and special provision was made for these vessels to enter the growing sablefish fishery, as well as others for which they had already been licenced or for which no licence was required. Significant increases in the value of abalone, geoduck, and sablefish, among others, attracted new effort in these fisheries, and management was necessary for this reason as well.

In terms of landed value, the herring spawn-on-kelp industry is the most important example. This is a traditional native Indian food fishery that was viewed as having commercial potential in the early 1970s, in light of the growing Japanese roe market. A limited-entry program was announced for 1975, with the start of commercial exploitation. The concurrence of licencing with the beginning of commercial exploitation is absolutely unique among the west-coast fisheries.

The principal aim of the spawn-on-kelp licence distribution system was to provide employment and higher incomes for native Indians and those living in remote coastal areas. Twenty-eight participants were involved in 1981. Each licence has an individual quota attached to it as a special condition, but the aim of these quotas is to prevent the market from being flooded, rather than to achieve optimum economic performance (the quotas are not transferable). In fact, the quotas are rarely reached, and available stocks have provided the true constraint. Production is complex: live herring are caught by seine nets and transported to enclosed ponds where they spawn and they are then released; high quality kelp is transplanted in the pond beforehand, and the kelp is subsequently harvested and the roe recovered from the surface of the kelp. The market is the same as that for roe herring, so that returns are quite high, in excess of \$100 000 per licence in recent years. The goal of boosting incomes is thus clearly being met. The administrative costs are also quite high, however, because supervision of

quality is maintained throughout the process, and observance of catch quotas must be ensured, nominally at least. In other words, this may be a rather inefficient way of subsidizing isolated communities.

The groundfish fishery in aggregate is the most valuable of the smaller fisheries, but each of the several species involved (various types of cods, soles, etc.) is individually unimportant, and a general groundfish trawl licence is issued. This fishery has a long history of exploitation, but the Canadian fleet has traditionally been only one part of a larger fleet fishing the groundfish stocks on the west coast. The Canadian catch has been gradually increasing since 1977, the year in which limited-entry licencing was imposed. The licences were distributed on the basis of prior catches, but special provision was made for dislocated halibut vessels to join the fishery without prior effort. In 1977, 112 of the 131 vessels reporting trawl landings were multiple-gear vessels, and income from their groundfish participation provided just less than one-half their total fishing income on average (Sinclair 1979). This fact highlights an important characteristic of several of the smaller fisheries: participants often are involved in the fishery mainly to supplement their income, especially in bad years for salmon and herring.

Sablefish is subject to a licence separate from that put on exploitation of the rest of the groundfish. The sablefish catch hovered between 500 and 700 t during the 1970s but jumped to 1400 t in 1979. The sablefish have increased in value relative to some other fish, and this improvement presumably accounts for the recent harvest increase. Large specimens are exported to Japan, whereas the smaller fish are marketed domestically.

Entry was restricted in 1980, and, although a historical-catch criterion was used as the basis for licence distribution, a series of special conditions attached to the program provides a revealing example of the conflicting objectives involved in managing particular fisheries. The historical-catch criterion was applied to longline and trap vessels, but entry into the fishery was allowed for vessels with these types of gear if they invested in refrigeration equipment. This provision reflects a tolerance of further growth in capacity in the interest of an upgraded product. Halibut vessels were also granted licences but only if they already held "A" salmon licences, or the new halibut licences. This condition is a further reflection of attempts to accommodate displaced vessels. Other halibut vessels were also allowed to retain longline sablefish catches if they were engaged in the halibut fishery at the time of the catch. This

provision is clearly difficult to police. Finally, groundfish trawl vessels that had established a historical stake in the sablefish catch were allowed to retain any sablefish caught on trawl, but only so long as the overall quota had not been reached. This condition was clearly aimed at establishing some sort of equity between the traditional gear types and those encouraged to develop the fishery in a new direction. The result, in terms of potential capacity that could be brought to bear on the stocks, not only is inefficient but also portends the kind of biologic management problems experienced in the more developed fisheries.

The other fisheries subject to limited-entry licencing — abalone, geoducks, and shrimp — have each exhibited a pattern of a large jump in effort and harvest in 1 year, in response to a rapid price increase, followed by the imposition of licencing for the next season. Abalone and geoducks are exploited by divers and so are rather separate from the other fisheries. The shrimp trawl fishery is basically an extension of the other trawl fisheries.

In summary, the DFO has established a record of responding quickly to situations in which effort is observed to be rapidly increasing, or in which significant potential for new products is observed. (Actual exploitation of such potential obviously requires some effort on the part of the processing sector as well, in terms of identifying and entering new markets.) These initiatives are certainly laudable in terms of providing for orderly market development and exploitation of new opportunities for international trade. The pitfalls of the regulatory tools employed tend to offset the benefits, however.

Current Management Issues

One particularly thorny issue that arises in the salmon and roe-herring fisheries is that of allocation of catch by gear type. The DFO is being forced to ensure particular divisions of the harvest among the gear types, for reasons both of equity and of stock management. In the salmon fishery, the different gear types have traditionally targeted on different species. They also fish in separate areas, the trollers tending to be seaward of the net fisheries. With the recent development of troll gear that can be used to catch sockeye, pink, and chum, the share of the gillnet fleet in the catch has dropped considerably. The significant catch by people who are sport fishing further complicates the issue. The DFO must, therefore, adjust catch limits, and area and time restrictions, to satisfy both biologic and equity objec-

tives. In the roe-herring fishery, the gillnet fleet is usually allowed to begin fishing first, and the number of seine vessels on hand at a particular spot may be so large that no opening can be allowed. Gear-type allocations are highly controversial, and the various participants are jealous of their stake in the fishery. These facts greatly complicate efforts to reduce the fleet to a manageable size and to reduce the costs of taking harvests. The problem is complicated further by efforts to accommodate vessels moved out of other fisheries.

Another issue that applies to all fisheries is that of recovering at least a portion of the potential rent that these resources could return to the Crown, or the general public, as ultimate resource owner. A debate is currently under way as to the relative merits of profit taxes, catch royalties, greatly increased licence fees, and other means of garnering a portion of the rent. The impact of these levies is difficult to determine. Significant rents are being earned, however, the most obvious examples being the roe-herring and spawn-on-kelp industries in recent years. Government policy is unclear as to the extent to which rents must be left to the participants alone, and resolution of this question is a prerequisite to a satisfactory end to the debate.

A closely related question is whether the fisheries should be completely reorganized or redirected. The limited-entry licencing approach to regulation does not work, because it ignores the economic incentives to the remaining participants. Biologic difficulties have developed precisely because of this inattention to the economic aspects of the fishery. Thus, for rational stock management and economic efficiency, a complete restructuring of the fishery is warranted. So long as any rents at all are allowed to accrue to the participants, distortions from the optimal levels of effort and stock will result.

One alternative to methods that attempt to force fisheries into economic efficiency by extracting all the rents is that of using transferable catch quotas. Quotas would be equal to the optimal catch. The incentive to rush and compete for the catch would be eliminated, and the fishing operations would face incentives to minimize the costs of taking their predetermined catch. Because the quotas would be transferable, and finely divisible, they would shift to the most efficient participants, i.e., those with the lowest costs, thus maximizing the rents realized from the resource. Government policy could then determine the distribution of rents. In principle, then, the result is the same, in terms of efficiency, as that of a landings tax that extracts all the rent.

The quota system has the advantage of requiring somewhat less information for the regulators, and it also allows flexibility in the distribution of rent. Such rationalization is clearly required. Any scheme that aims at economic rationalization on this scale, however, would be difficult to implement not only because of its novelty but also because of variations in stock levels and dispersions of particular substocks.

Conclusions

The topic of west-coast fisheries management is a large and complicated one. Many details have been passed over in this discussion, a notable example being the special provisions for native Indians included in every regulatory program

described here. Fluctuations in prices, stocks, harvests, and effort have been all but ignored in an effort to convey the broad trends around which the industry inevitably cycles. The conclusion that must be drawn is that these fisheries are truly interdependent—biologically, economically, and internationally. Recognition of this fact in future efforts at fisheries regulation around the world would constitute a most valuable lesson from experience.

I wish to thank Professors Anthony Scott, Gordon Munro, and Peter Pearse, and Doug Macdonald, Sandy Fraser, and Alan Barber for their many useful comments, suggestions, and criticisms. This paper would not have been possible without their generous assistance.

Discussion

Yoshiaki Matsuda: Professor Moloney has stressed the importance of governments' recognizing the links among fisheries if they are to improve management of their fish stocks. These links include the biologic interactions among species; the interaction embodied in multiple-gear fleets that exploit quite different stocks over large and separated areas; and the interactions between domestically owned resources and foreign markets and fleets.

He finds that limited-entry licencing programs do not work because they ignore the economic incentives to the remaining participants and that the difficulties in managing the resources biologically have developed because of the inattention to the economics of the fishery. Thus, Moloney has concluded that the fisheries are truly interdependent, biologically, economically, and internationally.

In my view, the key to fisheries management is good administration based on:

- Attention to natural and artificial sources of fish;
- An understanding of the objectives, priorities, and limitations of fisheries regulation or management among administrators (Moloney has not spelled out the priorities of previous or future management practices, and yet one cannot produce satisfactory results without defining objectives, setting priorities, detailing the methods, and revising the approach systematically on the basis of feedback and results);

- Appropriate administrative costs;
- Qualified personnel; and
- Simple, practical, and flexible regulations that respond to needs rather than precede them.

Canada cannot blame Japan for the inadequate management of its resources just because Japan has provided a market for such products as roe herring and spawn-on-kelp herring. Conserving resources and capturing rents for access to them are part of the responsibility of coastal nations. The responsibilities are great, as are the benefits of ownership. The first responsibility is to decide objectives and set priorities among them. If the most important objective is employment, then efforts should not be devoted to expanding capital-intensive fishing operations but rather to encouraging small-scale, labour-intensive operations. The impact and efficiency of large-scale, capital-intensive fishing operations is greatest when fish are abundant, whereas those of small-scale, labour-intensive fishing operations are greatest when fish are scarce.

Coastal nations should not dismiss the possibility of permitting open access to their newly acquired resources. Open access is a valid tool in fisheries resources management. Fish are quite vital renewable resources with quick turnover rates. Natural selection under open access might be the best way to achieve maximum social welfare: fishing operations understand that what they are doing is at their own risk, and administrative costs are minimized. I believe that conser-

vation is less important in fisheries than in other renewable resources. For one thing, there is no single-species fishery, although policymakers take a monospecies approach to conservation. The disappearance of one species from a fishery means neither a decrease in harvest of multi-species fisheries (or biomass) in the same area nor the absolute disappearance of that species from the oceans. Unlike pollution problems, overfishing under open-access management is restricted by economic feasibility. Fishing efforts for particular species first increase rapidly along with increasing profitability, then increase at a diminishing rate along with diminishing profitability, and, finally, decrease, as participants begin to lose money.

Therefore, fishing operations under open-access management never wipe out any fish stocks, most of which have wide geographical distribution. A welfare policy that prevents fishing operations from leaving fisheries has a greater impact on depleting species than does a policy of open access. The more welfare, the more depletion. Governments' failure to use the open-access tool effectively is largely attributable to their too-high administrative commitments in fisheries.

Timing is also important. Good timing in the introduction of management tools, such as limited entry, is essential. Development must be a step-by-step process that provides time for gestation and adjustment.

The Developing Skipjack Tuna Fishery of the Central and Western Pacific Ocean

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The skipjack tuna fishery is the most valuable fishery in the central and western Pacific and the most important fishery of its type in the world. For the small, isolated and largely copra-dependent states in the region, its expansion represents a potential means of diversifying their economies, providing employment and much-needed foreign exchange. This paper addresses some of the trade and development constraints associated with the fishery's orderly and rational expansion, outlines the economic importance to the island states in the region, describes the fishery, and analyzes issues relating to increasing national participation, marketing, and management, including the role of Forum Fisheries Agency. I am generally pessimistic about the benefits that the majority of small states in the region will gain from the fishery's development because of their inability to present a united front in selling their valuable and sought-after fish.

La pêche de la bonite à ventre rayé est la plus rentable des pays du centre et de l'ouest du Pacifique et la plus grande industrie du genre au monde. Son développement représente donc, pour les petits états riverains de la région, isolés et dont l'économie repose principalement sur le commerce du copra, un moyen de diversifier leur économie, de créer des emplois et de faire rentrer des devises étrangères. La présente communication porte sur quelques aspects des contraintes commerciales qui s'opposent à l'expansion et à la gestion rationnelle de ces pêches, en souligne l'importance économique pour les pays insulaires de la région, décrit la pêche et analyse les questions relatives à l'accroissement de la participation, de la commercialisation et de la gestion nationale, y compris le rôle de Forum Fisheries Agency. L'auteur envisage avec pessimisme les profits éventuels que la plupart des petits pays de cette région tireront du développement de la pêche à la bonite, attendu leur incapacité de s'unir pour commercialiser cette ressource estimée et recherchée.

The area in the central and western Pacific covered by the South Pacific Commission (SPC 1980a) includes 20 island states. Through declaring 200-mile exclusive economic zones (EEZs), they have acquired vast tracts of ocean that, in many cases, have become their most valuable and abundant resources. Indeed, in no other part of the world has the potential impact of extended jurisdiction been greater because the EEZs cover almost 30×10^6 km² of the Pacific Ocean (SPC 1980a:2), stretching in a wide band north of the Mariana Islands in Micronesia to Pitcairn Island in the east.

The EEZs provide control over rich fishing grounds, significantly increasing the states' potential to develop commercial, marine-fishing industries. Such development should enable more economic self-reliance and lessen the

group's dependence on a restricted range of agricultural exports and aid handouts.

At present, skipjack tuna (*Katsuwonus pelamis*) is commercially the most important fishery in the region, although still relatively young and not yet fully exploited. The potential for its expansion is considerable, and many of the states look to the exploitation of their skipjack stocks as the basis for a sizable industry that would provide much employment on fishing vessels and on shore and that would generate needed foreign exchange. These two benefits and the extraction of resource rents are seen by most states in the region as equally important policy objectives.

Skipjack stocks can be successfully exploited with relatively uncomplicated and inexpensive fishing gear. In addition, skipjack shoals generally aggregate close to islands and surrounding

reef masses and are, thus, easily captured in contrast to deep-sea tunas, which are currently over-exploited and unlikely to generate increase of yields (Kearney 1976:4). Also, the nature of the expensive and sophisticated technology involved in deep-sea fishing limits participation by nationals of the region. Because the islands are surrounded by deep ocean, trawling opportunities are few — the one major exception being Papua New Guinea's trawling operations for lobsters and prawns.

Economic Importance

There are four main factors that make the skipjack fishing industry especially important for the socioeconomic development of the island states in the central and western Pacific. First, countries in this region are relatively small with limited areas for agricultural development. Nine SPC member countries are smaller than 500 km², and five are less than 50 km². Of the available land, much has a low carrying capacity, is inaccessible, or is not arable. Second, the climatic conditions throughout the region are not conducive to the production of a variety of agricultural crops. Many of the island states are dependent on a single agricultural export, copra. Third, the majority of SPC countries have few land-based, nonrenewable resources such as minerals, oil, and gas. The potential for development of renewable resources — mainly timber — is also limited. There are exceptions: Papua New Guinea, New Caledonia, Nauru, and to a lesser extent Fiji. Papua New Guinea and New Caledonia have significant endowments of copper, and the economy of Nauru revolves around the phosphate industry. Papua New Guinea and Fiji also have substantial forest resources.

Finally, industrial development in countries with small populations that are isolated from large export markets holds little promise, the possibilities for benefits and economies of scale in production being limited. Poor and expensive transportation networks within the region restrict trade, even for the two countries, Papua New Guinea and Fiji, that have established export-oriented light industries. However, during 1980 and 1981, the government of Papua New Guinea actively sponsored trade missions to northern Australia and the island states of the South Pacific in a bid to boost exports. As yet, however, the trade missions have only had mediocre success, as many of the goods being promoted, matches for example, are not price competitive with those from traditional sources of

supply. Expensive air travel and other costs hamper large-scale tourist development.

Exploitation

The commercial exploitation of skipjack stocks in the central and western Pacific only seriously began in the late 1960s. Before 1965, landings of the species were small. Traditionally, skipjack and other tunas have been regarded as a poor-quality fish. Their flesh is dry and considered inferior to reef fish that are available in plentiful supply. Thus, the development of skipjack fishing operations is not competing with a traditional food source. Since 1970, the industry has expanded rapidly, mainly as a result of intensive fishing activity by vessels from Japan (Kearney 1979a). International demand for tuna, which has been doubling about every 10 years, coupled with declining longline catches of larger tunas in the region, has prompted investment in skipjack fishing. Along with Japanese vessels, fleets of Korea, Taiwan, the United States, and the Soviet Union come to the region for tuna. Vessels belonging to joint-venture companies, notably in Papua New Guinea, the Solomons, and Fiji, engage in skipjack fishing operations as well. However, less than 15% of the total catch is landed annually by these vessels (Kearney 1976).

The relative importance of skipjack fishing in the region is illustrated by the total catch in 1978: 363 493 t, 46% of the total for tuna and like species in the region (FAO 1980). This amount, although including the catch in Indonesia and the Philippines, approximates total landings in the SPC area and is customarily used to describe landings for it. The next most important species was yellowfin tuna, which accounted for 15%, or 120 911 t, of total landings.

As a proportion of world landings of skipjack, catches in the central and western Pacific are significant (38% in 1975 rising steadily to 46% in 1978). Catches in the SPC area rose from 205 387 t in 1975 to 363 493 t in 1978, an average annual increase of 20.8% compared with 10% for world landings (540 381 t to 791 786 t). In fact, a large share of the increase in world landings each year is from the central and western Pacific. Without the region's contributions, the annual increase in world totals from 1975 to 1978 was only 6.4%.

Although precise figures for catch per unit effort (CPUE)¹ are not available, the rising pro-

¹CPUE is a basic measure of the abundance or density of a fish stock in a given area at a particular time (Cushing 1968).

portion of catches in the region compared with total catches indicates that the fishery is still in a developing phase, capable of sustaining even more intensive fishing effort.

The pole-and-line method of capture is used exclusively in the region, purse-seining being relatively unimportant at present. The reason, according to Kearney (1974), is that the water in the region is clear and the thermocline is not suitable for purse-seining. However, Bour and Galenon (1979) have recently refuted this argument, maintaining that purse-seining operations can be developed. The advantage of this form of capture is that live baitfish are not required, although highly sophisticated and expensive technology is used.

A major constraint on the development of any pole-and-line fishing is the availability of suitable baitfish (good survival even after repeated handling, attractive to skipjack, quick, etc. — Wilkinson 1977). For this reason, the development of the skipjack fishery and baitfish resources should be considered together. In some island states, the availability of bait does not pose problems, although in Western Samoa, Tonga, and Kiribati, bait cultivation is necessary if skipjack fishing activities are to be expanded. As bait cultivation is expensive, it gives those states with natural populations of baitfish a cost advantage in production. However, the cultivation or the collection and "hardening" of bait from natural populations presents an additional avenue for economic involvement by local fishing personnel.

In places without shore-based processing facilities, benefits to the local people of the skipjack fishing industry are not significant. Employment opportunities are usually temporary and for unskilled labour — catching of bait, carrying bait during fishing operations, storing skipjack after they have been caught and moving them to mother ships or shore facilities, scrubbing decks, cooking meals for crew members, and simple general maintenance tasks such as painting. Skipjack vessels, whether they are locally registered or not, operate only about 9–10 months each year and then return to their ports of origin. Local employees on these vessels are paid at this time, and there is no certainty that they will be reengaged if and when the vessel returns.

Where shore-based processing facilities have been installed, the benefits are substantially greater. There are already many processing facilities in the region. American Samoa has two canneries in Pago Pago employing about 1200 workers and providing approximately 20% of all tuna consumed in the United States. Fiji has one

cannery at Levuka. Since the establishment of this plant, processed tuna has become a major foreign-exchange earner, after sugar and timber. The Solomons has one cannery in Honiara where all the skipjack landed there are canned (Kent 1980). Vanuatu also has a processing plant at Pallicola, and there is a similar establishment in New Caledonia. Tonga has large cold-storage facilities at Nuku'alofa for skipjack taken in its waters (Wilkinson 1978b). Papua New Guinea, after negotiations lasting almost a decade, expects to have a cannery operating in Kavieng by 1983. It is projected that this facility will employ up to 300 Papua New Guineans and have an output of about 20 t/day.

Skipjack exports from the region between 1975 and 1978 rose steadily, whereas price per tonne rose from U.S.\$402 to a high of \$912 in 1974 and declined in 1978 to \$674. These dollar figures are based on the mean annual FOB prices for skipjack at Papua New Guinea and have been converted from Kina to U.S. currency at the average exchange rate for the year. In using Papua New Guinea export prices, I have assumed that the trends in Papua New Guinea's FOB prices reflect world price trends and that prices realized by Papua New Guinea's exporters are not significantly different from those realized in neighbouring island states.

The estimated export value of production (i.e., if all skipjack were exported fresh or frozen) rose from \$83 million in 1975 to \$245 million in 1978. The estimated value of exports in canned form is 250% higher (Fairbairn 1977; Kearney 1976), \$207 million in 1975 and \$613 million in 1978. These estimates are in minimum and maximum valuations, and the real valuation of exports for the region lies somewhere within these broad limits.

National Participation

In striving to develop the skipjack resources within their EEZs and to derive maximal benefit, the states of the region must come to terms with several problems. Perhaps the most imperative of these is to increase national participation in the industry. Local inhabitants are strongly nationalistic and will not tolerate indefinitely the fact that foreigners are exploiting the resources. Prudent distant-water nations (DWN) already have probably recognized that their future in the EEZs will be determined largely by their attitude to, and success in encouraging, participation in the industry by nationals (Doulman 1980).

Local participation needs to be increased at

three levels: in skilled positions on both foreign and locally registered vessels, in entrepreneurial fishing, and in processing. At present, most of the skilled positions are filled by recruits from Korea or Taiwan, as remuneration is now generally insufficient to attract the Japanese. Thus, there is an incentive to hire and train personnel for the island states. Although the pole-and-line method of fishing requires stamina, the necessary skills can largely be acquired fairly quickly. Wilkinson (1977) believes that staffing vessels with local people would not act as a constraint on the fishery's expansion. Initially, the key positions on each vessel — fishing master, chummers, and perhaps captain — that require experience and skill in locating skipjack schools should be staffed by foreigners. According to industry officials in Papua New Guinea, often the difference between a profitable and unprofitable vessel is determined by the skills of the fishing master in locating skipjack and being able to direct the vessel to a suitable position ahead of the school so that fishing can begin. Skipjack fishing could be made more attractive for nationals from the island states if conditions of service were improved. It should be seen as a permanent occupation with the rights and benefits taken for granted in other occupations.

Second, attention should focus on introducing nationals into the industry as entrepreneurs. Initially boats smaller than 10 m, powered by 15–40 hp diesel engines and employing standard pole-and-line fishing techniques, could be used effectively. The initial capital investment could be reasonably financed under local development bank arrangements or perhaps by Asian Development Bank (ADB) loans. Maintenance costs of these boats are also within manageable limits. When their skills and capital permit, nationals can move to larger vessels of the type currently used by DWN. Governments of the island states that want to become directly involved in fishing operations have a variety of options for the purchase or lease of conventional, skipjack-fishing vessels.

The third level of involvement revolves around the development of shore-based processing (canning or freezing) and the related infrastructure. Wherever the catch is sufficient (6 t/year) to justify processing facilities, they should be established. Employment opportunities created by such facilities are vital to every state in the region. The heavy migration from rural to urban areas and high rates of population growth give rise to unemployment and social unrest. Also, process-

ing facilities increase the value of exports and, thus, the foreign exchange.

Marketing

Almost the entire catch of skipjack landed in the central and western Pacific is destined for markets in the United States, western Europe, and Japan. The major market is the United States where, as in western Europe, the fish is marketed in either brine or oil packs. A significant proportion of the skipjack marketed in Japan is exported frozen, whole from the Pacific region. It is subsequently processed into a dried form such as *katsuobushi*.² Generally, skipjack frozen in brine is unsuitable for the lucrative *sashime* market, as it discolours after thawing and has a high degree of salt penetration.

Although the island states import significant quantities of canned fish each year, the potential for import replacement by locally canned skipjack and other tuna is not great³ because, in canned form, it is not competitive with cheaper imports. In Port Moresby, for example, a 180-g can of tuna retails for about \$1.30, whereas a 365-g can of mackerel imported from Japan sells for \$0.55. Part of the nutritionally good dark meat, which is unsuitable for A-grade tuna packs and which is currently canned as a pet food, could be packed for sale on local markets. This is the only way locally canned tuna could realistically substitute for imported canned fish. Thus, it seems likely that for some time skipjack landed in the region will be destined for markets in high-income countries.

A major problem in marketing for resource owners is the control of transfer pricing, which is especially a problem when vertically integrated companies operate in an industry. When the price is below world market values, not only is the value of the resource reduced but so is the internal revenue from the taxes paid by the exporter. Papua New Guinea has experienced blatant abuses because of transfer pricing, mainly in its

²Until 1979, Papua New Guinea had a *katsuobushi* processing plant with a throughput of about 3000 t of fresh skipjack each year. The plant employed approximately 50 Papua New Guineans. The entire output was exported to Japan, realizing about U.S.\$800 000 annually.

³According to ADB figures, imports of canned fish and other fish preparations by seven member countries of the SPC (Cook Islands, Fiji, Kiribati, Papua New Guinea, Solomon Islands, Tonga, and Western Samoa) amounted to U.S.\$21.4 million in 1977 (Lawson 1981).

prawn fishery. The Fisheries Division of the Department of Primary Industry estimated losses to be U.S.\$2.3 million–4.3 million. These abuses prompted the government in 1980 to introduce two policies to check prices of all marine exports. The first of these policies was to establish a government-owned corporation, the PNG Fish Marketing Corp. Pty. Ltd. This corporation is legally empowered to purchase 25% of all fish products exported annually at the exporter's declared market price. This means that it can take advantage of low prices and resell products at their true market value. If fish are being sold at what is considered to be a fair export price, the corporation does not intervene. The second policy on pricing requires companies to seek export price approval from the Secretary, Department of Foreign Affairs and Trade, for all fish exports. To date, these new policies have operated effectively and could serve as a model for other island states in the region.

Management

Following the introduction of extended jurisdiction, island states have focused most of their attention on how best to develop their skipjack stocks. Management issues have been largely ignored, although these issues will become more important as the level of fishing effort increases. Historically, however, fisheries management has not been seen necessary until problems of over-exploitation and overcapitalization have clearly manifested themselves. To minimize the effects of these problems, governments should introduce popular, regionally based management early.

The effective management of the skipjack stocks in the central and western Pacific is complicated because skipjack migrate over wide areas in the region in unpredictable patterns that vary year to year (Kearney 1976). Because of this erratic migratory behaviour, biologists believe that it will probably be impossible to exploit these stocks to their maximum sustainable yield (MSY). This means that policies should be geared primarily to economic management of the fishery rather than to questions of resource conservation.

The case for effective regional management of skipjack stocks has been clearly stated by Kearney (1976) and Lawson (1979). Both writers argue for common licencing arrangements for all foreign and locally registered fleets, as well as coordinated and harmonized policies. Essentially these would permit a licenced vessel to move unimpeded from one EEZ in the region to another in pursuit of skipjack. Such policies are

necessary for reasons of economic efficiency because vessels must be permitted to pursue the fishable concentrations of skipjack along their migration paths. Without common licencing arrangements, interzone pursuit of fish is unlawful (unless the vessel is registered in adjoining zones), although the chances of detecting poachers are remote. Poached skipjack are considered part of the catch taken in the EEZ of the state where the vessel is licenced, and that state derives the financial benefits.

Common licencing arrangements would be advantageous to all states, even smaller ones that do not wish to, or are unable to, become directly involved in exploiting skipjack stocks. Under these arrangements all states would reap part of the resource rent. Kearney (1979b) recommends that a fee of 6% of the value of the catch be charged. In the absence of uniform policies and regional cooperation, the states are forced to compete with each other for resource development — a situation that dissipates the resource rent and fosters irrational resource use.

The major arguments for implementing a regional management policy for the exploitation of skipjack stocks in the central and western Pacific are:

- Because of their highly migratory nature, skipjack stocks are a shared resource among the various island states and, as such, should be regarded as a single fishery for management purposes. It is, therefore, in the interests of all states to follow policies that do not adversely impinge upon fishing operations. A common management policy should minimize conflicts between neighbouring states and promote regional, political cohesiveness.

- Uniform management policies will protect the interests of all states in the region, especially the smaller, economically disadvantaged ones, and help ensure that an equitable share of the resource rent is retained by them in return for access by fleets of the DWNs. It is on this point that strong arguments can be made against states' entering into bilateral arrangements with DWNs: resource owners tend to be weak bargainers and sellers, and such arrangements inhibit political unity in the region (Lawson 1979).

- Regional management better serves the interests of economy and efficiency. Effective regional planning should prevent problems of overcapitalization in the industry. Standard region-wide data collection and central analysis would provide basic biologic and socioeconomic information necessary for good management decisions and intraregional comparisons. The

costs of surveillance and enforcement of fishing agreements could be shared — an important consideration as surveillance costs for individual states' waters may at present offset financial benefits and discourage them from participating in the skipjack industry.

- Regional cooperation could include training of nationals from states in the region — a vital step if part of the industry is to pass into national hands. Regional training institutions would obviate duplication and mean reduced cost per unit output. Small states that cannot economically justify the establishment of their own institutions could derive significant benefits. The University of the South Pacific in Fiji has created a precedent in this regard. Fisheries training could also be undertaken at an institution like Papua New Guinea's Fisheries Training College in Kavieng.

- International legal provisions relating to extended jurisdiction require that resources of individual states within EEZs be conserved and that optimal use be made of them. For the island states in the region, these obligations could be best met through a regional management agency.

From an administrative point of view, the obvious organization to be assigned the responsibility of coordinating the management of skipjack stocks, including the control of fishing effort, resource exploitation, and distribution of revenue from the common licencing fund is the recently formed Forum Fisheries Agency (FFA) whose member states are Cook Islands, Fiji, Kiribati, Nauru, Niue, Papua New Guinea, Solomons, Tonga, Tuvalu, Vanuatu, and Western Samoa (Australia, New Zealand, Palau, Federated States of Micronesia, and the Marshalls have observer status). The 1979 Convention establishing the agency has as a goal to promote conservation and rational use of fish stocks and to coordinate management policies throughout the region. In this task, the most controversial policy area that the agency would have to grapple with, given that it will be responsible for levying and collecting access fees, is determining the split in resource rent between the resource owners and harvesters exploiting the resource. Similarly, controversy also may surround the adoption of an acceptable formula for sharing the rent among the various resource-owning states.

Since its inception, the FFA has paid only lip-service to its role of coordinating a regional management policy for skipjack stocks. If the FFA is to do this task effectively in future, its composition should be expanded to include others besides the resource owners. At present,

there is no provision for representation from DWNs or countries that process or consume skipjack. An expansion of the agency's membership to include representatives from these groups would place it in a better position to devise and implement management programs. But, given the states' current suspicion about the motives of the resource harvesters, processors, and consumers, such a recommendation will be interpreted as politically naive by many observers. The United States' intransigent stand on highly migratory species has been a major stumbling block for widening membership of the agency. At the South Pacific forum meeting in Niue in 1978, the Solomons, Papua New Guinea, Nauru, Tonga, and Kiribati staunchly opposed United States' membership in the FFA. Australia, New Zealand, Western Samoa, the Cook Islands, and Niue took the opposite view (Kent 1980).

One justification for widening the composition of the FFA is funding. The 1981 budget for the agency was projected to be about U.S.\$350 000, two-thirds of which would be contributed by the governments of Australia and New Zealand (FFA 1979). Apart from the total budget's being small in comparison with the task at hand, the disproportionate share coming from two sources (both formerly colonial powers in the region) could mean that these governments have undue influence on the agency's operation. Also, if they chose to withdraw their financial support, the FFA's collapse would be virtually assured. If the agency's membership were widened, the total budget could be raised and the potential influence of one country would be diminished.

Politics of Management

Despite many socioeconomic similarities between the developing island states of the central and western Pacific, they exhibit a striking propensity to disagree, even when the common good is at stake. This lack of cohesion has infiltrated the operation of the FFA and hinders rational economic management of the fishing industry on a regional basis.

The reasons underlying the seemingly petty rivalry of the states in this region are numerous. They can probably be traced to colonial experiences and are reflected in differences of geographical location and size. There is a definite feeling in most regional organizations in the South Pacific that the large, affluent, and better-developed states dominate organizations to the detriment of the smaller ones. Issues such as the location of regional meetings and, more recently, the appointment of staff to the FFA have been

divisive. In fact, at least one of the agency's largest member states is lending only nominal support to its functioning because the nominee of that state for a particular position in the agency's secretariat was not appointed.

The attitude of states to regional management of the skipjack stocks also varies. At least three states, Papua New Guinea, the Solomons, and Fiji, have already entered into bilateral agreements with Japanese and American corporations for the exploitation of part of their skipjack resources. If an all-encompassing regional management policy is to be implemented, these joint-venture arrangements will have to be accommodated by special provision or be discontinued. Other members of the FFA would press for the latter course of action, because these three countries are the "big three" in the agency. There is also genuine skepticism on the part of some states in the region as to the ability of the FFA to coordinate and manage the skipjack stocks. Logistically, this will be an awesome task.

What must be recognized by the island states in the region is that failure to present a united front to the DWNs will invariably mean that benefits, resource rent, and other potential gains will be less than they otherwise might be. The experienced DWNs find it relatively easy to deal with small countries on an individual basis and to play one against the other. With a regional management policy for access to the resource, the scope for such bargaining tactics will be reduced.

Future Prospects

Whether regional management is implemented or not, the large, more-developed states in the region that have already actively encouraged exploitation of their skipjack stocks and states having substantial shore-based facilities will realize financial benefits from the expansion of skipjack fishing activities. These states have a strong negotiating position in dealing with DWNs or their own joint-venture companies. In the absence of regional management, the losers will be the majority of small states that lack a strong negotiating stance but that are most in need of economic diversification because of their relative disadvantage in their economies. The resource rent will be distributed according to the rules of the jungle, and the resource owners will be exploited by the DWNs (usually represented by multinational corporations) so that their share of the rent will be little more than a token. Enforcement of such arrangements by the small island states is difficult. The only option under these circumstances is to accept the situation as it is or

prohibit fishing within their EEZs. This latter option is impossible to enforce without effective and continual surveillance, which is very expensive and beyond the financial means of most states.

When viewed from an international standpoint, the potential value of skipjack is great. Almost without exception, larger tunas around the world are currently being exploited at MSY levels. The only tuna fisheries where there is considerable scope for further development are skipjack, the largest of which is located in the central and western Pacific. Despite steeply rising production costs (mainly labour and oil prices), this industry remains economically attractive because international demand for tuna continues to increase, whereas international production is leveling off. In the United States, where approximately 50% of world production is consumed annually, per-person consumption is rising in spite of real increases in price. This situation is expected to continue. Like any primary commodity, skipjack prices fluctuate widely from year to year, but over the past decade these fluctuations have moved upward. Production costs for tuna substitutes — primarily beef and poultry — have also risen sharply, with the result that tuna has probably maintained its relative price position. Thus, the future prospects are bright.

Conclusions

Skipjack tuna of the central and western Pacific is the region's most valuable fish resource and the most important fishery of its type in the world. Although it is already being exploited to a significant degree, further exploitation is possible. The industry is particularly important to the small and isolated states of the region as a means of broadening their narrow economic bases and increasing their potential for development. Its development should generate much-needed foreign exchange and, where processing facilities are established, have a considerable impact on employment and the balance of trade.

At present, most skipjack are harvested by DWNs, with only a small proportion of total landings being taken by locally registered vessels. For the continued orderly exploitation, efforts should be made to redress this situation, as it will become increasingly difficult to justify in political terms.

Being highly migratory fish, skipjack move through the EEZs of many island states. Thus, effective regional management might be implemented under the auspices of the FFA. The management agency should have representation not

only from the resource owners but also from the harvesters, processors, and consumers. However, the politics associated with implementing this type of management arrangement poses enormous practical problems mainly as a result of the lack of political unity among states in the region. Evidence already suggests that attempts to introduce common licencing arrangements will be futile, as several of the member states have opted

to follow independent management policies.

Despite the problems in implementing a regional management program for skipjack, the future of the fishery seems bright. With the exception of isolated mineral developments in the region, the skipjack stocks belonging to the island states of the central and western Pacific are without doubt their most valuable and important natural resource.

Discussion

Theodore Panayotou: Doulman's description and analysis of the skipjack tuna fishery of the central and western Pacific Ocean is both informative and thought provoking. He addresses four issues — the importance of the skipjack fishery to the island states in the region; the new opportunities produced by the 200-mile EEZs; the objectives of, and constraints to, the development of the skipjack tuna fishery; and advantages and difficulties of regional management.

Doulman states that the skipjack tuna fishery in the central and western Pacific countries potentially offers opportunities for employment, foreign exchange, and resource rents. The only way that the fishery could produce these benefits simultaneously would be if one were to shadow price labour and foreign exchange below or above their market value. Such adjustments, often appropriate for developing countries (many of which have considerable unemployment and balance-of-trade deficits), should be incorporated in the calculation of resource rents, which are likely to be social rents rather than private profits.

To say that demand has been doubling every year without indicating at what prices is not meaningful because it does not indicate whether one is moving along the demand curve in response to changing prices or shifting to a new demand curve as a result of population growth, income rises, or taste changes.

Doulman does not show clearly the relative importance of the skipjack fishery in Papua New Guinea, the Solomons, and the other countries because he does not give rough estimates of the fishery's contribution to gross domestic product (GDP), employment, foreign exchange, or government revenues. Similarly, the difference between the value of fresh and canned tuna in Papua New Guinea does not accurately reflect

the potential contribution of canning to those who do not have the facilities yet. Not only the cost of processing and the economies of scale should be considered but also the possibility that the spread between the price of fresh and canned food would not remain unchanged if all the countries in the region were engaging in processing.

Doulman does not distinguish between nominal and effective control of the resources, although, no doubt, he is aware of the difference. The simple declaration of EEZ does not establish control of the resource unless effective enforcement can be exercised. Moreover, from the viewpoint of the coastal state, a resource is not a resource if, in the foreseeable future, the country has no capability to extract a resource rent (directly or indirectly). It is a resource for the poachers and the distant-water fleet, but it is no more than a potential resource for the coastal state. Only when these distinctions are clearly made, can one fully appreciate the investments necessary to convert a potential resource to an actual one.

I don't share Doulman's opinion that the rising proportion of catches indicates that the fishery is capable of sustaining even more intensive fishing effort. Economic and biologic overfishing has rarely been preceded by falling total catch, much less by a falling proportion of catch from a given location relative to the world catch as he states. Increases in effort (either through more vessels or through technological progress) can increase total catch far beyond the MSY. The effects of overfishing will be experienced much later. An example is the demersal fishing of the Gulf of Thailand, which is currently undergoing a decline partly as a result of overfishing.

Doulman gives ample evidence of the problems that fisheries development in the region is facing, and he is justifiably concerned about the

low retained value. He recommends localization of the skilled crew positions while retaining the services of some skilled foreigners; promotion of locally owned and operated pole-and-line fishing boats; and more government investment and development of onshore processing. Correctly, he also perceives a number of constraints — inadequate and unreliable sources of baitfish; temporary and uncertain nature of employment; and control transfer pricing in marketing. On the positive side, the capture of skipjack is comparatively easy even with relatively uncomplicated fishing gear of low capital and operating cost; funds can be found and fishing skills can be acquired fairly quickly. The problem appears to be more in management than in development.

Doulman argues that the *unpredictable* migratory patterns of skipjack call for a regional management policy geared to economic management rather than to resource conservation. First, the difference between these two types of management is not obvious to me. Second, and more

importantly, he underestimates the obstacles to an operational management agreement. Although the benefits from a regional policy may be large, it is unlikely that the 20 or so island states in the region can agree on a policy. The large number of states, their difference in size and level of development, as well as their history — “petty rivalry and propensity to disagree even when the common good is at stake” — operate against such an agreement. Even if they could reach agreement, there would be an incentive to chisel and a tendency to break away under foreign encouragement. Doulman advocates enlarged membership for the Forum Fisheries Agency, but experience suggests that the larger the membership, the less cohesive the group and (hence) the more difficult the enforcement.

These comments notwithstanding, Doulman's paper adds considerably to the knowledge and understanding of the refractory problems of development and management of the skipjack tuna resources of the central and western Pacific.

Fisheries Development in the South China Sea

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This paper is a critical review of the South China Sea fisheries from a statistical point of view. The focus is marine fisheries, although inland fisheries and aquaculture also have a significant role in the countries exploiting the South China Sea. Because of the lack of statistics for the nonmarket economies, these have been little explored in this paper, Thailand, Indonesia, the Philippines, and Malaysia receiving most of the attention. Expansion of fishery production in this region over the last few decades has mainly resulted from the introduction of trawl boats, large and small, which have also been responsible for the recent emphasis on the by-catch, a particularly noteworthy example being found in Thailand. All the countries in the region were seriously affected by the oil shortage in recent years, and those for which distant-water vessels dominated fishing activities have lost considerable ground.

La présente communication est un examen critique des pêches du sud de la mer de Chine, en terme de statistiques. L'étude porte principalement sur les pêches marines, bien que les pays de cette région pratiquent également les pêches continentales et l'aquaculture. L'absence de statistiques dans certains pays a limité l'exploration à cet égard, le document portant surtout sur la Thaïlande, l'Indonésie, les Philippines et la Malaisie. L'extension de la production halieutique de cette région depuis quelques décennies résulte principalement de l'adoption de chaluts de petite et de grande taille, qui a donné lieu à l'exploitation des pêches auxiliaires, nouveau débouché bien illustré par la Thaïlande. Tous les pays de la région ont été sérieusement affectés par la pénurie de pétrole des récentes années et ceux qui exploitaient les lieux de pêche les plus éloignés ont vu leur industrie s'affaiblir considérablement.

The volume of world fish catch has increased from 20.3 Mt to 71.3 Mt over the last 40 years (1938–79). Figures for the Southeast Asian countries during the period rose from 1.3 Mt to 7.3 Mt. The other major fishing countries of Asia (Japan, North and South Korea) increased catch to 2.5 times their pre-War figures (Japan from 3.60 Mt to 9.97 Mt, although a high of 10.2 Mt was recorded in 1978). The United States and Canada experienced a modest increase, the USA from 1.9 Mt to 3.5 Mt and Canada from 0.8 Mt to 1.3 Mt; the USSR had the greatest increase in catch (1.5 Mt to 9.1 Mt), some six times its 1938 level. The greatest single catch (12.61 Mt) was recorded by Peru in 1970. The upward trends of catch recorded by developing countries during the 1960s and 1970s should be seen as a catching-up process.

Among the three major developing regions of

the world, Latin America grew most significantly, followed by Africa, and Asia (31, 10, and 3 times respectively). In Latin America, fish was a secondary source of food until the end of World War II, and overall catch was low in 1938 (0.26 Mt). Peru and Chile found anchovy to be the basis of a lucrative industry and greatly developed the anchovy-meal industry after World War II. With the development of a large-scale processing system, this region's catch reached 10 Mt. Thus, total output rose to 14.45 Mt by 1970, accounting for 21% of world catch.

In Africa, the pre-War method of fishing was traditional and small scale; inhabitants caught fish from the lakes and seas strictly for their own use. With the introduction of modern technology and the input of capital, the supply and demand for fish expanded.

In Asia, historical and social conditions were

different from those in other developing regions. Fish were, and still are, an inseparable partner of rice in the daily diet, particularly in East and Southeast Asia. In Japan, as well, fish and other marine products have been a major source of protein, although the rice-fish diet is now changing, with meat, bread, and noodles gradually replacing fish and rice.

Trends

The use of resources in the South China Sea is primarily a concern of the Southeast Asian countries — particularly the ASEAN, Taiwan, and Hong Kong. China, Vietnam, Kampuchea, and Brunei are also concerned in the overall fish resources of the South China Sea, but data from these countries are not available. Brunei's annual catch is fewer than 30 000 t, and this volume does not affect the total picture of the South China Sea fisheries.

In all the ASEAN except Singapore, fish production has expanded sharply since World War II. The increase was marked after 1960 and continued until 1977 when the oil crisis seriously hampered Thailand and the Philippines. Interestingly, the fish industry in Indonesia and Malaysia appeared to be little affected by the oil crisis, with a continued expansion of the trawler fleets. The main reason is that diesel fuel is available and cheap. Thailand was most directly affected by the increase in oil prices, with drops in catch in 1974 and from 1978 to the present (FAO yearbooks on fishery statistics, 1954–55 to present). The implication is that the Thai economy is vulnerable to the oil shortage and its fishing industry is not protected by government measures or industrial control. The fishing personnel are not equipped to cope with this international crisis.

Since 1978, the supply of diesel oil has often been disrupted — a fact that prevents the off-shore fishing fleet from acquiring a minimum oil supply. During 1979 alone, the number of powered boats, large or small, that failed to set sail reached some 6000 (unofficial estimate). The result has been increasing pressure on the country's balance of payments, with exports (mainly to Japan) of shrimp being drastically reduced since 1980.

In the ASEAN, the annual growth rates in fish catch for 1961–65 and 1966–70 were 10.2% and 9.9% respectively. For 1971–74 and 1975–79, the figures were 3.4% and 4.0%. These two distinct movements are clearly demonstrated by Thailand. Thailand, which held the record for greatest catch since 1969, relinquished its position to Indonesia in 1979, its total catch falling from 21.9

Mt to 17.2 Mt in 1977; Indonesia rose from 15.7 Mt to 17.3 Mt in the same period. The fishing industry in the Philippines survived the initial oil crisis of 1974 but has been adversely affected by subsequent shortages. Thus, the 1976–79 estimates of average annual catch denote an increase of only 2.1%.

China, Burma, and Indonesia traditionally have been inland fishery countries, recording a high of 50% of total catch from inland waters. Statistics show that Indonesia recorded the highest inland catch among Southeast Asian countries during the 1930s and 1940s. In 1955, it still maintained a high of 60% of total catch. Thailand also depended heavily on inland fishing, with some 30% of the total catch coming from inland waters. Today the share of inland catch has been reduced considerably, as the marine fishing industry has rapidly expanded. Inland fishing should not, however, be ignored. The majority of inland consumers in all Southeast Asian countries (including Thailand) still depend heavily on fish from fresh water.

SEAFDEC (1976, 1978) and FAO data on marine fish for 1970 and 1978 show that marine production in Brunei, Indonesia, Malaysia, and Singapore increased markedly as a percentage of total catch, whereas in Taiwan, Hong Kong, the Philippines, and Thailand, the percentage declined. Whether or not this trend in marine fishing is temporary is difficult to evaluate.

In contrast, aquaculture is showing signs of increased production in the major Southeast Asian countries (515 000 t, 640 000 t, and 687 000 t in 1974, 1976, and 1978 respectively).

The future of the fishing industry of the ASEAN, and Southeast Asian countries, will be determined by the maintenance of fish stock, both economically and politically. The growth of the demand for fish in both domestic and foreign markets hinges on the government's ability to manage its fishing resources and to deal with increasing conflicts of interest between traditional fishing personnel and the large-scale modern industries.

Inland Fisheries and Aquaculture

Inland fisheries in the Southeast Asian countries were a source of 18% of total catch in 1978, natural sources and aquaculture operations accounting for 9.5% and 8.5% respectively. The quantities are not high, but the real value is considerable because the species (shrimps, sea bass, groupers, etc.) are highly desired by both importers and local consumers. By-catch from prawn trawling costs U.S.\$0.05–0.10/kg, whereas good-quality prawn costs \$6.00/kg. This comparison

indicates the importance of price-conscious assessments of subsectors of the fishing industry.

Although the proportion of marine catch for human consumption is declining, the proportion of fish from inland waters and aquaculture has remained at 100%. In the case of Thailand, with a tremendous increase in fish caught for fish-meal processing, the percentage of fish caught for human consumption declined from 70–80% in the mid-1960s to 30% by the mid-1970s. This change has meant drastically reduced prices for the total catch and, thus, lower incomes for those who derive their livelihood from marine fishing. The ratio of marine to inland catch is 84:16 in terms of quantity, but in real values it is 69:31 in the four major fishing countries of the ASEAN.

The percentage of fish used in fish-meal plants is increasing for each country of the region. The marine/inland fish ratio in value terms is also changing and, in the foreseeable future, may be 50:50 with perhaps a bias toward the inland industry because of the increase in quantity and value of aquaculture and the overexploitation of high-valued fish and shrimp in marine waters. If, as the trend indicates, some (or all) of these fish disappear from the South China Sea, the total value of marine fish catch would further decline both in absolute and in relative terms, although the demand for feed in the livestock and aquaculture industries raises the market price of poor-quality fish.

Structure of Marine Fisheries

Comprehensive figures on the number of fishing personnel by working status are available in SEAFDEC's 1978 report. Given that fishing is an occupation where the majority have small-scale operations and a considerable number are part-timers, a comprehensive assessment of the employment status in these countries is complicated.

The total number of fishing personnel aged 14 and older in Southeast Asia is 1.55 million, of whom 0.97 million (63%) are fully employed in the industry. If Vietnam, Kampuchea, and Taiwan figures are included (about 0.6 million), then the number reaches 2.2 million. Because another 2.5 times as many people are supposedly engaged in fishing-related occupations, then a total of some 7.7 million people are supported by the fishing industry. If the households of these people and those of southern coastal fishing personnel are included in the calculation, one could say the South China Sea and its adjacent waters are the primary source of food, employment, and income for about 50 million people.

Because the fishing operations are affected by

weather and the availability of stock, many fishing personnel are unemployed for days and even months every year. It is probable that the oil shortage has been especially damaging for the temporary labourers. In Indonesia, for example, it is reported that to catch the number of fish in a powered boat originally operated by two, at least three and as many as seven are currently being employed. It is safe to say, then, that the coastal small- and medium-scale fisheries are one of the important cushions for the unemployed in South-east Asia.

SEAFDEC (1978) reported small- and large-scale fishing contributions to total catch. In 10 countries of the region, a total of 7.16 Mt was caught in the sea and inland in 1978, 27.3% by small-scale operations and 52.5% by large-scale. Large-scale operations in Thailand accounted for the greatest proportion (77.3%), followed by that in Malaysia (68.6%) and the Philippines (32.0%).

The increase in fishing activity during the 1960s and 1970s coincides with an increase in powered boats in the region, both in number and size. This change is predominant in Thailand, which exhibited an impressive increase in trawlers (more than 5 t) (201 boats in 1961, 2395 in 1965, 3114 in 1970, and 6041 in 1978). In Indonesia, where motorized fishing boats are the least common, the proportion of motor boats in the total fleet was only 1.3% in 1966. By 1978 this had reached 10.5%, of which 5468 were 5 t or more.

As of 1978, no fewer than 132 000 powered fishing boats were operating in the South China Sea and adjacent waters, with many more under construction. If the boats belonging to Vietnam, Burma, Taiwan, and China that also fish these waters are added, at least 200 000 motor boats are engaged in marine fishing.

In Thailand and Malaysia, trawling produces the largest catch, whereas in the Philippines, gill and seine nets share the largest catch. Data are not available for Indonesia (SEAFDEC 1978); however, it is known that the emergence, in Indonesia, of a modern fishing subsector of large-scale shrimp trawling is hindering the traditional small-scale operations in the same waters.

Statistics on catch by species (about 20) show by-catch from shrimp trawling and sardines as the largest contributors to total catch. The remaining species are evenly spread in availability. By-catch is by far the greatest in Thailand (0.85 Mt of total 1.02 Mt). However, statistics on by-catch are unreliable and in most cases underestimated because the fish are landed at the discretion of the ship's captain and usually when a

monetary gain is expected. Some determining factors for landing by-catch are the distance from the fishing ground to the harbour; oil consumption for the transportation; prevailing market price; and the contract between boat owner and fish-meal plants.

In the domestic market, demands differ by country. In Thailand by-catch fish are an essential raw material for livestock feed. Now that they command 70% of the total market in Thailand, fishing can be seen as part of the fish-meal industry. The practices in Thailand contrast dramatically with those in Sabah and Sarawak where there is no domestic market for by-catch and the fish caught incidentally by shrimp trawlers are returned to the sea. The mortality for fish handled in this manner is extremely high, sometimes 100%.

By-catch fish are the predominant catch in the South China Sea, and comparing them and miscellaneous fish with the other major species is quite informative when assessing stocks and looking at the economy of the sea (SEAFDEC 1978). In value terms, expanded in dollars, penaeid prawns rank first, albeit seventh in quantity, and account for 15.7% of the total marine fish catch. They are followed by sardines (5.6%) and anchovies (5.0%). In value terms, by-catch fish rank 14th (2.2%). Due to the export market, penaeid prawns are particularly important for Malaysia and Thailand, with values to the country of \$264.3 million and \$132.8 million respectively. Sardines are important to the Philippines (\$133.7 million), and, in Thailand, by-catch fish are the second largest source of income, \$62.6 million. Penaeid prawns will continue to be economically valuable only if effective fishery management is introduced. At present, prawns are endangered and are the target of trawling fleets.

Fisheries in Coastal Ecosystems of the Humid Tropics

The coastal areas of the humid tropics are among the world's most productive and scientifically interesting regions. Some 60% of the population lives near the coast, and, at present, almost 90% of marine protein is derived from coastal fishing areas. It is estimated that more than half the world's recoverable hydrocarbon resources are located beneath these waters. Moreover, these regions provide prime sites for urban development, industry, agriculture, and, above all, fisheries.

Coastal areas comprise highly complex and productive ecological systems that, because of the interaction between land and water, are

among the least understood. They are also vulnerable to environmental abuse. Some of the world's most densely populated areas are found in the deltas and coastal plains of Southeast Asia, whereas similar regions in South America (for example, the Orinoco Delta of Venezuela) are among the least-populated regions on earth. These regions, with large areas of alluvia resulting in tropical soils with above-average fertility, are highly productive breadbaskets in Southeast Asia. In tropical South America, however, they are regarded largely as marginal areas (Ruddle and Manshard 1981).

As the global population expands, the pressure on forested and tropical humid areas is bound to increase dramatically. Although, to increase productivity, most nations emphasize policies that intensify the use of resources that are already being exploited, governments are either promoting or at least not restricting local-level development of agriculture and other resources of forested areas. Many of the schemes are poorly conceived and will undoubtedly have an adverse and widespread effect. Yet, such areas are alluring to decision-makers who, when faced with the demographic situation of Java, for example, see a future in the 8.5 Mha of Indonesian lagoon and estuaries for at least partial development of aquaculture, especially in the mangrove and freshwater swamp forest of Sumatra.

The importance of mangroves to the populations of many tropical countries is gradually being acknowledged. The peoples of Southeast Asia perceive that the plant is not only useful as a raw material (firewood, charcoal, timber, etc.), but also essential for nursery-hatched shrimp (or other aquatic renewable resources). As the exploitation of coastal aquatic resources intensifies, the development of these mangrove areas appears more attractive to the villagers.

Fish production from the mangrove forests is difficult to estimate, as it is currently a subsistence activity. However, the mangrove forest is a reliable food source for many aquatic animals. The young of many kinds of prawns live in a mangrove area for at least 2 months and leave when they mature. No data on production from a mangrove forest have been recorded, although it is clear that the mangrove forest has potential for the development of the fishing industry.

The potential productivity and the "value" of the humid areas are not widely appreciated by the communities that traditionally use their renewable natural resources. For example, estuaries have been used as garbage dumps and seen as

wastelands, which they may, in fact, become if not reclaimed and upgraded in the near future. The hidden costs of the destruction are only now being realized.

A major part of the mangrove forests is located in Asia and the Far East. In this region alone, roughly 6–8 Mha of forest have been identified (Christensen 1979). As these areas are rapidly being deforested, the identified areas have been considerably reduced.

Policymakers foresee a specialized use for reclaimed tropical wetlands, including large-scale agriculture, forestry, and aquaculture, and have, unfortunately, lost sight of the need to preserve the natural functions of the forest.

Mangrove areas are lush in nutrients for coastal aquaculture. The National Research Council of Thailand reported in 1977 that an area of approximately 19 000 ha has been used for this purpose. The total annual yield is about 37 355 t (Sanit et al. 1980). According to the Department of Fisheries, the area of mangrove forest suitable for shrimp culture is about 62 800 ha. This figure is based on soil properties, water salinity, tidal periods, and the availability of commercial shrimp.

A hazard to mangrove areas is mining, especially in the southern Thai coastal zone where tin is a major resource. Mining concessions may cover both mangrove and nonmangrove areas, and the defining of mangrove limits is difficult. In spite of government regulations aimed at minimizing pollution in the areas concerned, ignorance of these regulations is common.

Over the last decade, Thailand has witnessed an appalling increase in pollution in all land and water areas. The use of chemicals in the rice fields is widespread. Coastal waters and rivers are polluted by the indiscriminate dumping of wastes. Consequently, the fish catch has been greatly reduced, and many fishing personnel are finding other employment more lucrative.

Multiple and complex factors influence the overall ecosystems in mangrove areas, and it is still difficult to assess the economic implications of their interaction. One thing is certain: arbitrary use of the coastal waters of the South China Sea will have a deleterious impact on the aquatic resources.

Recognition of the real and strategic value of the coastal zones is forcing scientists and administrators to treat seriously the long-term implications of human–nature relationships. Fishery economists must also be cognizant of these implications, which will profoundly affect the income, health, and nutrition of the region's people. At a

time of increasing socioeconomic difficulties, the careful use of economics and ecology in the management of this fragile and fertile area of the South China Sea could guarantee the Sea's lasting fertility in aquatic resources.

Two Problems

Infrastructure and Marketing

In all the countries of the region except Taiwan, the infrastructure supporting the fishing industry is inadequate. Above all, the development of fishing ports, most basic to marine fishing, lags behind the economic and infrastructural requirements. Most of the major fishing ports of this region have grossly inadequate facilities.

As fishing activity expands, the standard of port facilities becomes more important to the net value and net income of fishing personnel. All the postcatch facilities are weak in the countries of the region — a fact that reduces the quality fish to the level of by-catch fish. In my observations in various ports of Thailand, I found that significant numbers of quality fish are being shipped to fish-meal plants along with the poor quality fish from the by-catch.

Fishing villages scattered along the coastal areas have even worse infrastructural facilities. There are generally no moorage facilities for local fishboats, powered or not, and these boats are usually beached. Even when relatively large wooden piers are available, trawlers over 10 t often have to wait until peak tide to dock. Medium- and large-scale boats are totally dependent upon the tides. Not only is this inefficient, but it reduces the value of the fish.

Inefficient ice-making machines and the lack of freezers also cause many problems. Although it is unrealistic to expect the degree of modernization of port facilities in developed countries, improvement of present conditions is crucial to the growth of the industry. A conservative estimate of food products not reaching the market is from 22% to 35%. This is almost totally caused by spoilage. This is a loss both to the people who need more nutrition and to the economy of the country.

The problems among the rural, traditional fishing personnel differ considerably from those facing people living in large, urban areas. The size of boats, the limited means of transportation, and the distance from village to the markets result in fish being preserved by salting, drying, or smoking methods. The fish preserved in this traditional way are sold at a low price to interme-

diaries and meet the demands of the majority of consumers.

I have frequently visited rural fishing villages of the southern and eastern regions of Thailand. Ice is usually unavailable to rural operations, and the slow process of salting is frustrating. The people are deeply aware of the problems for which there is no immediate economic or technical solution.

In my view, a large portion of the technologies originating in the developed countries can be easily adapted to the existing large-scale industries of the South China Sea, but, for the remote and small villages, special attention must be given to the cultural needs of the villagers before modern development techniques can be applied.

To some extent, fishing personnel can participate in the construction of ports, which should be initiated by public institutions and governments with international support in terms of capital and money. The Japanese experience is noteworthy: many of the major issues and problems have been solved by fishing cooperatives.

From the economic point of view, the small quantity of fish handled and inefficient means of transporting fish to the market are major problems in rural areas. Government assistance is essential, and technical assistance is needed to promote effective and economic methods of fish processing. The ultimate objective is to upgrade the fishing industries, both rural and urban, and to ensure economic prosperity.

Thailand's By-Catch

A worldwide tendency of fishing industries currently is to use a high percentage of the marine catch for purposes other than human consumption. This is especially true of incidental catches by shrimp trawlers that scoop up everything along the ocean floor in their search for shrimp. In Thailand, the trawlers use mesh sizes that are extremely small; inevitably, this practice means young, undersized quality fish are caught and that the availability of adult quality fish will be drastically reduced in the future. The use of the fish for fish meal devalues the total catch and allows an inferior industry to flourish. This industry is profitable only to owners of large trawler fleets or fish-meal plants. Eventually the misuse of the industry will affect everyone. The diminishing supply of quality fresh fish available to the people will be at too high a price.

The misuse is exemplified in the fishing statistics from the North Sea. Fish caught here were directed in alarmingly large quantities to fish-meal plants. During 1966-75, the percentage rose from 27 to 75. This figure will rise to more than

80% if the trend continues. Although the quantity of fish caught during this period did not alter, there was a dramatic change in the varieties of fish caught; such quality fish as cod decreased from 0.8 Mt to 0.3 Mt; horse mackerel from 1.0 Mt to 0.25 Mt; and sprat of less than 15 cm increased from 0.11 Mt to 0.64 Mt.

In the northern seas, monophyletic fish are caught, and resource management is easier than for multispecies. In these areas, the small fish can be used for human consumption. In contrast, regulations in countries like the U.S. forbid the use of mixed species in processed foods; therefore, catches of multispecies have no value other than for fish-meal production. In many areas in the tropical seas, personnel pick only shrimp and relatively large fish from the catch and, after sorting, dump the remainder.

Serious attention must be given to the importance of the by-catch fish and fish-meal industry to Thailand. Once a subsidiary market (in this case fish meal) is established, it is extremely difficult to reestablish an industry geared toward products for human consumption.

Peru's experience in anchovy use is noteworthy. Peru is the world's largest fish producer and recorded a 12.5 Mt catch in 1970, almost all of which was anchovy. When the fish-meal industry began to base its operations on anchovy, the Peruvian people changed from treating the fish as a delicacy to believing the fish suitable only for animal feed. Thus, the landing and processing of anchovy is a mechanized chain of mass production for feed purposes; the freshness and quality of fish have become unimportant. Also, most vessels contract with plant owners for direct delivery of all anchovy caught. So, a market was created. Given the efficiency of the meal industry, where one labourer can process 60 t of anchovy daily (compared with 2-3 t for human consumption), the economic gains made from maintaining the fish-meal industry are quite dramatic.

The basic principles of economics underlying the Peruvian fish-meal industry are applicable to Thailand. The existence of such efficient and modern fish-meal industries presupposes the future availability of an unlimited supply of raw material. A lesson can be learned from Peru where anchovy has become scarce. The investment in a highly mechanized fish-meal industry and the alternative, high-priced, quality fish market have been lost.

The fish-meal industry has an advantage over the fresh or frozen fish trade in that the international demand for fish meal is potentially unlimited. In fact, fish meal is a commodity having high

elasticity in the market and can maintain a demand by a minimal reduction in price.

Hirasawa (1980) refers in his recent book, *Fisheries of Japan and the World*, to proper feed mixing rates in relation to fish meal. The mixing rate of fish meal in livestock feed is generally set at 2-6%. Below this rate, animal growth is restricted, and, above it, the animals acquire a fishy smell. In the past, fish meal was thought to contain some "unknown factor" that accelerated animal growth. As biochemistry developed, it was discovered that meal contains a specific amino acid that today can be artificially manufactured. Unfortunately, the synthetic product is still too expensive for practical use, and livestock enterprises continue to use fish meal. If the percentage of fish meal in animal feed is raised 2-3%, the demand will increase by 50% — an increase that shows the great elasticity of demand.

Prawn and shrimp continue to be the highest value export of Thailand, and the country's trawler fleet will continue to fish the South China Sea and its surrounding waters, even though the margin of profit is falling in proportion to rising oil prices. These facts indicate the need for better management of the fishing industry and the implementation of government regulations to protect it.

Conclusion

In this paper, I have not touched upon the subject of stock assessment, leaving this to partic-

ipants with a greater knowledge of the subject. This paper deals more with the fish catch aspect and its economic and physical facets. In the course of my research for this paper, I found many similarities and differences among the countries exploiting the South China Sea.

By far the most common characteristic in these fishing countries is that a dual economy exists in the fishing sector. I also found that fishing achievements (catch, farm production, etc.) cannot be discussed in terms of the "national average." This sector is distinctly divided in half: the small-scale, coastal fisheries and the large-scale, modern offshore fisheries. It is clear that the gap between these two sectors is getting wider, and this trend is reflected in all major fishing countries surrounding the South China Sea.

The most common problems are historical and cultural in nature; for some fishing communities the problems are ethnic. It is a time when all coastal and island countries must recognize that many international agreements and regulations oppose domestic ones, in particular with regard to resource management. Conflicts and disputes occur in many fishing grounds and, generally, concern fishing limits. To minimize losses stemming from these disputes, the governments and educational institutions must educate the fishing personnel (and their children) about the importance of conserving the precious renewable resources.

Discussion

Aida R. Librero: Sakiyama classifies the fishing industry in Southeast Asia according to economic structure, i.e., small scale or traditional, industrial or commercial, and artificial (aquaculture operations). His is the first paper at this conference to distinguish the contributions of these three sectors, and I believe his recognition of the special contributions and needs of the small-scale sector is essential for adequate fishery management and stock control.

In general, for Southeast Asia, the small-scale fisheries sector provides income, employment, and protein to the local people. In the Philippines, of total fish production, 60% comes from small-scale fisheries, 30% from the commercial sector, and 10% from aquaculture.

Although small-scale operations contribute a large proportion to production, they pose development problems. They constitute a large proportion of the rural population; they have low incomes; the reasons include inadequate vessels and gear, lack of alternative employment opportunities, and inflation.

Sakiyama noted that fishery production expanded rapidly until 1977 when the oil crisis seriously affected countries dependent upon imported oil, specifically Thailand and the Philippines. The series of fuel-price increases in the Philippines has seriously taxed industries since 1973 when the price (U.S.\$0.03/L) increased by 77%. The price has continued to rise and is now more than 20 times that in 1972.

The effects of the oil crisis on the fishing industry vary with the degree of oil dependency of a country. As fuel costs account for about 38% of the total costs in small-scale fisheries production, this sector is seriously threatened. The amount of fuel consumed is also dependent upon the type of fishing gear used. Hook-and-line users spend 50% of their total operating expenditures on oil, whereas lift-net users spend only 16%.

In the South China region, the component of the marine catch that is destined for human consumption is declining. Apparently, the tremendous by-catch landings from Thailand have dominated the picture. Clearly, however, this varies among the countries in the region. In the Philippines, virtually all fish catch goes for human consumption, and demand for fish is increasing. By-catch fish serve as feed for livestock and for fish cultured in ponds, and this use is an indirect increment to food for humans.

The coexistence of traditional and commercial fishing operations has given rise to conflicts over the resource base and the markets — both factor and product (Smith 1979). Surveys show that, despite legislation designating fishing grounds for small-scale and commercial fishing operations, commercial fishing has continually encroached on the fishing grounds set aside for small-scale fishing (Librero et al. 1981).

Competition in the factor and product markets is less obvious but probably has an equally serious long-term effect on small-scale operations. Economic theory is that, under competitive conditions, factors of production are used in activities that provide the highest marginal return. Competition leads to capital-labour ratios that reflect the contribution to output of these factors. However, small-scale and commercial fisheries operate in two separate labour and capital markets. For example, in small-scale fishing communities, where the source of capital is the private moneylender, the price of capital may be as high as 100% a year. In contrast, development loans available to commercial fisheries have been highly subsidized, both by international lending agencies and by domestic development bankers (Librero et al. 1981).

Competition in fish marketing may also work to the disadvantage of small-scale fisheries. As commercial fisheries expand, the relative level of living of those dependent on small-scale fishing declines. However, there may be advantages accruing to the traditional sector from the development of the commercial sector. Infrastructure improvement, for instance, is mutually beneficial, and the two sectors do not necessarily catch

the same species nor do they supply the same markets.

Sakiyama also pointed out the inadequacy of vessels and gear that are used in small-scale operations and that contribute to low productivity. Steps must be taken to develop management schemes to help solve such problems.

The economically optimum catch is lower than the maximum sustainable yield (MSY) because, at MSY, the marginal cost is greater than marginal return. In agriculture, there is an analogy: biologists generate technology in crop production with the objective of maximizing total output. This is not a wrong objective, of course. However, to entice producers to adopt new technology requires that the net benefit be maximized. Attitudes to risk are closely related to the social and economic environment of the producers. A low-gain/low-risk strategy that generates a market for the product and, more importantly, guarantees survival of the family may be more attractive than a high-gain/high-risk technology.

Whether in agriculture or in fisheries or in forestry, policymakers must work toward complementarity among the biologic, technological, and socioeconomic aspects. Often, biologists, technologists, and economists have worked independently of each other. Mutual cooperation among these disciplines in technology generation could bring about technology that is feasible, economically viable, and socially acceptable.

The other fisheries sector that I would like to comment on is aquaculture. Sakiyama reports that aquaculture in Southeast Asia is showing signs of increased production. An earlier paper stated that efforts in conserving renewable natural resources have invited desirable reactions in the market, e.g., fish culture. I would like to say that there are both desirable and undesirable reactions.

Fish culture is increasingly becoming an important component of fisheries production in Southeast Asia. In the Philippines, aquaculture development has received particular attention. However, the industry has been faced by a shortage of fry and has been marked by low productivity. Two-thirds of the fish ponds in the country apply fertilizer, a large proportion compared with many agricultural crops. Despite this, productivity has remained at about 700 kg/ha, only about one-third the yield obtained by Taiwan fish farmers.

Increases in aquaculture production are brought about by an increase either in yield or in area or in both. Pond areas per farm range from less than one hectare to hundreds of hectares,

although not all the area is necessarily cultivated. Yet, increasing pressure has been brought to bear on policymakers to open new lands for fish ponds, particularly from mangrove swamps.

Competition among sectors who wish to maintain mangrove swamps and those who wish to open them for fish development makes management of mangrove areas difficult (Librero 1980). Mangrove forests are a fast-dwindling resource in the Philippines, although they may be classified academically as a renewable resource. The current practices of exploitation and utilization make them nonrenewable. Mangrove areas in the country have been declining at the rate of 24 592 ha annually, having been cleared for culture or simply as fuelwood and timber.

The importance of mangrove areas cannot be overemphasized. From the ecological viewpoint, mangroves serve as an effective buffer to the upland environment during storms by preventing soil erosion and minimizing seawater pollution. They also act as shelter for wildlife.

The significance of mangrove from a forestry point of view in the Philippines lies in the timber and nontimber products it provides such as firewood and charcoal, nipa shingles, palm sap, etc.

For fisheries, mangrove areas serve as breeding, spawning, and nursery grounds for numerous species of fish, molluscs, and crustaceans. The tidal characteristics of the mangrove swamps lead to the suitability of this ecosystem for aquaculture purposes.

The suitability of mangrove areas for fish production has encouraged the tapping of these areas for fish-pond development. In the early 1950s fish-pond area in the Philippines was only about 88 681 ha, but it rose to 100 000 ha in 1954 and further increased to 129 000 ha in 1962, 176 000 ha in the 1970s. In 1981, there are 3300 applicants for developing new mangroves, the area constituting about one-third of the remaining mangrove areas in the country.

The magnitude of the conversion of mangrove areas into aquacultural production, human settlements, industrial development, and other uses is not documented. However, observations indicate the wide areas that have been utilized for such purposes.

The multiplicity of uses of the mangrove areas and their environmental impact demand sound management and disposition. Optimization models for the use of these resources should incorporate ecological, economic, and social parameters in a language that policymakers and program implementers can understand.

Explicitly or implicitly, several papers in this conference point out the "fishiness" of fishery statistics. To a large extent, the ability to do policy-related research depends upon the availability of reliable and accurate statistics. Thus, a great deal of improvement in data collection and reporting is essential.

Norman J. Wilimovsky: Sakiyama's paper covers a broad area and invites comments and discussion on several fronts. In one respect, the wide scope has the consequence that details are sometimes insufficient to be judged adequately.

In analyzing the trends within fisheries, Sakiyama does not distinguish between catches and landings, and, in the regions discussed by him, these factors vary widely. Some countries land most, if not all, of what they catch, and others keep only a proportion of the catch. Also, as Sakiyama and, earlier, Christy pointed out, economic analyses based on the value of landings frequently show patterns significantly different from those based on weight. Likewise — although not mentioned by Sakiyama — attention must be given to the problem of natural fluctuations in abundance, as they influence interpretation of fishery catches and landings. Many investigators feel that the way in which the statistics are reported varies widely and depends on, among other things, politics. There are statistical artifacts for the South China Sea area. They are difficult to document and adjust for but are worthy of mention. For example, significant portions of the Thai catch apparently are taken in areas other than indicated, and many catches within China's coastal waters are landed elsewhere. These inconsistencies are accommodated under local ad hoc sharing arrangements, and often all parties who are involved in submerging the details of the catches benefit. The recognition of EEZs has not materially changed practices in the reporting of fish catches.

Sakiyama recognizes the dual nature of the fishery within the region, but his analysis would have benefited from a detailed consideration of the different institutional arrangements within the industrial fishery as opposed to the artisanal fishery. The need to upgrade the latter without superimposition of the former is critical in this region. The management problems imposed by the dual nature of the fishery are significant and have not been treated in depth by Sakiyama. For example, the effects of "growth" overfishing and "recruitment" overfishing by both large- and small-scale operations are distinct and need to be

spelled out. Sakiyama recognizes that the solutions to the problems lie in the provision of infrastructure such as transportation, port facilities, and ice plants. However, he does not expand enough on this point and expresses only limited hope for the near term. He suggests the use of cooperatives as a mechanism appropriate to the area, but this is a particularly sensitive national question and regional attitudes vary widely.

The position of those who derive their livelihood from fishing in the area is central to solution of the problem. Even within this cultural group, there is little tendency to induce younger members of the community to consider continuing in the fishery tradition. To my knowledge, only in the Philippine islands is a serious attempt to change this attitude taking place. It is a significant sociological problem requiring attention and has direct management implications.

A strong case is made regarding by-catch. Sakiyama recognizes the multispecies catch/price problem but limits his analysis of driving forces to price elasticity. There are deboning machines and other chemical utilization techniques amenable to at least part of the solution of direct use of less profitable fishes that have had dramatic effects where introduced.

Considerable attention is given in the review to the mangrove conservation problem. Recent studies have indicated that the actual impact between forestry and fisheries can be substantially mitigated. The solution lies in a central responsibility, authority, and communication between the institutional units involved. At the field level, the problem usually can be readily solved. Moving the solution through the bureaucratic hierarchy poses some serious political questions in almost all countries.

In summary, I am sure Sakiyama would agree that there is an overall need at the policy level for recognition of the fundamentally differing problems between the industrial fishery and the artisanal fishery that the advent of the EEZs has not materially changed. Sakiyama stresses the need for fishery management and stock control but the options available to the two groups grossly differ. To cope with this problem, policymakers must carry rational planning beyond the confines of fisheries and its infrastructure. The time frame to implement change is limited and growing shorter as the EEZ-induced institutional changes become fixed. Any long-term solutions require upgrading of the artisanal fishery, involving training and not just superimposition of a modern industrial fishery that can replace the small-scale sector but not solve the basic problem of their needs. The

ultimate problem lies in an area of declining popularity, i.e., the control of population growth. Fishery planning on a long-range scale cannot take place in the vacuum of single-resource analysis. Sakiyama's review raises many of the central points for a discussion.

Theodore Panayotou: The Sakiyama paper provides an informative account of the long-term trends and problems of the South China Sea fisheries. My comments focus on what I consider to be his main findings:

- The fishing industries of the countries bordering the South China Sea are characterized by ever-widening dualism manifested in the persisting coexistence of a large-scale mechanized fishing sector, accounting for most of the catch and exports, side-by-side with a traditional small-scale sector accounting for most of the employment and local fish consumption.

- The fishery makes a substantial contribution to employment, income, and food consumption of the Southeast Asian population; more significantly perhaps the fishery is seen as "one of the important cushions for the unemployed in Southeast Asia."

- Rising fuel prices and fuel shortages are the major factors responsible for the decline of the fishing industry in several Southeast Asian countries, particularly in Thailand and the Philippines, which import oil.

- By-catch predominates the catch from the South China Sea and its share is increasing over time. The use of the by-catch for fish meal rather than for human consumption is an inferior industry and in the long run erodes the demand and availability of edible fish.

- The development of a supportive infrastructure, such as landing ports, transport systems, and ice plants, has been lagging behind fisheries development, and it is at present grossly inadequate for large-scale fisheries and almost nonexistent for traditional fisheries. This means that the value of fish caught is lower than it need be because of delays, spoilage, and inappropriate processing; edible fish, thus, become suitable only for fish meal — a fact that reduces further fish-protein availability.

- Trawling operators must be educated to see the importance of conserving renewable resources and traditional operations should be assisted through more economic methods of fish processing.

- For the long-term sustained growth of the fishing industry, conservation of the mangrove forests and the coastal ecosystem (presumably

the spawning and feeding grounds of fish) should also be part of fisheries management. Moreover, conflicts and disputes between international agreements and domestic regulations (or practices) must be recognized and dealt with if renewable resources are to be properly managed.

There can be no dispute that a dualistic structure exists in Southeast Asian fisheries, but this is neither uniform in all countries nor unique to Southeast Asia. Although dualism is found in the fisheries (and other sectors) of virtually all developing (and some developed) countries, it is quantitatively and qualitatively different in Thailand from the dualism in Malaysia or the Philippines. In Thailand, it is a dualism between coastal operations and long-distance trawlers and has been fostered by an immaculate *laissez-faire* policy and an expediently distorted capital market. Before the early 1960s, the Thai marine fisheries were all coastal and employed traditional gear such as traps and cast-nets. Following the successful demonstration of trawlers with German assistance in 1960, fish traders and investors acquired the new technology.

As the coastal fishing personnel were expected either to obtain employment on the rapidly expanding trawl fleet or to switch to other occupations, they attracted little government attention until very recently when it was realized that their numbers, far from declining, have been rising. Apparently, distorted relative factor prices and increasing unemployment elsewhere resulted in a capital-intensive trawl fishery and a reverse flow of labour from farming to coastal fishing, which perpetuate dualism.

The situation is clearly different in other ASEAN countries (Malaysia, the Philippines) where the governments took a leading role in fisheries development with an explicit objective to protect and upgrade the small-scale fisheries. Through a series of credit and subsidy schemes for small-scale or municipal fishing operations and the regulation of large vessels, these countries managed to contain dualism within smaller limits than was the case in Thailand where the problems of small-scale operations are still regarded more as social than economic.

In a comparative study of a number of countries over a number of years, one can learn much about key variables. If dualism is common, but neither uniform nor constant, what accounts for the differences and changes? Such an attempt to analyze and explain would help policymakers identify instruments that will reduce dualism if dualism is considered undesirable. Sakiyama stops short of such analysis.

One may take issue with the way Sakiyama estimates the contribution of fisheries to employment and income, but even the casual observer finds that fish and fishing play a prominent role in the economy and life of Southeast Asia, a role that is perhaps reflected more in the culture than in the statistics. Also, as Sakiyama aptly points out, the fishery is one of the important cushions for the unemployed in Southeast Asia. This is, however, at best, a mixed blessing. In the short run, open access to resources can serve well the role of a cushion or a safety valve for a "marginalized" section (landless and unemployed) of the population who, in the absence of any better option, take up fishing, mangrove forest felling, or illicit offshore mining.

In the long run, however, free entry and increasing numbers of people of a nearly zero opportunity cost lead to depletion, if not destruction, of the resource. The increasing use of dynamite, poison, and fine-mesh nets by coastal fishing personnel in Thailand exemplifies the problems. A decline in catch per unit effort when neither expansion into new fishing grounds nor alternative employment is possible leads inescapably to the adoption of fishing methods that only a few years earlier were considered unacceptable. Although it may be fashionable to blame the large trawlers for the destruction of much of the coastal fishery in Southeast Asia, the small coastal operations are as much to blame. The difference is that trawlers have options (other fishing grounds and other investments), whereas the small-scale operators do not.

One cannot rely on the fishery to serve forever as a cushion for the unemployed. Most coastal fisheries in Southeast Asia are already overexploited, and, if complete destruction is to be avoided, the direction of migration should be reversed soon through alternative employment opportunities in the interior as well as in coastal aquaculture. This will also meet Sakiyama's requirement that the mangroves and the coastal ecology be preserved for the long-term viability of the fishery.

The impact of the rising oil prices on South China Sea fisheries depends not only on whether a country is an oil producer or an oil importer but also on whether a country is a distant-water fishing nation or not, as well as on the degree of capitalization of the industry and on the effectiveness with which EEZs are implemented. The oil crisis has changed the relative costs between near- and distant-water fishing. To the extent that the declared EEZs are enforced, a distant-water fishing nation such as Thailand faces a

dilemma between retreating into its overfished waters or venturing further away, beyond its neighbours' EEZs, an option increasingly discouraged by rising fuel prices.

For most Southeast Asian countries, expensive fuel may help save their fisheries; after all, whatever is bad for fishing operations is good for the fish. It is not so with Thailand: as distant-water fishing becomes more and more costly, as a result of both higher fuel prices and higher probability of being caught in foreign waters, increasingly larger numbers of vessels are shifting their operations to the Gulf of Thailand with detrimental effects on coastal operations and fish. Yet, higher fuel subsidies would not save the resource, for they will attract more entrants into the coastal fishery from other sectors of the economy, further exacerbating the misallocation that already exists as a result of the open-access status of the resource and the chronic undervaluation of capital and energy.

Joint-fishing ventures between capital-surplus fisheries, such as Thailand, Taiwan, South Korea, and Japan, and resource-surplus countries, such as Indonesia, Malaysia, the Philippines, and Indochina, are a promising option not discussed by Sakiyama. Nor does one find much reference to the problems of encroachment and jurisdictional conflicts that afflict the South China Sea fisheries.

I agree with Sakiyama's assessment that by-catch fish predominate the South China Sea catch and that the share of by-catch has been rising, but I find his argument on the causes and implications of this trend somewhat dubious. Although trawling for shrimp in a multispecies environment results in a certain amount of by-catch, I believe the source of the problem is more institutional and economic than technical or environmental. Most of the by-catch is not obtained as a by-product of shrimping but as a target catch. That fishing operations prefer a low-valued catch today to a high-valued catch tomorrow (more than half the by-catch is juveniles of high-value species and much of the remainder is food for these species) could be the result of lack of property rights over the resource or of too-heavy discounting of the future. Probably both factors are in operation, and open access explains the observed behaviour.

Of course, the demand for by-catch fish by the fish-meal plants is also a necessary condition for the continued survival of the practice, but it cannot be offered as the sole cause of the problem. Nor can it be meaningfully charged that, as a

result of the high and rising by-catch production, an inferior (but efficient) industry is established and that consumers lose their "taste" for fish used in fish meal.

Instead, I see four distinct social costs in the increasing trend toward by-catch use:

- As a result of the open-access status of the resource, the demand for by-catch will encourage investment in more capital and labour than is socially optimal for the harvesting of by-catch, i.e., any of the rents from the exercise will be dissipated;
- The opportunity cost of immature capture — that is, the future revenues foregone because the fish are not allowed to reach marketable size — is substantial;
- The future benefits will be lost if the fishery collapses as a result of the reduction of the adult fish population below a critical minimum; and
- There will be overinvestment in by-catch processing (at present, fish meal) on the false assumption of "future availability of an unlimited supply of raw materials," as Sakiyama aptly points out.

The research and policy issue is whether the total net benefits from leaving the fish to reach maturity and harvesting the "right" amount exceed the cost of regulation and enforcement to achieve this result. For at least some countries in the South China Sea (Thailand is a good example), enforcement costs are often prohibitively high.

Sakiyama has identified one of the most potent constraints to fisheries development in Southeast Asia: lack of infrastructure. Except for a few urban landing centres and the general transportation network, postharvest infrastructure is minimal. More landing facilities in remote areas, marketing outlets, ice plants, and cold storages are needed, but they are not provided by the private sector because of stringent government regulations or market failures (economies of scale, public goods, externalities). The government that is supposed to provide such infrastructure is often unable to do so because of inability to tax the fishing operations and unwillingness to effect a net transfer of funds from other sectors of the economy to the fishery.

Unlike agriculture and industry, which are often heavily taxed, fishing operations resist taxation on the grounds that, being sea-oriented, they do not benefit much from public services. Every time the Thai government attempts to impose a tax or a landing fee, the Thai trawlers

start landing their catch in Singapore or Malaysia. This leaves the coastal fishing operations "with the bill," which they are unable to foot even if the government had the resources to collect taxes from thousands of dispersed operators. This situation, coupled with the fact that income taxes outside the urban areas of developing countries are inoperative, means that the fishery, its natural-resource base notwithstanding, yields little or no government revenue. As already too much capital and labour are occupied in the fishery (and too little elsewhere), the government would be misallocating general revenues if it were to build fishery-supportive infrastructure that would attract new entrants into an already crowded sector.

Of course, foreign development assistance, some fishery-specific, may be used for infrastructure, but, in the absence of restrictions on entry into the fishery, the long-term effects of such investment are not economic. Inadequate infrastructure may well be a substitute (however imperfect) for taxation and fisheries management that governments are unable to enforce.

Fisheries management is understood to mean different things to different people. Here, it is defined as a move from an existing situation to one in which net social benefits are enhanced. Management comprises the move, the means of moving, and the means of maintaining the new position. For the calculation of the net benefits of the move, one presumes knowledge of the distributional weights and intertemporal trade offs and ability to quantify all relevant costs and benefits.

Sakiyama has outlined a number of factors that should be part of such a move:

- Trawlers should be educated to see (or

rather made to behave as if they see) the importance of conserving renewable resources;

- Small-scale fishing operations should be assisted through more infrastructure; and
- Future availability of fish should be ensured through preservation of coastal ecology.

These recommendations clearly outline a move and an implicit set of distributional and intertemporal weights, but they remain silent about the means of effecting such a move and maintaining the new position. How can trawlers, without property rights over the resource, be made to abstain from landing by-catch? How can small-scale operations enjoy long-term benefits from more infrastructure in the absence of restrictions on entry? How can the felling of mangrove forests and the destruction from coastal mining be regulated when unemployment and landlessness are rising and other sources of income are hard to find? Even if answers to these questions are found, there remains the question of whether the benefits from such a move are large enough to justify the enforcement and other costs involved.

These difficulties are not offered as reasons for despair and inaction but as grounds for more in-depth analysis to identify moves that are feasible within the economic, institutional, and administrative constraints of the countries concerned. Sakiyama has provided us with solid background and high-quality food for thought. I hope his contribution will be used as a seed for further research and analysis rather than as raw material for an inferior policy. Sakiyama's contribution, however, goes beyond the figures and their interpretation to the approach of looking at the South China fisheries as a whole, an interdependence underlined by fish migration, overlapping EEZs, and a host of common geoclimatic and cultural features.

The Squid Fishery in New Zealand: the Role of Joint Ventures and Foreign Fleets

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The catching capacity of the New Zealand fishing industry has grown rapidly since the mid-1960s. New Zealand's declaration of its exclusive economic zone (EEZ) in 1978 forced resource managers in the country to parcel out the fisheries resources among competing claimants: the domestic, joint-venture, and foreign fleets. The squid fishery is one in which there is no domestic capacity; therefore, at present, joint ventures and licenced foreign squid jiggers are operating in New Zealand's waters. The total contributions of each to the balance of payments of New Zealand have been similar and relatively small, but individual companies have differed dramatically. Export incentives applied by the New Zealand government to the operations of the joint-venture companies dominated their performance results and were highly discriminatory. The policy changes to the basis of the application of these incentives altered results significantly and were well directed. The licenced foreign fleet's operations contribute more in direct benefits than do joint ventures, but the comparison is exceedingly sensitive to the institutional framework that governs the operations of the joint ventures. The research is still in progress.

Le volume des pêches de la Nouvelle-Zélande s'est rapidement accru depuis le milieu des années 60. Cependant, en 1978, après que le gouvernement eut délimité sa zone économique exclusive, les administrateurs ont été obligés de répartir les ressources halieutiques entre les concurrents intéressés, soit les flottes domestiques, étrangères ou conjointes. Dans le cas de la pêche au calmar, qui n'est pas pratiquée par les Néo-Zélandais, des permis d'exploitation ont été accordés à des propriétaires de cotres, étrangers ou conjoints. Leur contribution totale à la balance des paiements est relativement modeste et à peu près égale alors que celle des entreprises privées accuse des différences considérables. Les stimulants à l'exportation fixés par le gouvernement, qui influent directement sur le rendement, devenaient discriminatoires pour les flottes conjointes. La réorientation de cette politique a contribué à faire évoluer les résultats. Aujourd'hui, les flottes étrangères opérant sous permis, rapportent plus de profits directs que les autres mais la comparaison est établie en fonction du cadre institutionnel qui gouverne les opérations des flottes conjointes. Cette recherche est encore en cours.

Optimism prevailed on 1 April 1978 when New Zealand resource managers assumed responsibility for what was then the fourth largest exclusive economic zone (EEZ) in the world. True, much of the zone was inhospitable, or the sea floor too rough or deep for bottom fishing methods, but the acquisition of the EEZ did seem to offer a stimulus to the development of new fisheries for New Zealanders, especially the deep-sea, migratory pelagic and squid resources.

The resource managers had first to estimate the total resource; though the estimate is now being revised downward, they guessed then at 400 000–600 000 t. Their next task was to allocate the resources between competing claimants — the

domestic fleet and the foreign fleet. The domestic fleet has virtually no deep-sea capacity, and few of the vessels have fast-freezing facilities. In contrast, the foreign fleet was well equipped. It consisted of Japanese, Koreans, Taiwanese, and Soviets who had, over the preceding 7 or 8 years, fished in the area during their home off-seasons. The compromise arrangement of the joint venture, with equity and, possibly, activities being shared between New Zealanders and foreign partners was also an option, both a compromise and, possibly, a tool of development.

High fish prices in 1978, caused by the efforts of distant-water nations to stockpile fish supplies against uncertain future access in EEZs, contrib-

uted to New Zealanders' optimism. Some saw the joint ventures as a shortcut to development of the domestic industry, foreign partners supplying skills, technology, capital, equipment, knowledge of the resource, and markets in exchange for access to the resources.

Another view of the joint-venture arrangements was that they could be a method of obtaining for the New Zealand partner and nation quick access to extra income in much-needed foreign exchange. Others thought the joint ventures would have a neutral impact on the industry's development, simply reserving the resource for the domestic fleet to "grow into."

A fourth and less enthusiastic view often held by domestic operators was that the joint ventures were simply a back-door method used by foreigners to avoid licence fees and that, worse still, they could be expected to preempt the New Zealand catch on foreign markets or even local markets. By overfishing, the joint ventures could actually inhibit the development of the domestic fishing industry.

It was further asserted — although without substantiation — that the taxation and incentive system was such that New Zealand was actually "paying the foreigners to take the fish away."

For me, the debate generated a whole series of questions:

- Why, with its long coastline, early history of sea-mammal hunting, and pre-European Maori economy in which fish was important, had New Zealand's fishing industry been so slow to develop?

- If there were development blocks, what were they? Had they disappeared? Would either joint ventures or the licenced fleet option remove those that remained?

- Would the presence of joint ventures inhibit the development of the domestic fleet?

- Could the domestic fleet be expected to "grow into" the resource?

- Were the joint ventures helping or damaging the balance of payments?

I found a consumer's choice of explanations for retarded development although none has been rigorously tested: restrictive measures imposed by successive New Zealand governments to protect the resource or those exploiting it; capital-market imperfections; inefficiencies caused by oligopsonies; cultural inadequacies; and lack of knowledge of the resource.

There are too many questions, and too many competing answers, for one paper: they will be examined later in the research program. In this paper, I examine in the context of the squid

resources the scope for domestic expansion into squid fishing, and I compare the immediate impacts of the joint venture and licenced fleets on national income and the balance of payments.

The New Zealand Fishing Industry

The New Zealand fishing industry encompasses coastal pelagic and demersal resources; rock lobster; shellfish such as oysters, scallops, paua (abalone), and mussels; freshwater resources are mainly managed for recreation and tourism, although the export of live eels is important.

The fishing fleet has many part-timers; vessels operating full time in 1980 probably numbered around 1500, employing some 2900 crew (New Zealand Fishing Industry Board estimate). Few of the vessels are longer than 27 m, and most lack deep-freezing capacity.

Owner operators concentrate in the high-value fisheries, such as rock lobster and whole, chilled snapper for export. The larger companies tend to dominate the large-volume, low-value fisheries.

In 1980, about 87 000 t of finfish, 4000 t of rock lobster, and 18 000 t of shellfish (including small quantities of squid) were caught by the domestic fleet. Finfish accounted for 59% of landed value, rock lobster 29%.

The industry had stagnated at 20 000–25 000 t of finfish during the 1950s, but there was a take-off in the mid-1960s. Growth during the 1970s was rapid, although greatly exaggerated in later years by the original statistics that frequently included figures relating to joint ventures. Japan and Australia are major markets; the USA absorbs high-volume shellfish and rock lobster.

Squid

New Zealand's interest in developing the squid fishery was stimulated by the appearance of Japanese vessels — some of them converted tuna boats — fishing for squid off the New Zealand coast. In the 1970–71 season, eight Japanese vessels were observed squid fishing, and the Japanese Fishery Agency research vessel was recorded as having returned for a second catch.

Records are incomplete, but, in a report to the government (unpublished 1975), a New Zealand fishing firm recorded that in the 1972–73 season, 69 Japanese vessels landed squid at an average of 3.9 t/fishing day (rather high by recent standards). Successive New Zealand Fishing Industry Board reports have recorded increasing total squid catches by the Japanese from New Zealand waters.

By 1977, both the Soviets and the Japanese had increased their fleets, landing a total squid catch from New Zealand waters of about 83 500 t. New Zealanders caught only about 500 t. Of the foreign total, just over two-thirds was taken by trawling (28 500 t by the Soviets, 20 000 t by Japan, and 8500 t by Korea). Japan took a further 24 500 t by jigging and Taiwan about 1800 t.¹

Since the introduction of the EEZ and of foreign-fleet licencing arrangements, the Japan Squid Anglers' Association has acted as an intermediary for Japanese vessels. Owners send vessels to New Zealand under the auspices of matchmaking companies.

The affairs of the vessels are usually looked after in New Zealand by a port agent who, for a fee, handles the arrangements necessary to secure customs' clearances and formalities, harbour board services, medical and dental treatment for the crew, repatriations, repairs, surveys, and sundry other services. Such agents also handle onshore arrangements for some joint-venture vessels.

The Nature of the Resource

At least 70 species of squid have been identified in New Zealand waters, but arrow squid (*Notodarus sloani*) is by far the most important commercial species, well-liked by Japanese consumers. Squid are cephalopods, part of the mollusc family.

Most of New Zealand's knowledge of its squid resource has come from foreign fishing and research activity, especially that of the Japanese. New Zealand scientists have only recently begun to research the squid resource. They still lack an understanding of its distribution, migratory patterns, life cycle, position in the food chain, and population size and dynamics.

Squid occur in areas rich in species upon which they feed: saury, fingerling fish, krill (small crustaceans), and small squid. These areas tend to be where ocean currents converge and bring nutrients from the ocean floor into the zone where light penetrates and allows photoplankton to grow.

Squid are thought to migrate in swarms from around New Zealand to warmer waters for spawning. Evidence suggests that a series of swarms, more-or-less independent of each other, move at different times, at intervals, along several migration paths. Scientists believe that the squid live for about 12 months, growing rapidly during

¹Unless otherwise specified, the information in this section comes from successive annual reports of the New Zealand Fishing Industry Board, Government Printer, Wellington.

migration. When the mantle — or body — is 20–35 cm long, the squid are mature. They spawn and apparently die soon afterward, although no large concentrations of dead squid have been found. An enormous loss through natural mortality has been recorded. In one major New Zealand fishing ground, Korean squid-trawling figures for 1978 suggest natural death and migration accounted for a loss by August of 83% of the July stock (Roberts 1978).

Squid occupy an important position in the food chain. As well as being predators of many species, they are preyed on by sea mammals, tuna, and other fish. Squid stocks can be expected to fluctuate considerably from year to year (according to environmental conditions). Stocks are thought to recover quickly because the squid are short lived.

The jig fishery is concentrated in 40–250 m deep water. Early estimates, based on random samples of foreign-trawling catches with allowances for escape, placed total standing stock of squid at 300 000 t (Roberts 1978), but scientists now consider this estimate to have been too high.

Squid fits the vent-for-surplus model. The domestic market is limited to a small demand for food and anglers' bait. The main limitation on the domestic market apart from the size of the population is consumer preference.

How far squid is a surplus that can be vented is also a biologic question. If this year's crop of squid is not used, is it wasted? Where in the rest of the food chain does it go? Uncaught squid serve an economic function if they eat the predators of commercial species or are a food source for commercial species.

Problems of Domestic Industry Development

So far, squid fishing is seasonal, with foreign vessels moving into New Zealand's waters during their own off-season. Since 1972–73, the Japanese (and for a while the Taiwanese) jig fleets have arrived in mid-December and left in early to mid-April, although the New Zealand season is now thought to extend from at least November to June–July. New Zealand trawling data suggest year-round presence, but, until a year-round fishery is identified, the New Zealand squid-fishing industry would need off-season employment of crew and capital to be viable. For the foreigners and joint ventures, this complementarity is provided by their domestic season for squid.

Possible options for a New Zealand fleet include:

- Specialized jig boats that pursue squid year round, either in New Zealand waters or in foreign waters under reciprocal agreement; and

- Dual or multipurpose boats that can fish for squid and other species with a complementary season.

Unless the fishery is close to onshore facilities for freezing the catch to an unvarying -50°C within a short time, a primary requirement for squid boats would be this freezing capacity. Stability — and, hence, trawl boats — is also necessary for inclement weather, although boats fishing only in summer and close to shore would be relatively free from this constraint.

Complementary-Season Fisheries

If the New Zealand squid season is about November–June, then the seasons for bluefin tuna, oyster, and snapper complement it. The oyster season is 1 March–31 August, but entry to this fishery is already limited. Squid jigging with finfish longlining in the off-season has been tried by a Korean–New Zealand joint venture, but so far results are not encouraging. The bluefin tuna season is May–October (at least that is when the Japanese operate in New Zealand waters). Both squid and bluefin tuna require quick freezing and, in that sense, are technically suited to combination. Tuna boats, however, are usually slim, with a cutaway side for brining the big fish. Lack of stability is thus a problem for their use in squid fishing.

Jigging is a line-poling technique that became mechanized in the early 1970s so that one person can operate several lines. The machines are mounted along each side of the deck, with lines being paid out and then reeled in over elliptical drums. Bright lights are usually used to attract the squid to lures, although off-season trials by New Zealanders working close to shore have given good results in daylight.

Trawling is the major alternative to jigging and is so far the only technology that is suitable to rough seas where the motion of the boat and the tangling of the lines preclude jigging. The drawback of trawling is damage to the squid. Purse-seining or other forms of aimed net fishing have not been shown to be viable, because the New Zealand arrow squid probably does not concentrate for spawning as densely as other species of squid.

Net fishing, including trawling, has the disadvantage of being nonspecific so that mesh sizes fine enough to catch squid tend to be ruled out by the requirement of protecting the young of other commercial species. Most of the current squid-trawling operations (mainly Soviet and Japanese) are restricted to the rough southern waters for this reason.

With the introduction of the exclusive economic zones around the world, many distant-water fleets have considerable excess capacity, and vessels may be available for the market — a source for increasing New Zealand's fleet capacity.

Squid Joint Ventures

The 1978–79 squid season was the first after the declaration of New Zealand's EEZ took effect. In that year, 12 joint-venture companies were given approval to operate, a total 71 squid-jigging vessels (of which 59 actually arrived and operated in the zone). The vessels came from Japan, Korea, and Taiwan.

The 1979–80 season saw approvals given for 108 vessels under charter to 18 companies to be operated in the EEZ, but only 82 actually operated. Together, they caught a total 15 381 t, according to company records.

Joint-venture companies were set up between New Zealanders and foreigners by means of a shared equity company and a charter arrangement whereby partners assumed various responsibilities; a charter fee was paid to the foreign partner (or, where a matchmaking company participated, to a third party), which supplied vessels and crew. Arrangements for the provision of supplies, fuel, onshore and marketing services varied. Risk-taking by the local partner ranged from full catching and marketing risk, with vessels being hired on a contract basis, to a fee that depended on catch volume or on the eventual sale-value of the catch.

The New Zealand government vetted arrangements, insisting on copies of charter and other documents and financial accounts of operations at the close of each season, as a condition of approval. These data were the basis for my study of the joint-ventures' contributions to the national economy and the balance of payments, in particular. The cooperation of the companies is greatly valued.

The study is still in progress; at this time, the results are preliminary and do not deal with multiplied effects or opportunity costs. The flows treated are current flows: capital has been left aside. The development issues of the transfer of skills and technology, market pioneering, or the generation of backward and forward links have not been addressed. Thus, the features of joint-venture arrangements that make for good or bad performance from a national-interest point of view have not been identified, although the relative effects of the existing export-incentive schemes are clear.

Method and Terms of Assessment

A host country (such as New Zealand) considering the immediate effects of private direct foreign investment, such as a joint fishing venture, would chiefly be concerned with what it gets from the operation. National income, rather than domestic income, is the key to my analysis. Whereas gross domestic product, or income (GDP or GDY), is the sum of value added by each industry in the economy, gross national product or income (GNP or GNY) is GDP minus the net remittances to foreign factors of production abroad.

Gross national income is the sum of all incomes accruing to domestic nationals. This includes wages and salaries; rents to resources and facilities; net income to government; profits, interest charges, and other payments to capital. Transfer payments between New Zealand nationals are excluded and net payments to foreign factors of production are deducted.

I have calculated the balance-of-payments impact, or returned value to New Zealand, in two stages. First, I found the net effect on foreign exchange earned (revenue less all direct outgoings of foreign exchange); then I adjusted this figure for leaks abroad in the form of the import content of the goods and services purchased locally. (Details of methods and assigned import contents could not be included here for reasons of space, but I will be pleased to provide them on request.)

For the joint-venture approach to be worthwhile to the host country, it should compare favourably with a total New Zealand enterprise on one hand and the flows generated by licenced foreign vessels on the other. Although returned-value and value-added generated by joint ventures and the licenced foreign fleet are considered here, the domestic industry does not yet exist, so no consideration is given to this alternative.

A balance-of-payments approach, rather than an overseas-exchange transaction (OET) approach, is used. In other words, all profits to which a foreign partner has claim have been subtracted from New Zealand's foreign exchange, and, similarly, all funds to which New Zealand has claim have been added.

Export incentives

One of the policy objectives of government has been to promote exports, one method being taxpayer subsidies for exports. During the period studied, two sets of rules on incentives applied, referred to here as the old rules and the new rules. The latter were phased in during 1980. The old rules provided a tax credit or payment on the

basis of a percentage of FOB export receipts. The new rules provide rewards for the domestic value-added of exports. For the 1979-80 season, I made calculations of the export incentive for each company based both on the old and on the new rules so that the impact of the two export incentive schemes could be compared. Probably all ventures were in fact rewarded for exports according to the "old rules."

Implicit foreign-exchange premia

The returned-value (adjusted for leaks abroad) to New Zealand of a venture's operations, when related to the size of the export incentive, provides an indication of how much taxpayers paid for foreign exchange, or how much taxpayers paid to the joint venture to secure export dollars. In the study, I looked at two measures of taxpayer subsidy — net (export incentive less tax) and gross (export incentive alone). The latter, divided by returned-value, is probably the best measure of the implicit premium on foreign exchange because it measures what the taxpayer pays out to secure national income in foreign exchange rather than in New Zealand dollars. This is not an exchange transaction but a direct subsidy from the taxpayer to the joint-venture company. For example, the gross figure may be 0.70. This indicates that New Zealand taxpayers paid \$0.70 to the joint-venture partners for every \$1 of returned-value. The net figure is sometimes negative. This is caused either because the returned-value was negative (foreign exchange drained away) or because taxation exceeded export-incentive payments.

I added wages, rents, return to capital and entrepreneurship, and net payments to get incomes to factors of production directly employed by the venture. Returned-value is this amount plus the local content of locally purchased goods and services in the venture. Viewed another way, it represents that part of the export receipts that ends up in New Zealand after all foreign-exchange leaks have been accounted for. The measure of value added directly by the firm can be viewed as the direct gain to New Zealand national income if the domestic factors employed by the company would otherwise have been idle, that is, if there were no opportunity costs.

Comparison between values added by individual ventures is difficult because of the considerable differences in the way in which joint-venture companies arranged and reported their affairs in their accounts. For example, some joint-venture companies hired New Zealand companies to perform various services for them. Sometimes, the company hired was one of the New Zealand

Table 1. Aggregate squid-fishing joint-venture performance, 1978-80.

	1978-79	1979-80 old rules	1979-80 new rules
Exports (\$1000)	12221	20868	20868
Net returned value (\$1000)	1623	2883	3279
Value added nationally (\$1000)	416	991	1386
Net taxpayer subsidy (\$1000)	1081	1501	237
Export incentive (\$1000)	1279	2311	532
Catch (t)	7445	15423	15423
Returned value per tonne caught (\$)	218	187	213
Value added nationally per tonne caught (\$)	56	64	90
Export incentive per tonne caught (\$)	172	150	35

partners in the joint venture. Thus, comparisons of interfirm performance are made on the basis of returned-value, corrected for foreign exchange leaks, rather than on the basis of value-added.

The study material

The study covers the accounts for the operations of 10 joint-venture companies operating in the 1978-79 squid-jigging season and 13 companies in the 1979-80 season. The majority of vessels were Japanese, but some were Korean and Taiwanese.

The 1978-79 figures exclude the results of one company that went out of operation early. The results of another company that operated in the 1978-79 season but not the following season have been included in the aggregate results but excluded from the presentation of the individual results because of the need to maintain confidentiality.

Caveats

The figures on costs, charter fees, and prices have all been taken at face value and have not been independently checked, although queries to companies sometimes elicited revised figures that were adopted for the study. Some caution should be exercised in accepting the final figures. The existence of export-incentive payouts provides a clear reason for companies to inflate export revenue or, in the case of the new rules, to boost local spending. Various controls and levies on imports to markets also provided incentives to manipulate figures.

One company, D, noted on its 1978-79 return that the price it received was U.S.\$1550/t CIF "But...the letter of credit was established at \$1050/tonne." There is an obvious local corollary to this kind of practice.

The Results

The aggregated performance results (Table 1) of all the squid-jig joint ventures in 1978-79 and

in 1979-80 disguise a wide difference between individual companies.

In 1978-79, the gross value of joint-venture squid exports stood at \$12.2 million, of which the returned value to New Zealand was \$1.6 million (\$0.4 million of value being added directly by the companies), and the export incentive was \$1.3 million. The New Zealand taxpayer, thus, paid a subsidy of \$0.79 on average for every \$1 of foreign exchange. Thirteen percent of the value of exports returned to New Zealand. For every tonne of squid caught, \$218 returned to New Zealand but \$172 in export incentive was paid to the joint-venture company. The companies paid out, as direct income to factors of production that they hired themselves, 3% of their total export receipts. Among individual companies, returned-value ranged from -\$1173/t to a high of \$356/t (but both of these results are somewhat suspect). The next two extremes were \$34/t and \$306/t.

Value added nationally also varied significantly and was negative in 4 of 10 cases. The highest figure for value added nationally was \$169/t. The range in implicit foreign exchange premia was very wide. One company was paid \$0.13 for every dollar of foreign exchange that it drained away. Another company received \$3.75 for every dollar of foreign exchange it brought in, and three other companies received payments in the \$0.40-0.50/\$1 range.

Export incentives per tonne caught varied but less dramatically and were within \$100-200/t. The average was \$172/t. The export incentives made a difference to the profitability of the joint ventures, 4 of 10 ventures recording losses before taxes and 2 reporting profit levels at 0-5% of export receipts.

In 1979-80, a gross \$20.9 million in export receipts was recorded from a squid catch of 15424 t. Under the old export-incentive rules, about \$2.9 million would have been returned to

New Zealand, compared with \$3.3 million under the new rules (Tables 2 and 3). The former, based on total export receipts, averaged \$150/t, whereas the latter, paid out on the basis of domestic value-added, averaged \$35/t. The difference in payout per dollar of foreign exchange earned was dramatic — under the old rules \$0.76 was paid on average, whereas under the new rules, the subsidy would have been only \$0.16/\$1. In 1979–80, no returned-value was negative, although value added nationally was negative in 5 of 12 cases. Under the new rules, returned-value and value-added would both have been generally higher, the latter being negative in only two cases. Under the old rules, the implicit foreign exchange premia, or export-incentive payments, ranged from \$0.18 to \$2.98/\$1 of foreign exchange earned.

The overvaluation of the New Zealand dollar (20% commonly regarded as being a realistic estimate of the implicit shadow exchange rate premium) indicates that New Zealand would be behaving rationally in providing a subsidy of up to \$0.20/\$1 of foreign exchange if the balance of payments were the criterion.

Under the new rules, the payout to all but 1 of the 13 companies was within this "rational" range, but, under the old rules, only 1 company was paid at a rational level, and 10 were paid at more than three times this amount.

Licensed Foreign Vessels

In the 1979–80 season, 102 vessels were licensed to jig squid, 98 of them Japanese, the others Korean. The licence fees were \$14 250/vessel plus \$95/t for every tonne over 150 caught. Licence fees totaled \$2.5 million. Accounts for 29 of the vessels (all Japanese and operating during 1979–80) were available, and I used these to derive figures for returned-value for both seasons.

The accounts covered all port calls and recorded provisions, cash advances, maintenance, air fares, and hotels for crew leaving the vessel, medical fees, and other charges such as harbour board, port agency fees, and sundries. Purchases listed in the accounts as provisions were separated into categories and calculated as a

Table 2. Performances by individual joint-venture companies under old rules for export incentives, 1979–80.

Company	Profit or loss as % of X						
	Net returned value as % of X	Value added nationally as % of X	Net profit to venture before tax and incentives	Net profit to venture after tax and incentives	Net profit to NZ partner after tax and incentives	Value added nationally per tonne caught (\$)	Export incentive per tonne caught (\$)
A	14	-5	-11	-1	-0.5	-63	120
B	11	-1	1	12	7	-12	113
C	14	6	3.5	12	6	7	117
D	63	6	-213	-203	23	134	134
E	15	8	9	17	13	82	113
F	12	7	6	14	14	101	172
G	4	-1	6	14	7	-19	159
H	17	7	5	14	13	86	145
I ^a	27	-6	-5	6	1	-62	111
J	11	-1	3	12	9	7	122
K ^b	12	6	9	16	12	120	212
L	21	-1	3	12	6	-11	100
M	16	7	5	14	9	75	129

^aThe results of company I, which in 1978–79 showed the highest figure of returned value per tonne of squid caught should not be taken at face value. The company did not supply figures for its accounts in the standard form requested and instead presented the figures for both squid seasons and other fishing operations in consolidated form. The figures have been untangled as far as possible but staff changes in the company and uncertainty over the eventual size of the catch has left unsolved problems. Lack of certainty that surrounds both the accounts and the catch makes the distribution of returned-value, value-added, and tonnage between seasons suspect.

^bThe results of company K in 1979–80 were suspect for several reasons: its average price per tonne was, at \$1881, much higher than that of any other company in the season; the charter arrangement it had with the foreign owner of the vessels gave K a fixed fee that did not vary with the catch or its value; and, like other companies, it stood to gain a great deal through export-incentive payments.

Table 3. Individual performances by joint-venture companies if new rules on incentives had applied, 1979-80.

Company	Profit or loss as % of X						
	Net returned value as % of X	Value added nationally as % of X	Net profit to venture before tax and incentives	Net profit to venture after tax and incentives	Net profit to NZ partner after tax and incentives	Value added nationally per tonne caught (\$)	Export incentive per tonne caught (\$)
A	18	-1	-11	-9	-5	-16	22
B	15	3	1	3	2	29	23
C	16	3	3.5	8	4	30	71
D	63	6	-213	-203	21	134	111
E	17	11	9	7	5	106	18
F	12	7	6	5	5	101	25
G	9	3	6	5	2	48	22
H	18	7	5	5	5	97	33
I	30	-3	5	-1	-3	-31	44
J	14	3	3	2	2	36	6
K	14	9	9	7	5	161	41
L	25	4	3	4	2	28	21
M	19	9	5	5	4	107	33

percentage of the aggregate budget. The import content of the categories was then estimated.

The procedure carries the implicit assumption that the 29 vessels whose records were available were representative of the rest of the fleet. There is no check on this, but the size of the group — about one-third of the fleet — makes it unlikely to be highly inaccurate.

For the 1979-80 season, I arrived at a figure of \$4.4 million for value returned by the 102 vessels. The Japanese had caught 25 150 t, the Koreans 403 t. Licence fees averaged \$24 141/vessel, or \$94.36/t of squid. The average returned-value stood at \$43 437/vessel or \$251/t.

The accounts for the 1978-79 season were not available so the 1979-80 figures were used, with adjustments for changes.

In 1978-79, 117 vessels from Japan and Korea were approved, and those that came caught a total of 18 471 t of squid. Allocations were made on a quota basis, and in this year fees were levied on the basis of a flat fee, \$80/t allocated. Japan's quota was 29 000 t, Korea's 1000 t. Actual catch (18 471 t) was well short of the total 30 000 t allocated. The full amount of \$2.4 million of licence fees was collected. The net result of the calculations was a figure of \$4.1 million in returned-value. This gives an average returned-value per vessel of \$35 043 or \$222/t. The licence fee averaged \$130/t caught.

Comparison

New Zealand government officials allow vessel entry on the basis of an expected season's catch of

220 t/vessel. In the 1978-79 season, 71 joint-venture vessels were approved, reflecting an implicit allocation of 15 620 t. Fifty-nine joint-venture vessels actually operated, and company records give a total catch of 7352 t. In the 1979-80 season, only 82 of the 108 joint-venture vessels approved actually operated, catching a total of 15 381 t. The allocation to joint ventures was 23 760 t. The foreign fleet in 1979-80 was allocated 115 vessels, or a total allocation of 23 760 t.

The shortfall in joint-venture vessels reflects the fact that some partners were either unwilling or unable to complete the charter of foreign vessels. The inability of a few joint-venture companies to secure all the vessels for which they had approval heavily influenced the joint-venture record on the basis of allocation.

Comparative Catch Rates

Analyses by Roberts of the squid catch rates of foreign and joint-venture vessels fishing in the New Zealand EEZ during 1978-79 (Roberts unpublished) revealed that, at 161 t, the average catch per vessel of the licenced Japanese fleet was considerably higher than the joint-venture vessel average of 125 t.

Roberts' work also revealed that the Japanese vessels of all sizes consistently outfished Korean and Taiwanese counterparts on the basis of catch per vessel-day. He attributed this difference mainly to greater length of fishing experience of the Japanese in the waters around New Zealand.

The difference in average catch by the foreign and joint-venture fleets has been attributed by New Zealand officials to the presence of Korean

and Taiwanese vessels in the joint-venture fleet; to the most experienced crew and skippers being attracted to the licenced fleet; and to the licenced fleet vessels being on the whole newer and better equipped than those of the joint ventures. Roberts reported that foreign vessels and joint-venture vessels stayed in the EEZ for about the same length of time and fished for about the same proportion of that time.

Returned-Value

The returned-value per tonne caught and per tonne allocated of the joint ventures was virtually the same as that of the licenced foreign fleet in 1978–79 on the basis of actual catch, although the foreign fleet returned about 30% more on the basis of allocation (Table 4).

The 59 joint-venture vessels that fished for squid returned \$1.6 million in foreign exchange to New Zealand in 1978–79, 13% of the total export receipts earned by the squid joint ventures. The figure for 82 vessels in 1979–80 was \$2.9 million (or \$3.3 million if the new rules on export incentives were applied). This constituted 14–16% of export receipts.

In contrast, the licenced foreign fleet of 117 vessels approved in 1978–79 contributed \$4.1 million. In 1979–80, 102 foreign vessels returned \$4.4 million in foreign exchange to New Zealand. In 1978–79, there was little difference between results from the foreign and joint-venture fleets. In 1979–80, the change in the export-incentive rules improved the returns to New Zealand of the joint-venture fleet, but a change in the licencing fees improved the returns from the licenced fleet and gave relatively better results than the change for joint ventures.

The range of performance by individual joint-venture companies, both in terms of their profitability and their contribution to national economy, was wide, conforming to the pattern noted by Lall and Streeten (1977) in their studies of private direct foreign investment in manufacturing.

Table 4. Comparison of returned values from joint ventures and the licenced foreign fleets.

	1978–79	1979–80 old rules	1979–80 new rules
Per tonne caught			
Joint venture	221	198	213
Foreign	222	251	251
Per tonne allocated			
Joint venture	104	128	130
Foreign	137	197	197

The influence that overwhelmed that of the institutional arrangement was the highly discriminatory export-incentive payments and the manner of levy of the licence fees on the foreign fleet. The export-incentive payments arrangements under the “old rules” were irrational and inequitable as they rewarded earners of foreign exchange very differently for their contributions to the balance of payments and even paid for the draining away of foreign exchange.

Changes to the incentive scheme have been made and have improved returns to New Zealand. The payments under the new rules can be regarded as generally sensible, so that government policy has moved appropriately. Even with the new rules, however, rewards are unevenly bestowed.

Shadow prices and opportunity costs have not been built into the study, but the major distortions to prices and returns caused by inappropriate institutional arrangements that stem from government policy are particularly clear. In this context, calculation of the real social cost–benefit of alternative options is extremely difficult. The role of different institutional arrangements in overcoming possible development blocks — if these can be identified — and the identification of any tendencies toward systematic development inhibitors are subjects for continuing research.

Particular thanks are owed Dr Geoffrey Bertram of Victoria University of Wellington, on whose methodology this study is based, and Dr Peter Bushnell, head of the Research Section of the Economics Division of the Ministry of Agriculture and Fisheries, New Zealand. Both have given much advice and help. Thanks are also due the numerous individuals in the Fisheries Management, Fisheries Research and Economics Division of the Ministry of Agriculture and Fisheries, New Zealand. Dr Peter Roberts and Peter Riley have been especially helpful. Any errors are mine and the views represented here do not constitute official New Zealand government policies. The work is in progress as part of a PhD thesis with Victoria University of Wellington and this section was completed under contract for the Ministry of Agriculture and Fisheries, New Zealand, whose assistance is gratefully acknowledged. Most of the aggregate figures concerning the fishing industry as a whole were compiled by the New Zealand Fishing Industry Board; the information supplied concerning squid came from Dr Peter Roberts of the Ministry of Agriculture and Fisheries, whereas I obtained the information on the companies and the foreign fleet while working under contract with the Ministry of Agriculture and Fisheries. The cooperation of the companies is also gratefully acknowledged.

The raw data for the study are confidential, and the results of this study have been presented in a form that

does not disclose the identity of the firms. Individual results are interesting for their range, so these have been written up as ratios, percentages, and rankings. Abso-

lute figures have been avoided, except as aggregates, so that the results cannot be reconstructed to identify individual firms.

Export Potential of Coastal Shrimp Cultured in Thailand

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Thailand is searching for a new marine resource to meet its future demand for fishery products and to maintain the contribution of fisheries to the national economy. The cultivation of marine shrimp appears particularly advantageous as a means to expand production for export. To obtain one unit of foreign exchange from this export would require only 0.55–0.77 units of domestic resources. In other words, the cost in bahts to realize U.S.\$1 from export would be only 12.97–18.14 baht at the shadow exchange rate. Therefore, the promotion of coastal shrimp farming is highly recommended, and government policies that encourage its growth should be formulated.

La Thaïlande s'engage dans l'exploitation d'une nouvelle richesse marine afin, d'une part, de répondre à la demande toujours croissante de produits de poisson et d'autre part, de maintenir la contribution de ce secteur à l'économie du pays. L'élevage de la crevette marine est particulièrement indiqué, étant donné les possibilités d'exportation de cette espèce. Il n'en coûterait à la Thaïlande que de 0,55 à 0,77 unité monétaire locale par unité de devise étrangère; par exemple, au taux de change fictif, cette production rapporterait 1 \$ US pour de 12,97 à 18,14 bahts. L'élevage intensif de la crevette dans les eaux côtières est donc hautement recommandé et le gouvernement doit élaborer une politique qui favorisera la mise en oeuvre de cette nouvelle industrie.

With a long and fertile coastline of 1900 km along the Gulf of Thailand and another 700 km along the Andaman Sea, Thailand has long supported a thriving fishing industry. Of its total 72 provinces, 22 are located in such areas. However, only after 1960, did fishing operations become more than subsistence activities with stationary gear such as bamboo traps, fence traps, block nets, and winged set bags, etc. The contribution of fishing to the Thai economy was minor — a source of village employment and domestic food supply.

The rapid development of the fishing industry began when Thailand, with the technical cooperation of the German government, succeeded in using a movable gear — trawl nets — in the Gulf of Thailand. The otter-board trawl proved most effective among the various types of trawl net and became increasingly popular. Trawl nets have gradually replaced all other equipment, including the Chinese purse seine. During 1960–70, the number of fishing boats increased from about

700 to more than 5000. Thus, the Thai fishing industry has become one of the most vigorous sectors of the economy.

Thailand now has the most developed fishing industry in Southeast Asia and, in terms of production, is one of the top 10 countries in the world (Table 1). The industry is not only a source of employment but also a source of foreign exchange. In 1979, it comprised about 25 000 fishing boats, earning 7326 million baht (U.S.\$358.24 million) from exports of only 15–20% of the total catch. In Thailand, the per-person consumption of fish is about 20 kg annually. About 300 000 people are now directly involved in the industry, and not fewer than 100 000 are involved in related activities such as cold storage, processing, and ice industries.

Current Problems

Thailand's fishery production increased gradually from about 170 000 t in 1957 to 762 188 t

Table 1. Fishery production and exports, Thailand, 1970-78.

Year	Production				Exports	
	Marine		Freshwater		Quantity (10 ³ t)	Value (million baht)
	Quantity (10 ³ t)	Value (million baht)	Quantity (10 ³ t)	Value (million baht)		
1970	1335	4096	112	906	44	369
1971	1470	4554	116	973	55	497
1972	1548	4936	131	1371	82	807
1973	1538	6562	140	1646	104	1649
1974	1351	4093	158	1646	88	1548
1975	1394	5102	106	2092	98	2106
1976	1551	5968	147	2152	133	3097
1977	2067	8622	122	2038	180	3590
1978	1957	11458	141	2369	235	5086

Source: Department of Fisheries, Fisheries Record of Thailand, Bangkok, Ministry of Agriculture and Cooperatives, various issues.

and 1.47 Mt in 1967 and 1971 respectively. In 1977, the total catch of marine fish was 2.07 Mt; this was the highest production ever achieved by the Thai fishery. The growth in production reflected two key factors: the efficiency in management as well as technology and the fertility of the natural marine resource in the Gulf of Thailand.

In a survey conducted in the Gulf of Thailand, the Department of Fisheries found that an hour of trawling in 1965 produced 300 kg; by 1973 this number had dwindled to 57 kg (Manasawet 1976); and, in 1978, a survey conducted by Kasetsart University revealed that the fish captured in an hour of trawling in some areas around the Gulf of Thailand had dropped to 30 kg. These figures indicate that the fish resource is inadequate to support current trawling efforts. As a consequence, the amount of fish captured per unit of fishing effort must be decreasing. The maximum sustainable yields of demersal fish from the Gulf of Thailand and the Andaman Sea have been, respectively, estimated to be not greater than 500 000 and 200 000 t annually; the figures for pelagic fish are about 380 000 and 100 000 t. The reason that fishery production has continued to increase (average annual production for the last decade was 1.75 Mt) is that a considerable number of fish have been taken from waters outside the Thai boundaries — the Indian Ocean and South China Sea and joint-venture projects with neighbouring countries like Bangladesh. The ratio of fish by-catch (Thailand, Government of 1979) to the total catch increased from 33% in 1970 to 48% and 65% in 1973 and 1976, respectively, whereas it accounted for only about 10% of the total-catch value. Moreover, only 46% of the by-catch is species that would be

unsuitable for domestic consumption or export if given time to mature. Therefore, the increase in by-catch production incurs a long-run economic loss to the Thai economy.

Other factors that have had negative effects on the Thai fishery industry are the expansion of exclusive economic zones and the oil crisis. Almost half of the total fish production in recent years has come from waters now under coastal states' jurisdiction, and the input cost of oil has accounted for 30-50% of the total costs in operating a common trawler.

The spectacular development of the fishing industry has benefited only the large-scale operations (Panayotou 1979); small-scale operators, who are the majority (70%) of the fishing-dependent population, account for only 30% of the total catch. Using traditional fishing gear, such as bamboo traps, hooks, winged set bags, etc., they must compete with modern trawlers for a portion of the fishing grounds and inshore resources. Thus, they not only have not participated in the recent boom of the Thai fishery industry but also have lost ground in their occupation.

One solution to the problems facing the Thai fishery is to enlarge the source of fish production through cultivation, in particular, cultivation of marine shrimp along the fertile coastlines of the country.

Although 85% of shrimp production is at present consumed domestically, shrimp is the most important marine export. The commercial shrimp species in Thailand can be categorized as white (*Penaeus merguensis*), flower (*Penaeus semisulcatus*), black tiger (*Penaeus monodon*), and pink (*Metapenaeus monoceros*) (Koyama 1976).

Thailand started trading shrimp in the 1950s and accelerated its export in 1962 when Japan began to import the products at a relatively high price. Because of the export demand, the Thai shrimp industry has emphasized quality control and standardization of products. This emphasis encouraged the growth of the cold-storage industry, which gradually increased from 3 units in 1963 to 24 and 32 units in 1973 and 1977, respectively. During 1962–72, annual exports of shrimp were about 6000 t, rising to about 14 000 t after 1973. In 1980, Thailand exported 18 000 t of shrimp to the world market, with Japan importing about 56.21% of this amount (Table 2).

Most of the shrimp traded internationally are beheaded and frozen in a block or beheaded, peeled, deveined, and frozen individually.

The export market for shrimp is still considerable. Although Thai shrimp account for only 6–10% and 1–2% of the shrimp imported respectively by Japan and the United States, they represent 60% and 15% of Thailand's total exports in marine products. The annual increase in export price between 1967–78 was 11.68%, whereas the increase in amount exported was only 7.71%.

Shrimp Cultivation

There is no record of when shrimp cultivation began in Thailand, but local shrimp farmers say it was practiced before 1930. Historically, farmers reclaimed estuaries around their rice fields, allowing the brackish water to flow in and out of the fields after the paddy had been harvested. Thus, the fields became sanctuaries for shrimp and other species. Eventually, the profit from

selling the shrimp led some farmers to full-time shrimp cultivation. The industry received renewed interest about 1950 when prices for salt dropped, and many salt farmers switched to shrimp-pond operation.

Conditions in Thailand are favourable for shrimp farming: the temperature is lower than 34°C along the coastline, and there are rich natural food areas (about 72 720 ha coastline). Although the area under shrimp cultivation almost trebled between 1970 and 1979, it is still less than half the potential.

Cultivated shrimp totaled 664 t in 1979, of the total 63 652 t harvested. In 1972, the Thai government initiated a shrimp culture development program in the Third Development Plan (1972–76). Three marine fishery stations were established to conduct research and to produce shrimp seeds for shrimp farmers.

Increases in cultivated shrimp, however, have mainly been reflections of the response by private shrimp farmers to higher market prices. To date, most shrimp farming in the country is still done with traditional techniques. Hence, the production has remained far below the target in the development plan.

To test the hypothesis that shrimp farming in Thailand is economic, we have evaluated the endeavour's social costs and returns; we have also attempted to determine whether or not Thailand would have a comparative advantage in the production of cultivated shrimp and how much foreign exchange the country could earn from exports of cultivated shrimp.

The data derive from traditional operations in 1980 at Samutsakorn, a province at the mouth of Chao Phraya River and the Gulf of Thailand.

Table 2. Marine shrimp production and exports, Thailand, 1970–79.

Year	Production		Export	
	Quantity (10 ³ t)	Value (million baht)	Quantity (10 ³ t)	Value (million baht)
1970	63653	1527	6421	224
1971	67614	1758	5593	247
1972	66887	1872	6726	340
1973	77525	2635	14875	803
1974	80093	1141	10251	602
1975	87039	1498	13541	891
1976	88672	1987	15218	1347
1977	118953	2844	13663	1171
1978	127414	4247	15378	1500
1979	na ^a	na	18626	2371

^a na = not available

Source: Department of Fisheries, Fisheries Record of Thailand, Bangkok, Ministry of Agriculture and Cooperatives, various issues.

Table 3. Cost structure of shrimp cultivation in Thailand, 1980.

Item	Costs (baht/rai)	
	30-rai farm	50-rai farm
Investment	3099	1860
Water pump	833	500
Water gate	1333	800
Drain	533	320
Warehouse	333	200
Other	67	40
Annual operating costs	2733	2020
Fuel	833	700
Pond maintenance	700	600
Labour	1200	720

Yields per rai (0.16 ha) were 60 kg/year, with an average farm-gate price of 70 baht/kg (U.S.\$1 = 20.45 baht) (Table 3).

Methods

We assumed that Thailand would have a comparative advantage in shrimp cultivation for export if the domestic resource cost in producing one unit of foreign exchange were less than the shadow price of foreign exchange (Bruno 1972). To such a model, the two numerator terms are the direct domestic factors including land, labour, and capital evaluated at their opportunity costs and the indirect nontraded domestic commodity inputs, whereas the denominator is the net foreign exchange earned. To make the model more applicable to Thailand where the inputs and outputs for the agricultural sector are not available, we used a modified version of the model (Pearson et al. 1976) such that the domestic inputs were divided into tradable (if they were fully traded) and nontradable (if they were not fully traded). The nontradable inputs were subdivided again into tradable components and primary domestic factors.

We calculated opportunity costs of land, labour, and capital. In general, the land would be used for mangrove-tree growing, the net benefits of which, according to Department of Forestry data, would be 123 baht/rai annually. We multiplied the number of person-days (both hired and family labourers) by the market wage rate. Funds invested in the fixed assets were assumed to be 15%, and 10% depreciation was assumed.

Indirect costs of production were the intermediate input costs incurred in shrimp cultivation: costs for fuel, shrimp seed, pond maintenance, transportation, marketing, and processing (conversion ratio from raw to frozen shrimp was 1:0.65). Cost of input at the farm-gate price was

calculated as the sum of the foreign content of the input, the value of the input generated in the country, and overall taxes levied by the Thai government. Because our study concentrated on traditional cultivation, in which shrimp seeds are obtained from natural seawater, the opportunity cost for the use of shrimp seeds was zero.

The price of foreign exchange or the social value of production is the FOB price of one unit of output, whereas the private value of production is the FOB price less all direct and indirect taxes at the border. These taxes are export duty, business tax, municipal tax (and other equivalent tax in terms of premium or quota for some commodities such as rice). In this study, the social value of the final output was the FOB price/kg of frozen shrimp, which is 130 baht, the private value being 127.14 baht.

The shadow price of foreign exchange, which is the rate of exchange that would apply if there were no trade barriers such as tariffs, taxes, subsidies, etc. (McCleary 1976), is the product obtained from multiplying the official exchange rate by the sum of the foreign exchange premium (weighted average of import barriers and export subsidies) plus 1. The official exchange rate for 1980 was 20.45 baht/U.S.\$1 and the foreign exchange premium 0.15; hence, the shadow exchange rate 23.52 baht/U.S.\$1.

Findings and Implications

The domestic resource cost would be 0.55–0.77/ unit of foreign exchange; that is, Thailand would spend 11.28–15.77 baht/U.S.\$1 at the official exchange rate or 12.97–18.14 baht/U.S.\$1 at the shadow exchange rate. The social benefits from investment would be more than 2000 baht/rai, and society would receive a net benefit of between about 1000 and 2000 baht, depending on the scale of operation with increasing returns to scale (Tables 4 and 5).

The activity is highly labour intensive, with labour costs accounting for 63% of the total domestic cost and capital costs accounting for only 32%. Shrimp farming, therefore, could be a means of decreasing unemployment in the country. Jobs would be created both directly in the farm and indirectly in activities such as processing, cold storage, transportation, and marketing.

To determine the relationship between factor costs and the comparative advantage in shrimp production, we estimated the domestic resource cost sensitivity and found again that labour costs were more significant than any other factors. An increase in cost of 1.56% (30-rai operation) or 1.58% (50-rai farm) would result in an increase of

Table 4. Applied cost structure of shrimp cultivation, Thailand, 1980.

Item	Annual costs (baht/rai)			
	30-rai farm		50-rai farm	
	Direct	Indirect	Direct	Indirect
Primary factor costs				
Land	123		123	
Labour	1200	882	720	791
Capital		368		349
Opportunity cost	464		279	
Depreciation (on nontraded only)	226		136	
Foreign input costs				
Capital	83		50	
Fuel	517		434	
Transportation, marketing	116		116	
Processing	124		124	
Tax, tariff	264		224	

1% in domestic resource cost. The elasticities with respect to capital and foreign-input costs for 30- and 50-rai farms were 3.09, 3.15 and 4.93, 5.95 respectively; land exhibited the highest value (20.00, 26.66), the effect of this elasticity being relatively insignificant compared with the other factors. The elasticity with respect to yield was negative, indicating that increasing yield per rai by 0.93%, 0.96% would decrease cost by 1%.

Policy Recommendations

The potential of shrimp cultivation indicates that government should implement policies that promote increased shrimp production along the coast. Improvements in cultivation technology

Table 5. Social costs and benefits of shrimp cultivation, Thailand, 1980.

Indicator	Annual costs (baht/rai)	
	30-rai farm	50-rai farm
Domestic factor costs (other than capital)	2205	1634
Domestic capital cost	1058	764
Social value of product (foreign exchange earned)	5070	5070
Foreign input costs	840	724
Social profitability (net foreign exchange minus domestic factor costs)	2025	2712
Baht of domestic cost to earn U.S.\$1 at official rate	15.77	11.28
Baht of domestic cost to earn U.S.\$1 at shadow rate	18.14	12.97

such as shrimp pond management, use of fertilizer and feed, and removal of predator fish should be a priority, and training programs in shrimp farming should be provided by the government. Moreover, effective credit and marketing systems are needed for this industry to grow. One direct way to increase shrimp production is to increase the shrimp-seed supply; thus, government should aim for increases in its shrimp-seed producing units (usually within the fishery station) as well as those within the private sector by providing both financial and technical support.

Mangrove Preservation

Expansion of the area devoted to shrimp production should be directed in such a manner that mangrove forests are preserved. Because the forests are essentially natural sources of shrimp seed and feed, destroying the mangrove trees should be avoided and the boundaries of the forest reserve should be clarified.

Environment Controls

Environmental pollution from the industrial sector, especially from factories located near the river estuary, must be carefully controlled because contaminated water would be a hazard to the shrimp seeds. Also, control of overfishing is important in the promotion of shrimp cultivation. Particularly, enforcing the prohibition of trawling inshore would mitigate shrimp-seed scarcity and encourage a biologic equilibrium. Overfishing in Thailand is the core of all fisheries problems in the country and must be controlled.

Discussion

Hugh Patrick: The Kamphol and Thanwa paper has considerable merit. It is a specific case study analyzing the social cost-benefit ratios for coastal shrimp cultivation by Thailand. The paper makes standard introductory bows to the general state of fishing in Thailand, with statements about new trawler technologies, increases in output, recent inclines in productivity, dire warnings of overfishing, higher fuel costs, etc. that we, as participants, have heard in discussions these past several days and have learned to accept in part, qualify or reject in part, and remain less than fully informed about in other respects. Then, the paper gets down to the main business: shrimp, their rapid growth in production, domestic consumption, and exports, in volume and value terms. Put simply, between 1970 and 1978, total production doubled and total value almost trebled, whereas exports (1970-78) trebled in quantity and rose some 10 times in value. Thais have had their shrimp and eaten it too! That is to say, about 85% of production is consumed domestically, with only a modest rise in prices, whereas exports have done extremely well in both volume and prices. It would be interesting to know why the gap between domestic and foreign prices has widened so much. Does the trend reflect normal market forces, lack of infrastructure, government policy, or what? Maybe the high-quality, high-priced shrimp are being exported to Japan, and it is Thai rather than only the Hong Kong cooks who are so excellent!

The main purpose of the paper is to estimate quantitatively Thailand's comparative advantage in shrimp cultivation. The authors use the standard technique of domestic resource cost per unit of foreign exchange earned, with shadow prices in principle (assuming those close to factor-market prices in practice). They derive data from a sample of unspecified (but I suspect very limited) size and range in one shrimp-cultivating region, comparing two scales of operation, 30- and 50-rai farms. They assume the traditional type of cultivation, with shrimp seed coming from the natural flooding of coastal ponds. Their results are impressive. Thailand has a strong locational advantage — comparative advantage — in shrimp cultivation. There are substantial differences in economies of scale, in both capital and other input uses, between 30- and 50-rai production units. In addition,

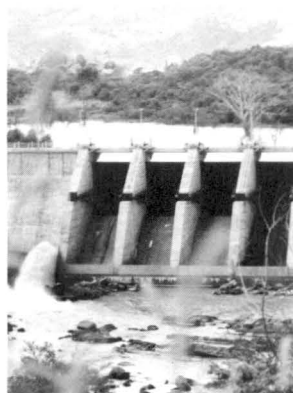
the production process is quite labour intensive in terms of share in value-added. Shrimp farming, on this evidence, makes a great deal of sense for Thailand. Moreover, the possibilities seem excellent for substantial expansion in production and export sales at least. Only about 5% of shrimp production is from cultivated rather than natural sources. Only about two-fifths of the suitable coastal area is actually under cultivation. The major constraint is in obtaining adequate supplies of shrimp seeds, as industrial pollution, trawler small-mesh nets, and other uses of mangrove swamps cut into natural sources of supply. Whether this is a serious constraint is not clear. At any rate, fishery research institutes are at present attempting to develop supplies of shrimp seeds. Moreover, the demand in foreign markets appears excellent. Shrimp apparently have high-income elasticity of demand in Japan and the United States, and the Thai share of those markets is small enough that price elasticity of demand must also be high. This paper bears out earlier qualitative statements in this conference that shrimp cultivation, essentially a private operation with some governmental technical assistance and perhaps help on infrastructure, is profitable for domestic and especially for foreign markets. It well combines trade and development. As one who loves shrimp, I hope the Thais rapidly take full advantage of their comparative advantage and expand production significantly.

There are always questions one has about such a study, usually those about further information. How representative is the sample? How good are the input-price assumptions? My guess is that the results are so strong that more expensive capital and cheaper labour shadow prices would not substantially alter the conclusions. Is the long-run supply schedule highly elastic for large expansion in production, i.e., what about the facts of the extensive margin? And how about the intensive margin? It is suggested that Thai shrimp cultivators do not bother with fisheries institute shrimp seeds. Are there serious problems of adoption of new technologies? How good are those technologies? Are the requisite infrastructure — storing, transporting, marketing — readily forthcoming without great need of government subsidy? How important — and distorting — are government export-subsidy programs in the estimates?

Finally, it would be useful to look at the income-distribution effects of the expansion of shrimp cultivation and of economics of scale in that production.

The Kamphol and Thanwa paper is concerned with the economics of production. Rents play no essential role in the authors' analysis. In this respect, this paper is different from most in this conference, which focus on issues for renewable

resources of how to generate rents, how to collect them, how to distribute them, and how to ensure that resources are allocated efficiently. I have come away with the impression that, in fisheries in particular, resources are far from allocated efficiently and that rents go predominantly to groups outside government. The problems of distribution seem to be deeply intertwined in this process — bargaining and other power games within nations as well as among them.



***R**enewable
substitutes
for fossil fuels*



Substitution of Nonexhaustible Resources for Fossil Fuel Energy and Industrial Raw Material Resources

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We examine the substitution of nonexhaustible resources for fossil fuels to indicate the factors important in determining the rate and pattern of use of these resources. The characteristics of nonexhaustible substitutes and resource requirements suggest important distinctions between concentrated and diffuse energy forms, between tradable and nontradable energy products, and between energy forms of limited use and those more widely useful. We have used taxonomy based on these distinctions to examine possible implications for trade and investment flows of substitution toward nonexhaustible resource use, although the conclusions depend heavily on assumptions about future nuclear fusion technology. The uncertainties, and the possible significant adjustments required, call for governments to become involved and to encourage cooperation so that adjustments are efficient, and inefficient pursuit of energy security by individual countries will be avoided.

Le présent exposé porte sur la recherche des facteurs déterminant le niveau et le mode d'exploitation des ressources renouvelables en vue de la substitution des combustibles fossiles. Les caractéristiques de ces énergies de remplacement impliquent l'établissement des distinctions existant entre les formes d'énergie — diffuse ou concentrée, d'un emploi limité ou non — et entre les produits énergétiques — commercialisables ou non. La taxonomie a été fondée sur ces distinctions afin d'examiner les incidences possibles de la substitution sur la circulation des investissements et du commerce, bien que les conclusions dépendent fortement des hypothèses relatives à la technologie de fusion nucléaire. La difficulté d'établir des prévisions et l'importance des ajustements exigent l'intervention et la coopération des gouvernements afin que les mesures retenues soient fonctionnelles et que les pays ne se lancent dans une vaine poursuite de la sécurité énergétique.

Heavy dependence on exhaustible mineral and energy resources can continue only for a finite period. For most of the minerals on which present production patterns are based, the time is sufficiently long for there to be little present incentive to alter the rates at which they are consumed. In the case of energy, however, the size of exhaustible fossil fuels and uranium reserves, relative to demand, is small. Thus, within a relatively short period, production and consumption patterns must shift so that they are more consistent with the availability of energy supplies from nonexhaustible sources.

In the intermediate phase, there will be a strong substitution of the more readily available fossil-fuel resource, coal, for the shorter-lived oil and gas resources, and the stimulus to this is now leading to major developments in the countries with relatively abundant coal supplies. Progress-

sively, however, coal reserves will also be depleted and nonexhaustible energy resources will increasingly have to be substituted for fossil fuels.¹

Aside from their use in direct energy supply, fossil-fuel resources are also used as sources of industrial raw materials for several purposes. The most important of these are synthetic fibres and rubber, plastics and other petrochemicals, and the fixation of nitrogen in fertilizer production. To a considerable extent, this use has been a

¹We do not discuss prospects for nuclear energy development. We note that all existing nuclear technologies are based on exhaustible resources, including experimental nuclear fusion technology, which requires lithium. Although an inexhaustible supply of electric power may ultimately be available from nuclear fusion based on the use of deuterium, we have not counted this as one of our nonexhaustible alternatives.

process of substitution, first of coal and later oil and gas, for earlier "natural" sources of supply of these materials — a progression that must ultimately be reversed in some way.

Although the transition from dependence on fossil fuels is sometimes characterized as moving from a high-energy demand pattern, in which stored supplies of energy are progressively run down, to a "steady-state" energy demand pattern where demand adjusts to the rate at which additional energy resources become available, that physical rate is not the real limiting factor. The amount of nonexhaustible energy supply available to be tapped from geothermal, gravitational, and solar sources is, to all intents and purposes, infinite. It is not, however, free. To convert the natural forms of energy supply into forms useful to people, it is necessary to employ other factors of production (land, labour, and capital) and the opportunity costs of doing this are the chief limit on the extent to which it is desirable to use energy.² In addition to this, however, the forms of usable energy that are technically obtainable, or that are likely to be economic to obtain, from the various natural sources differ in some important ways. It is useful to distinguish between concentrated and diffuse energy resources, between tradable and nontradable energy resources, and between those forms that can be used in many different ways and those that cannot. Clearly, these factors influence the rate and pattern of substitution away from use of fossil fuels, as well as the emerging patterns of trade specialization in energy products and energy-using products.

Substitutes for Exhaustible Resources

Throughout this paper, we use the term "non-exhaustible" rather than "renewable" to describe the resources that may be substituted for exhaustible fossil fuels. Given the general focus of this volume on renewable resources, this terminology requires some clarification.

The standard economics literature (Plourde 1970; Brown 1974; Long 1976) defines a renewable resource as one that is depleted by use but that has a natural capacity to regenerate. Although the resource is capable of being depleted to the point of exhaustion, it is also capable of providing a sustained yield where the

rates of depletion and regeneration are matched. Although biologists tend to suggest management strategies providing the maximum sustainable yield — at which the marginal rate of regeneration is zero — this will be optimal only if the net price of the product is rising at the required rate of interest. If the net price of the product is expected to remain constant, the optimal strategy is to deplete beyond the point of maximum sustainable yield, settling ultimately on a sustainable yield at which the marginal rate of regeneration is equal to the interest rate.

Although these issues are relevant to the exploitation of biological alternatives to fossil fuels, other potentially important substitutes in the energy area are clearly not appropriately classified as "renewable" resources. Some of these are inexhaustible resources, whose future availability is entirely unaffected by current levels of exploitation, whereas others are exhaustible within a time scale irrelevant to human consideration.

We distinguish between resources that are exhaustible over a relevant period (fossil fuels) and those that either are not exhaustible in such a time frame or can be managed to provide a continuous, nonreducing level of supply. The latter category we refer to as "nonexhaustible" resources.

Simple Substitution Model

We have constructed a simple substitution model in which a single, homogeneous resource product "energy" may be derived either from an exhaustible source (E) or from a nonexhaustible source (N). We have assumed extraction costs are zero for the exhaustible resource so that the cost of exploiting this source of supply would be simply the lost future opportunity to do so. In contrast, we have supposed that extraction from the nonexhaustible source would involve a present cost, as factors of production need to be diverted from other uses to obtain energy from that source.

Fig. 1 shows the demand for energy and the supply curve relating to the nonexhaustible source, both of which are assumed for simplicity to be constant over time. The upward slope of S_N reflects the increasing opportunity cost of diverting resources from alternative uses to the extraction of energy from N. In the absence of the exhaustible resource, a "steady-state" level of consumption, Q^* , and price, P^* , will be maintained. However, this steady state results from the assumed stability of demand and nonenergy resource costs, not from any ultimate limit on energy availability.

Although the exhaustible resource has zero

²The use of energy could, in principle, also be constrained by the possibility of "overheating" the earth. However, the only serious prospect of this lies in the effects of increasing the carbon dioxide concentration of the atmosphere, an issue that arises only in the context of use of fossil fuels.

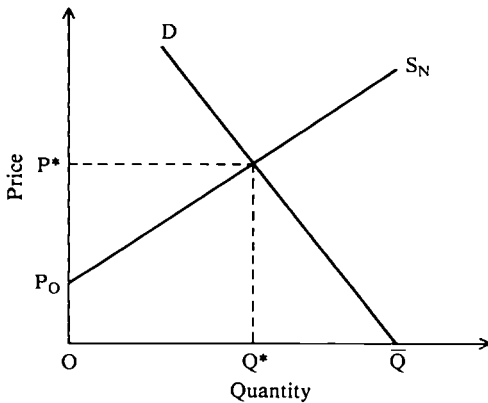


Fig. 1. Energy demand and supply from nonexhaustible sources.

extraction costs, energy will not be supplied at zero price from this source (with \bar{Q} consumed in each period) until E is exhausted, unless property rights in the exhaustible resource are undefined and nobody can make investments in conserving the resource. As a reasonable approximation, conservation decisions may follow the Hotelling rule (Hotelling 1931), with the price of energy rising over time at a rate equal to the rate of interest. The position of that price path (Fig. 2), and hence the current price of energy, is determined by the condition that total demand for E over the period until price reaches P^* (the "ceiling" price) must be equal to the total available stock of E.³ Other things being equal, the price

³This condition ensures that the resource is exhausted when demand for it ceases. Total exhaustion of the resource arises from our assumption of zero extraction costs. In reality, the exhaustible resource will cease being exploited when extraction costs reach the price P^* , and we think of this as equivalent to exhaustion (of lower cost reserves). Otherwise, the assumption of zero extraction costs does not affect the conclusions significantly.

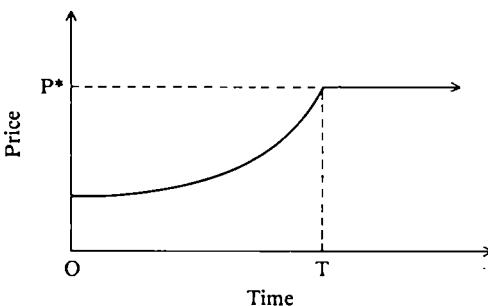


Fig. 2. Energy price path.

path will be lower and the life of the exhaustible resource longer, the lower the price (P_0 in Fig. 1) at which it is economic to start production from the nonexhaustible source because such production reduces the demand for E in all periods in which it takes place. Equally, the smaller the total stock of E, the higher the price path will lie and the sooner the nonexhaustible substitute will be brought into production.

This simple model indicates the essential elements in the interrelationship between exhaustible resource depletion and the availability and rate of development of nonexhaustible substitutes. Although the existence of a nonexhaustible alternative (whether currently economic to exploit or not) reduces the price of energy in all periods, we cannot say a priori whether the life of the exhaustible resource is actually extended or shortened by this.⁴

Nonhomogeneity of Product and Resources

We now complicate the model slightly by supposing there to be two different energy forms (A and B) that are not closely substitutable in their uses but can both be produced equally readily from the exhaustible source E. However, production of A and B from nonexhaustible sources requires the exploitation of two different resources (N_A and N_B) where N_A is available at a lower cost than N_B (Fig. 3). For convenience, the price at which N_A meets all A demand (P_A^*) coincides with the price at which exploitation of N_B becomes worthwhile (P_{B0}). The ceiling price for the exhaustible resource is P_B^* , at which all B demand is met by N_B , and the price of E will again rise at the rate of interest to reach P_B^* at the date when cumulative production (to meet A and B demands) is equal to the size of the resource stock (Fig. 4).

Below a price of P_{A0} , only the exhaustible resource will be used to provide both energy forms. Above this price, N_A will progressively be substituted for E in meeting demand for energy form A until, at P_A^* , the exhaustible resource will no longer be used to produce A and will provide only \bar{Q}_B of energy form B. The price of energy form A will remain constant at P_A^* (and consumption at Q_A^*) from time T_A onward, whereas N_B will progressively be substituted for E in meeting B demand until E is exhausted at time T.

⁴That is, the availability of nonexhaustible substitutes cannot necessarily be regarded as having the effect of "conserving" the exhaustible resource. Obviously, if a perfect substitute for oil were available in unlimited quantity at the current oil price, the (present) price of oil would fall sharply and the rate of depletion would accelerate.

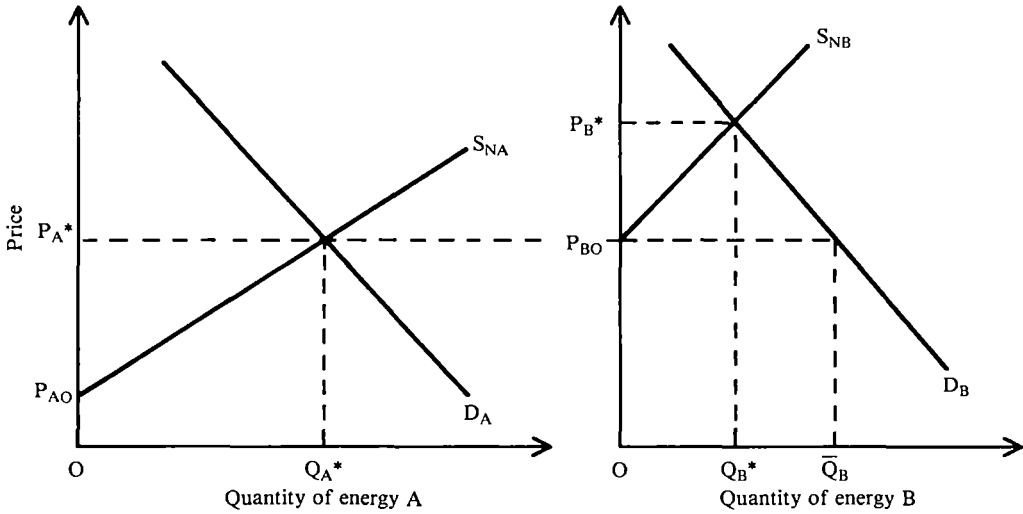


Fig. 3. Energy demands and supplies from different nonexhaustible sources.

The existence of the relatively low-cost alternative source of energy form A — and the consequent early substitution of N_A for E in meeting A demand — has the effect of conserving the exhaustible resource for use in the area with the less cheaply available substitute source of supply and, therefore, delays the date at which higher prices need to be paid for energy form B.

An alternative modification of the basic model is to suppose that the two forms of energy demand match the products of two different exhaustible resources (E_A and E_B) but can equally well be met by a single nonexhaustible resource. In this case, if one supposes that reserves of E_A are significantly smaller relative to demand over time than those of E_B , in the absence of the resource N , prices of both forms of energy would ultimately rise to \bar{P} where their demand would fall to zero (Fig. 5), although this would occur sooner for energy form A than for energy form B. Given the nonexhaustible alternative, however,

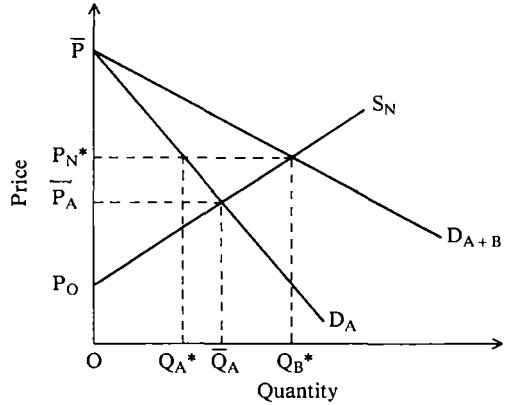


Fig. 5. Energy demands and supply from different nonexhaustible sources.

the ultimate steady state involves a price for both energy forms of P_N^* , with consumption Q_A^* of A and $Q_B^* - Q_A^*$ of B.

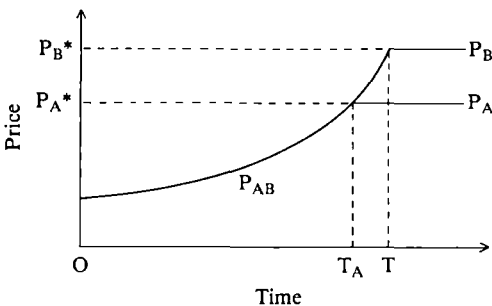


Fig. 4. Price paths of different energy forms.

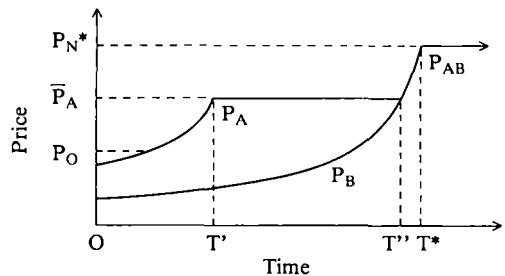


Fig. 6. Price paths of different energy forms and exhaustible resources.

Once the price of either A or B rises above P_0 , N will provide a substitute source of that energy form. Given the greater scarcity of E_A , this occurs sooner for A (Fig. 6) and N is used exclusively as a substitute for E_A until the price of A reaches \bar{P}_A and E_A is exhausted. From that time (T') until T'' , the price of A will remain constant and consumption will remain at \bar{Q}_A . Only when the price of energy from the initially more abundant E_B rises above \bar{P}_A will the nonexhaustible resource also be used to provide a substitute source of energy form B. From T'' until T^* , the prices of the two forms of energy will be the same, rising toward the final steady-state equilibrium price P_N^* .

In this example, the nonexhaustible source of supply is concentrated wholly on meeting demand in the area where the exhaustible source is less abundant, until such time as the initially more abundant exhaustible resource also becomes critically scarce. This has the effect of conserving the scarcer exhaustible resource and maintaining lower prices for the energy form produced from it.

One could go on to consider more complex problems using models, but the simple cases outlined indicate the essential issues and principles. Judgments about the probable real world rate and pattern of substitution between exhaustible and nonexhaustible resources require investigation of the actual mixtures of the sorts of situations described in the simple examples. In addition, however, judgments will also be necessary about possibilities of substitution between products, either as inputs into particular production processes or in final demand.

Product Substitution

In the preceding analysis, we assumed that the cross-price elasticity of demand between the different energy forms was zero. In reality, there is likely to be a high degree of direct or indirect substitution between energy forms.

A positive cross-price elasticity of demand between energy forms A and B would result in a greater expansion of supply from the lower cost nonexhaustible resource N_A and a reduced supply from N_B . The ultimate steady-state prices for the two energy forms, P_A^* and P_B^* , would lie closer together, the price path P_E would be lower, and the life of the exhaustible resource would be extended.

Likewise, a positive cross-price elasticity of demand would lead to a substitution of the more-abundant exhaustible resource, E_B , for the less-abundant resource, E_A , lowering the price path of the latter and raising that of the former. The result of this is that E_A is exhausted later and E_B

sooner and that the nonexhaustible resource begins to be substituted for E_A later.

In practice, the extents to which different energy forms can be substituted in consumption will clearly be major determinants both of the relative rates at which different fossil fuels are depleted and of the rate and nature of the development of nonexhaustible substitutes for fossil fuels.

A more indirect form of product substitution may affect the ways in which nonexhaustible resources are substituted for exhaustible resources. In the context of the above models, the product of the nonexhaustible resource may not actually be energy but a product capable of substituting for energy use. The natural fibres wool and cotton are, through their use in clothing, substitutes for the use of energy in space heating, and timber may provide a substitute for other structural materials (bricks, cement, steel, and aluminum) whose production is relatively energy intensive. In both cases, there is a more obvious direct substitution possibility — natural fibres for fossil-fuel-based synthetics and timber for direct energy production as a fuel. The dual substitution possibilities make it difficult to relate substitution incentives to energy prices from exhaustible sources. For example, if wool and cotton had the same thermal qualities as synthetics (and were otherwise also the same), one would expect their prices to reflect closely the cost of synthetics, which in turn reflects the price of exhaustible fossil fuels. However, given that the natural fibres have a superior thermal quality, it seems likely that their prices will rise more rapidly than those of synthetics as energy prices generally increase.

Substitution Possibilities

Alternatives to fossil-fuel sources of energy are (with the exception of the exhaustible resource uranium) derived directly or indirectly from solar radiation, from the heat contained in the earth's core, or from gravity. These primary sources are inexhaustibly large, both over time and at any time, but they are only to a very limited extent directly useful to people. We now consider briefly the various ways in which they can be harnessed to provide useful energy forms and the limitations and constraints that apply.

Direct solar radiation may be converted into useful heat or electrical energy, but conversion capacity is limited by the flux of solar radiation and by the capabilities of the extraction technology. The radiation flux varies with latitude, being greatest in the tropics and least at the poles. Cloudiness is also an important limitation for

collection systems dependent on focused radiation. Ordinary solar collectors supply heat at low temperatures (below 100°C), which may be used directly as hot water or, for example, to drive refrigeration or air conditioning equipment. Evacuated tube collectors and focusing systems supply heat at higher temperatures, which may be used as steam for a multitude of industrial heating purposes or to drive turbines to generate electricity. Direct conversion of solar radiation to electricity occurs in photovoltaic cells, which are a form of semiconductor. The technology for making them is closely related to that used in the production of silicon chips and is undergoing development only slightly less rapid.

These technologies all produce energy at relatively low concentrations and are useful for domestic and commercial purposes. The land area over which solar radiation would need to be collected for industries may be a serious constraint. Indeed, even for domestic and commercial uses, the land area on which solar radiation impinges limits the usefulness of direct solar conversion in densely populated areas. Considerable research is currently being devoted to schemes to produce large quantities of energy at a single site so that a solar power station can be fitted into an existing distribution infrastructure. The technology available to do this is extremely costly and the extensive use of land for the necessary collection systems would seriously limit the range of possible sites. It seems unlikely that such concentrated solar energy will prove a viable alternative in other than the long term and then only in locations where land has an extremely low value in alternative uses.

Much of the solar radiation impinging on the earth is converted into the energy of winds, waves, and ocean currents. Technology for extracting useful energy from these sources is still being developed, but it is possible to obtain electric power in concentrated form from them. As with solar radiation, however, the energy flux varies from place to place. In general, wind and wave energy intensity is relatively low in tropical latitudes, although local topography has an important influence on wind energy — coastal and hilltop sites being the best. For the tropics, there is more potential in ocean thermal energy conversion (OTEC), which uses the difference in temperature between seawater at the surface and at depth (off the edge of the continental shelf). The applicability of this form of energy conversion is clearly site dependent and is of greatest relevance to islands.

Hydroelectric power generation is also an indi-

rect form of solar energy and has a well-established technology. The hydropower resources of any country are limited by topographical and hydrological characteristics, and total world capacity has been estimated as 34.9×10^{18} J/year (Armstrong 1978), which is 12% of the current annual world use of commercial energy (British Petroleum 1980). In 1978, the output of installed capacity was about 20% of total electricity generated (UN 1979) and represented about one-seventh of the total potential annual hydropower output. In theory, hydroelectricity is an inexhaustible resource although in the long term the size of the resource is affected by climatic change. In practice, some hydro schemes have a relatively short life (measured in decades rather than centuries) because of siltation of the storage dam. Once the basin is filled with silt, it is unlikely to be economic to empty it, and the hydropower resource of the site is thus lost.

The direct and indirect solar energy alternatives described so far are all extremely capital intensive, producing energy from the application of capital to land or site-specific natural resources with minimal employment of labour.

The final means of converting solar energy to usable forms is through extraction of the chemical energy stored by living plants as wood, cellulose, starch, or sugar (i.e., biomass). In most developing countries, biomass already provides an important share of the total energy used. For example, the traditional fuels (fuelwood, crop wastes, and dung) have been estimated to supply more than 50% of total (traditional plus commercial) energy use in Burma, Indonesia, Laos, Malaysia, and Thailand (Brown and Smith 1980), and China has made extensive use of biogas derived from waste materials. In general, these are important sources of limited quantities of low-concentration energy mainly useful for domestic purposes, although wastes from centralized-agricultural or forestry-processing activities can sometimes provide sufficient energy for those production processes. In broad terms, the category of use of these resources (diffuse, low concentration) is similar to that of direct solar conversion, although substantially less capital intensive.

Concentrated-energy forms obtainable from biomass involve the conversion of wood to charcoal, pyrolytic oil, producer gas, or methanol or the fermentation of starch and sugar to produce ethanol. These energy forms have a wide range of potential uses and could, in principle, be employed to replace fossil fuels in any energy use. Production of the raw materials is an agricultural or forestry activity and, thus, has the same

resource-input requirements as those activities generally and the same possible range of capital and labour-intensive technologies (Binswagner et al. 1978). The processing of these materials, however, is necessarily relatively capital intensive.

Like solar energy, tidal energy is an inexhaustible resource of large magnitude. However, the nature of the resource is such that large-scale, capital-intensive technology producing concentrated electric power must be employed, and this can only be done where the tidal amplitude is large and the coastal topography is suitable. Significant exploitation of tidal energy is likely to be a viable alternative at relatively few sites.

The exploitation of geothermal energy is also constrained by the technical problems of extracting more than a small proportion of the total resource. Energy can only be extracted where particularly hot areas in the earth's crust are close to the surface. As it is not clear how quickly this energy would be replaced from greater depth, i.e., how renewable it is, it is usual to describe geothermal energy in terms of the total accessible resource base in situ, as is the case with fossil fuels. Even in these terms, the resource is large and has been estimated as 2.9×10^{24} J/year (Auer et al. 1978) or roughly 10 times the fossil-fuel resource. Technological difficulties and capital requirements for the extraction and conversion to concentrated electric power of that energy presumably vary widely across sites, so that the costs of extraction may rise sharply as the level of use of the resource is expanded.

Raw-Material Substitutes

The combustion of petroleum, natural gas, and coal to provide useful energy is the major use for these exhaustible resources. However, they are also used as raw materials for the production of nitrogen fertilizers, plastics, rubber, synthetic fibres, and a great many other chemical products. Renewable alternatives, derived from plants or animals, are available either as alternative raw materials for essentially the same production processes or as alternative products to meet the same consumer uses (natural rubber, natural fibres, and paper). The use of these alternatives would in most cases merely constitute a reversal of the process by which synthetic chemical products have replaced natural ones during the past 30 years. For example, before World War II, ethanol made by fermentation of crop-derived starch or sugar was an important raw material for the production of organic chemicals. After the War, it was rapidly replaced by naphtha (a petroleum product) and natural gas. The War itself provided the stimulus for the synthetic-rubber

industry. More recently, the natural fibre jute has been largely replaced by polypropylene. Some of these substitutions occurred because the synthetic alternative was a better product, but relative cost was frequently the more important consideration.

Other important nonenergy uses of petroleum products include bitumen, lubricating oils, and petroleum coke (used, for example, to make carbon anodes for aluminum smelting). Some plant products are a potential substitute for lubricating oils. For bitumen, however, mineral products such as cement are a more likely substitute.

As with biomass-energy resources, the raw-material substitutes for fossil fuels are agriculture- and forest-based and require the same inputs as these activities generally. In the case of fibres, rubber, and paper, production and trade patterns for the "natural" materials and intermediate products are well established. Substitutes for other raw materials are largely the same products, or types of products, able to provide concentrated energy from biomass and will require the same sorts of capital inputs in the processing of the raw materials.

The most important point about all nonenergy uses for fossil fuels is that they are a relatively small fraction of total use of those resources. In 1978, nonenergy petroleum products accounted for only 9% of total petroleum-product output from refineries throughout the world (UN 1979). Corresponding figures for the nonenergy uses of natural gas and coal are not available, but they are unlikely to be larger. Thus, although there are some raw-material uses of fossil fuels for which nonexhaustible substitutes are not readily available, this is unlikely to influence significantly the rate at which substitution away from fossil fuels occurs in aggregate.

Trade Possibilities

Heavy dependence on the use of oil, on a global scale, has been facilitated by the ease with which oil and petroleum products can be transported internationally, given that oil deposits occur in only a few areas of the world. The substitution of coal for oil involves transportation problems, providing some incentive for highly energy intensive activities to be located close to coal resources (Anderson and Smith 1981). But coal is still relatively easy to transport between countries, and an international trade in this energy commodity is developing rapidly.

In contrast, an important characteristic of most of the nonexhaustible energy alternatives is that their energy products (heat or electric power) are not tradable except in limited and unusual

circumstances. As these resources are substituted for fossil fuels, energy consumption will increasingly need to match the availability of nonexhaustible alternatives, not only in form and quantity but also in location.

The exception to this is concentrated energy derived from biomass. Products such as ethanol can readily be transported in much the same way as petroleum products, but it is unlikely that the agricultural raw materials for producing these energy forms would be tradable except at high cost. Thus, development of these sorts of tradable, concentrated energy sources will require that processing facilities be established in countries with the resource endowments suited to production.

In general, the nonexhaustible raw-material substitutes for fossil fuels either are the same products as the concentrated-energy forms from biomass or are agricultural, pastoral, or forest products that have well-established, international-trade patterns at various levels of processing. Thus, these substitutes are not significantly distinguished from the fossil fuels for which they provide alternatives by their degree of tradability.

Comparative Advantage, Trade, and Investment Issues

The review of substitution possibilities suggests a simple classification of three alternatives for fossil fuels: (1) agricultural — liquid (and other) fuels and industrial raw materials that are technically capable of substituting for fossil fuels across the whole range of uses and are tradable internationally; (2) direct-solar and traditional biomass — electricity or heat at low concentration that can be substituted for fossil fuels in low-energy intensive and domestic uses but is not tradable; and (3) indirect-solar, gravitational, and geothermal — electricity or heat at high concentration that can be substituted for fossil-fuel energy in any nontransport use and in electrified transport systems but is not tradable. Stretching the facts a little, we could regard agricultural sources of energy and materials as perfect substitutes for fossil fuels. If all demands could be met from these sources at prices lower than from the other alternatives (Fig. 1 and 2), agricultural energy and material resources would progressively be substituted for fossil fuels, meeting all demands at the price reached when fossil fuels were exhausted.

By introducing a spatial element into the model, we could predict that comparative advantage in the production of agricultural substitutes

for fossil fuels would approximate the pattern of comparative advantage in agricultural, pastoral, or forest products generally. That is, it would lie with countries with relatively large endowments of land suited to these purposes. Anderson and Smith (1981, Table 1) give details of the relative endowments of these resources of countries in the Asian-Pacific region. Because of the increased demand for land, the terms of trade of land-abundant countries would improve (through an increase in export prices of all land-intensive goods) relative to countries in which land is relatively scarce.

However, the extensive use of agricultural resources to provide substitutes for fossil fuels would be subject to opportunity costs that would increase sharply with increasing competition for land, particularly for the production of foodstuffs. The pressure may be reduced substantially by development of the other energy sources. Focusing on the third set of alternatives and treating them as relatively low cost (Fig. 3 and 4), we could say that early development of the nonexhaustible resource N_A as a substitute source of energy form A would effectively conserve the exhaustible resource for use in the area with the higher-cost substitute and, therefore, would postpone the need to develop that substitute.

The introduction of trade considerations complicates the issue more significantly in this case, because the energy products of these alternatives are not themselves tradable goods. Thus, the extent to which they are capable of substituting for fossil fuels (or, ultimately, agricultural energy resources) depends on the level and composition of energy demands in the countries with a comparative advantage in their production. We should expect a shift in comparative advantage in production of energy-intensive goods toward the countries with relatively abundant resources.

The variations in the characteristics of land areas are such that there is not a high correlation between land-abundance and availability of indirect-solar, gravitational, and geothermal energy resources. A clear example is Australia, a country with abundant land but with little potential energy resources of this sort. In general, prediction of comparative advantage in producing energy from these sources requires an inspection of the specific resource endowments of countries and assessment of the costs of exploiting the resources in each particular situation.

The characteristics of the second set of alternatives are such that their substitution for fossil fuels cannot be enhanced either by trade in the energy products themselves or to any significant

extent by the relocation of energy-using activities in countries with particularly favourable opportunities for exploiting these energy sources. Some production processes of medium-energy intensity could operate on the basis of direct-solar conversion (food processing, for example), and the availability of this energy form might influence location decisions for those activities where comparative disadvantage assessed independently of energy costs was not great. As a broad generalization, one might expect a higher level of processing of agricultural and forest products in the countries in which the raw materials are produced. In general, however, the main areas for substitution of these alternatives for other energy forms lie in diffuse domestic and commercial uses, that is, in essentially nontradable activities.

The availability of direct-solar energy depends on the intensity of solar radiation in the particular location and on the area of land on which it impinges relative to population and energy demands, whereas the availability of "traditional" biomass energy in general correlates closely with relative land abundance. For domestic and commercial uses, scarcity of land only really constrains the possibilities of substituting solar energy for fossil fuels in very densely populated areas. The potential availability of diffuse, low-concentration energy in some countries significantly exceeds energy demands in activities capable of employing these energy forms, whereas the reverse is likely to apply in other countries. Such mismatching of supply and demand reduces the possibilities of using these energy forms to increase the relative availability of tradable energy products or of energy products suited to use in production of energy-intensive tradable goods.

Capital and Technology

So far, we have focused principally on the nature of the nonexhaustible substitutes for fossil fuels and their resource-input requirements and paid little attention to the supply of technology and capital required for the exploitation of these resources.

In the exploitation of fossil fuels, capital and technological expertise are highly mobile internationally through the operations of large international companies, which also play an important part in establishing and maintaining trade links and matching supplies and demands (Smith 1978; Smith and Drysdale 1980; Anderson and Smith 1981). Thus, comparative advantage in the production of energy from these naturally occurring resources is almost wholly determined by their physical availability.

The development of agricultural-based substitutes for fossil-fuel energy, and the establishment of significant international trade in the resulting energy products, would increase capital demands in the producing countries and would require a significant degree of coordination between the structures of energy demands of importing countries and supplies of exporting countries. International companies can be envisaged as ultimately engaging in processing facilities in land-abundant countries and undertaking the required marketing and trading operations in much the same way as with fossil fuels. However, this route is uncertain, especially in the early stages of the development of agricultural-energy substitutes, when a high degree of coordination (in technology development, production and consumption investments, and infrastructure facilities) may be needed. The organization of agricultural production to provide secure supplies of raw materials for processing facilities will almost certainly require government involvement in producing countries. Policies that facilitate the international movement of capital and expertise, that provide security and access to resources and markets, that set terms for exploiting the resources are all keys to successful development of energy sources.

Indirect-solar, gravitational, and geothermal energy resources all require extremely capital-intensive technologies for their development. To advanced, capital-abundant countries, development would generally be undertaken by public utilities selling power to a wide range of consumers on a grid system. Additions to capacity to meet demands from particular processing facilities can, in general, be relatively easily accommodated at some degree of arm's length — as, for example, with the current generation of coal-fired power stations to service the demands of a growing aluminum industry in Australia. This is not to say, however, that there are no policy problems associated with developments (Department of the Treasury 1981; Clarke et al. 1981).

In capital-scarce, developing economies, however, significant exploitation of these kinds of resources will be much more closely tied to the requirements of specific energy-intensive activities dependent on export markets. The role of foreign investment is likely to be crucial not only in development of the energy-using activities and securing of markets for their products but also in the provision of capital and technological expertise for the development of the energy resource itself.

Direct conversion of solar radiation is also highly capital intensive, and exploitation of this

energy form in capital-scarce countries may thus be limited. Given the diffuse, small-scale uses to which direct-solar energy may be put, and the limitations on its use in the production of tradable goods, private foreign capital is unlikely to contribute to its development. In many areas, however, investments in direct-solar conversion equipment are capable of yielding high rates of return so that such investments may represent desirable ways of employing scarce capital resources. This is especially the case where, because of domestic-resource endowments and problems in the establishment of coal-fired power development based on imports, the alternative form of energy is oil or oil-derived. The major barriers may lie in provision of adequate information and in the channeling of funds to the diffuse individual investors whose decisions are critical. Although these problems may be avoided by smoothly functioning markets for capital and for solar-conversion equipment in advanced, capital-abundant countries, in developing countries government-sponsored programs may be required to improve information and capital flows. Given that comparative advantage in the development and manufacture of solar-conversion equipment lies with more capital-abundant countries and that a significant trade in such equipment can be expected to develop, the information and capital barriers of developing countries may sensibly be reduced by appropriate channeling of the technical assistance and capital available in aid programs.

Resource Rents

Both in the development of agricultural energy resources and in the exploitation of the various site-specific, concentrated energy resources, rents will be earned as a result of the fixed supply of the natural resources involved and their differential quality. It will be rare to find these energy resources being "sold" to foreign consumers (or foreign-owned consumers) at arm's length on competitive markets. This is particularly the case for the site-specific alternatives but is likely to apply also to agricultural resources because of the market structures. As with exhaustible resources, there will be important policy issues relating to the appropriation of those resource rents by the resource owners and to the sorts of controls on foreign ownership and control that are desirable.

Appropriate taxation arrangements for the collection of mineral rents have received considerable attention (Garnaut and Clunies Ross 1975; Smith 1979; Garnaut 1981; Lloyd and Emerson 1981), and the same principles apply

here. However, the high degree of vertical integration that is likely in the transfer of the tradable products creates particular difficulties for ensuring that resource rents are revealed as taxable profits. For agricultural energy resources, this may be a transitory problem. Ultimately, a large international trade in relatively homogeneous agricultural-based energy products could develop, from which taxation authorities would be reasonably able to judge appropriate transfer prices.

In the early stages of development of nonexhaustible substitutes for fossil fuels, rents earned by the natural resources employed will be small because, by definition, developments undertaken will be only marginally worthwhile. However, as fossil fuels move closer to exhaustion and as energy prices rise, rents on nonexhaustible-energy substitutes will increase. To reduce the uncertainties facing potential investors, governments should determine the mechanisms for appropriating rents in advance.

Concluding Remarks

In the immediate future, development of coal resources and a growing international trade in coal provide the most important area of substitution occurring in the energy area. Coal, or secondary fuels derived from coal, can be substituted for oil in any use but are most readily substituted in the provision of concentrated heat or electric power. Initially, at any rate, coal will principally be used in large-scale electricity generation and in the provision of process heat, thus conserving oil and gas for use as transport fuel and raw materials. This use will reduce the incentive for early development of all nonexhaustible substitutes. However, in future, and at present in areas where the scale of demand and its diffuse nature create problems for the establishment of coal-fired electricity based on imports, one would expect a relatively strong substitution of direct-solar alternatives in domestic and commercial use. The principal area in which one would not expect rapid substitution of nonexhaustible substitutes is in the agricultural production of liquid fuels and petrochemical feedstocks, because of the high opportunity costs of doing this on a significant scale, reflecting the displacement of production of foodstuffs.

On the one hand, one could suppose that, past a relatively moderate price of coal, concentrated power will be available competitively at any location in any quantity through some alternative technology (nuclear fusion), in which case coal would be reserved from that point on principally

to meet liquid-fuel and raw-materials demands. Under this assumption, energy demands in densely populated, resource-poor economies might be expected to switch almost entirely to electric power (with electrified transport systems) and the demand for liquid fuels would be largely concentrated in land-abundant countries with diffuse transport systems. Liquid-fuel and raw-material requirements would be met from coal and from agricultural resources, with the latter becoming increasingly important as coal is exhausted, but the aggregate effect on land use and competition with food-producing activities might never be great.

On the other hand, the possible substitutes in provision of concentrated power may be limited, with sharply increasing costs, and they may occur in areas that are not densely populated. Then coal would continue to be focused mainly on this use until it was exhausted, with increasingly large demands being placed on agricultural resources to meet liquid-fuel and raw-materials requirements and, ultimately, with the bulk of the energy requirements of densely populated regions depending on tradable agricultural energy products.

These extreme scenarios quite clearly would have dramatically different effects on the terms of trade of countries and on the patterns of comparative advantage in energy production and in the production of energy-intensive goods. Put simply, Japan, South Korea, Hong Kong, Singapore, and Taiwan (among others) would clearly prefer the first scenario, whereas Australia and Canada in particular would benefit substantially from the second.

Importantly, either of these extreme scenarios

could be an accurate prediction of the ultimate outcome, given the high degree of uncertainty surrounding technologies and resources available to provide substitutes for fossil fuels, particularly in concentrated-energy forms, and, indeed, about the future availability of fossil fuels themselves. Albeit a relatively distant prospect, the possible adjustments required in densely populated, resource-poor economies, in particular, provide a community interest in reducing uncertainty that will not necessarily be reflected in private levels of investment in the assessment of available resources and the development of appropriate technologies for exploiting those resources. The "public-good" aspects of such assessments and research efforts extend beyond national boundaries, both in terms of the reduction in risk for individual countries associated with a perceived level of economic cooperation in the development of strategies for providing energy security and in terms of the efficiency with which resources are allocated to minimize the opportunity costs of this.

We noted that capital-intensive technologies are required for most nonexhaustible-energy production and suggested policy intervention by governments. The uncertainties surrounding possible directions of development and the novel aspects of such development are a strong impetus to government involvement and economic cooperation. The first of these is probably inevitable, whether it is necessary or not, and, without the second, may involve substantial duplication and waste of research and capital resources in the pursuit of energy substitutions that appear desirable in particular countries for reasons of diversification and energy security.

Discussion

Miguel S. Wionczek: I found the Smith and Saddler paper intellectually attractive on a number of counts:

- Its analysis of factors that may determine the nature of resource substitution for fossil fuels and the possible implications of substitution for trade and investment;
- Its attempt to pose the questions that one must answer to make predictive judgments;
- Its treatment of indirect-product substitution of exhaustible by nonexhaustible resources (the return to the use of natural fibres — wool

and cotton, for example — instead of space heating and the use of timber as a substitute for other structural, relatively energy-intensive materials); and

- Its useful and clear distinction between concentrated and diffuse energy resources, between tradable and nontradable resources, and between those that are highly substitutable in different uses and those that are not.

I have, however, serious difficulties in accepting the paper's basic assumptions that lead the authors to the belief that the substitution of non-

exhaustible resources for fossil-fuel energy and industrial raw-material resources not only is inevitable but will be forthcoming relatively soon. I particularly distrust the assumptions that the exhaustible fossil-fuel resources are not only finite but also limited and that their depletion is fast because of the size of the resources compared with that of demand. It seems to me that this pessimistic vision of the future of fossil-fuel resources has been accepted by many people rather uncritically from the economic literature produced in the industrial countries in the 1970s and conditioned by the so-called energy crisis of 1973-74. The validity of the projections of that literature is being questioned all over the world. I maintain on the basis of my exposure to world-energy problems through the research programs undertaken from Mexico that this vision of the worldwide fossil-fuel shortages is largely mistaken. Although the fossil-fuel resources are finite, they are much larger than perceived in some circles in the Western industrial countries. The belief that the world will run out of commercially exploitable fossil-fuel resources by about 2000 is based partly on incomplete information and partly on the static view of the availability of such resources and the incorrect assumption about the future growth of world demand for energy. In fact, demand has been declining for some time from the unusually high levels registered in 1950-70 when GNPs grew rapidly and oil was cheap.

The world has already advanced substantially from the stage of total dependence on conventional fossil fuel. However, before nonexhaustible resources are substituted for fossil fuels as sources for energy and industrial raw materials, the present stage of use of nonconventional fossil fuels will have to run its full course. Heavy crude oil, shale oil, and tar sands, as well as coal and natural gas, are still abundant and have been

replacing conventional crude oil for some time.

Concentrating on the substitution of nonexhaustible resources for fossil-fuel energy, the authors occupy themselves with the technological and institutional aspects of the present stage of substitution — one fossil fuel for another. However, the present stage has involved considerable capital investment in new technologies for commercial exploitation of nonconventional fossil fuels or difficult-to-exploit conventional fuels. In the face of the manifold increases in the prices of crude oils, such exploitation has become not only possible but highly profitable. Most of the new technologies are the property of transnational energy corporations that can hardly be expected to abandon their newly created profit possibilities to search for new resources along the lines suggested by Smith and Saddler. And, because, according to the authors themselves, the substitution of nonexhaustible resources for fossil-fuel energy is capital and technology intensive even in the market economies, only very large productive units, usually transnational corporations, could afford to engage in this new stage of substitution.

Finally, Smith and Saddler leave largely untouched the question whether and to what extent the substitution of nonexhaustible resources for fossil-fuel energy, envisaged by them, would be of help to energy-poor developing countries beyond some improvement in their international trade position through the return to the use of some raw materials like natural fibres and timber. One suspects that the position of developing countries would not be improved much by the new substitution stage. The developing countries need less-intensive, fossil-fuel substitution, small hydroelectric installations, and small solar technologies. Their energy planners will find little help in the Smith and Saddler paper.

Prospects for Renewable Energy Resources in South Korea

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The total energy supply and demand plan, which has been formulated by the South Korean government, is summarized, and potential sources and domestic quantities for each energy source are presented. The potential technology applications, implementation considerations, and research program are explained, as are the current status of renewable energy commercialization in Korea, the government's future plan, and current problems.

Le présent exposé résume le plan global de demande d'énergie établi par le gouvernement de la Corée du Sud et il en indique les sources et les quantités possibles pour chaque catégorie. Le document comprend le programme de recherche, les applications techniques éventuelles ainsi que diverses considérations relatives à la mise en oeuvre, de même que l'état actuel de la commercialisation de l'énergie renouvelable, à l'échelle nationale, les difficultés rencontrées et le plan élaboré par le gouvernement à cet égard.

Korea has few energy resources. Consequently, imported energy, especially oil, plays an important role in meeting energy requirements. The demand for energy is expected to increase in accordance with the continuation of industrialization and social development. The government places great emphasis on enhancing energy supplies; developing new and renewable sources is one of its major strategies.

The annual growth of energy use in the next 5 years is expected to be about 7.7% (Table 1). During the same period, the economy is expected to grow annually at 8%. In 1980, total consumption of energy amounted to 38 Mt of oil equivalent

(toe). Petroleum accounted for 62%, anthracite 26%, and fuelwood (a noncommercial source) 7%. Nuclear, hydro, gas (liquefied petroleum gas), and bituminous coal made up the rest.

By 1985, the energy consumption will increase to 59 million toe. With this increase, the configuration of supply sources will change significantly. Petroleum dependency is expected to decline markedly to 48% with rising substitution of alternative sources such as nuclear power, coal, and gas. The expansion of nuclear energy and bituminous coal will be particularly noticeable, each rising to 10–11% of total energy consumption.

Table 1. South Korea's energy consumption plan, 1980–85 (1000 toe).

Energy resources	1980 (actual)	1981	1982	1983	1984	1985	1986	1981–86 average growth rate (%)
Petroleum	23566	25396	26916	28464	28027	27676	28667	2.5
Gas	458	569	622	700	788	1833	2904	38.5
Anthracite	9878	10198	10618	11235	11486	11740	12116	3.5
Bituminous	199	880	1467	2245	4474	6106	6154	47.5
Hydro	496	537	535	537	536	690	726	6.2
Nuclear	869	774	913	1484	3153	4561	6561	53.3
Fuelwood	2517	2517	2343	2260	2180	2110	2070	3.8
Solar	–	–	–	–	1	3	5	–

Energy imports will play an increasingly important role in the next 5 years. In 1980, imports accounted for 69% of total energy consumption, with petroleum imports being the largest. By 1986, import dependency is expected to increase to 79%. Petroleum will still be the largest energy import, but its relative position among energy imports will decline. The imports of bituminous coal and anthracite will almost double, and imports of liquefied natural gas (LNG) will begin in 1985.

The prospective sources for new and renewable energy in South Korea are the sun, wind, biomass, tides, and inland waters. Research and development of all these sources are under way. Several hundred solar houses are under construction, and the interest in photovoltaic research is also high. The government is collecting data on wind power, with the intention of using it to supply electricity to remote islands and villages where high transmission costs make other energy supplies infeasible. Biomass studies in the country are primarily of forest products and crop-residue conversion. These resources have some potential in South Korea, but their contribution to the total energy requirements of the country is small. The major increases in the utilization of biomass resources will come from improved efficiency in end use.

South Korea's small hydro resources are economically recoverable, and, currently, three small plants are operating. In addition, the government has started a feasibility study on the construction of a 400 000-kW capacity tidal power plant at Garorim Bay, and its construction is expected to be finished by 1988.

The country has invested only relatively small amounts in the development and utilization of new and renewable energy because of uncertain economic feasibility, engineering constraints, lack of capital for infrastructure, and unfamiliarity with alternative energy sources. Technical personnel and testing facilities for such work are scarce in this country. For example, mass construction of solar houses could only be undertaken if engineering design capability were improved substantially.

The potential for implementing new energy systems depends on how economic they are compared with other sources, whether they are marketable, and whether there are institutional or cultural constraints on their acceptance. Even if designs were possible, the infrastructure necessary to distribute them to the public and to ensure maintenance is at present not available.

To expedite the development of new and

renewable energy sources worldwide, we suggest:

- Increased international cooperation and coordination in research, development, and demonstration in new and renewable energy (e.g., joint-venture and licencing arrangements between developed and developing countries);
- Strengthened information exchange systems in new and renewable energy (e.g., establishment of a data bank on sources of energy);
- A commitment to increased financial and technical assistance from rich countries; and
- An international commitment to expanded education and training in new and renewable energy.

Solar Energy

The direct solar resource base in South Korea is small in terms of both total and direct-beam insolation. During the course of a year, average daily insolation ranges from 180 cal/cm² (7.5 MJ/m²) to 318 cal/cm² (13.3 MJ/m²). These averages represent 25–45% of annual extraterrestrial radiation, indicating relatively few clear days and low direct-beam insolation. The high end of the range is comparable to insolation in New England and the north-central United States.

Because of the rugged terrain and complex weather patterns affecting the peninsula, there is also substantial variation in available insolation within regions. For example, Jeongeub and Buan, two cities near the western coast, fewer than 30 km apart, receive daily average insolation of 180 cal/cm² and 244 cal/cm², respectively — a difference of more than 30%.

Potential applications for solar energy in South Korea include water and space heating. Electricity-generating systems are also possible with photovoltaic and high-temperature thermal processes, the latter of which is less feasible at present levels of technology.

Photovoltaic systems, which directly convert insolation to electricity via semiconductor material, can be either flat-plate arrays or concentrating systems. The grid-connected, south-facing, flat-plate, nontracking array appears to be the most cost-effective configuration. Flat-plate arrays are particularly suited to the cloudy Korean climate, where most of the available solar radiation is diffuse insolation. The collectors maximize annual insolation if tilted from the horizontal at the latitude angle, which ranges from 33°31" at Cheju to 37°34" at Seoul.

The output is estimated to be about 8% of the total energy incident on the collector surface and is based on a photovoltaic-cell efficiency of 12%;

the estimate takes into account the effects of cell packing, angular sensitivity, and power-conditioning losses. The performance of the photovoltaic system was estimated for four sites in South Korea: Kyungju, Seoul, Kwangju, and Cheju Island. Estimated annual outputs range from 76 kWh/m² in Kyungju to 102 kWh/m² on Cheju Island.

In high-temperature thermal processes, concentrating collectors are used to produce high temperatures that operate a heat engine to generate electricity. The most cost-effective technologies for solar energy are the point-focusing distributed receiver (PFDR) and the power tower. The PFDR uses a field of hundreds of thousands of parabolic-dish concentrators, with a high-efficiency stirling cycle engine at each focal point. The power tower consists of a single receiver that is mounted on a tower surrounded by a large field of sun-tracking heliostats. Both systems are at present not technically or economically feasible in South Korea.

The economics of solar-energy systems cannot be projected with complete certainty but do not appear attractive for the most part; consequently, the potential market is expected to be limited. Despite government efforts to encourage solar energy, institutional constraints limit its potential.

The Ministry of Energy and Resources (MER) has announced plans to encourage the use of solar energy in new housing. MER projects annual construction of solar homes (estimated at 45 homes in 1979) to be 2400 in 1980, 4500 in 1981, and 250 000 by 1990. To encourage solar construction, MER has set up a special housing fund to provide loans of up to 9.5 million won per solar house, has introduced tax exemptions for solar home builders, and has waived the requirement to purchase housing bonds (amount to 2-7% of the price) for solar homes. These incentives decrease the initial costs of solar homes by 10-30%.

The government program for research on solar energy is under way in the Korea Institute of Energy and Resources (KIER). For 1980, it includes photovoltaic technology (67.0 million won), solar-thermal heating and cooling (62.0 million won), standard development (35.0 million won), industrial applications (14.5 million won), and house construction and information programs (223.0 million won). KIER has constructed three demonstration houses using active and passive solar-energy systems. It is also developing photovoltaic systems for use in remote areas, such as lighthouses, buoys, and pumping stations.

The Korea Institute of Science and Technology (KIST) is also involved in solar-thermal, electric-power systems development. It is installing a combined wind and solar-thermal electric system, using a parabolic-dish system (manufactured by Omnium-G), on an island off the west coast.

In addition to government-supported research, housing developers and other private entities have shown much interest in solar systems. The Korean Housing Corporation is particularly active and is now sponsoring a design competition to select three to five prototype solar homes, on which construction will start in August. In addition, several companies are manufacturing solar panels and complete solar-energy systems both for the domestic market and for export.

Wind

The characteristics of the country's wind resource (estimated at 3.4×10^{10} kWh) make it particularly attractive for electricity generation (19 900 MW capacity) either on a large scale, for interconnection to the mainland grid, or on a small scale, for local use on the islands to the west and south. In the late 1990s, wind-generated electricity will provide 2.5% of the total electrical needs, if sufficient land can be made available for large wind farms.

Wind velocity and direction are recorded hourly by the Central Meteorological Office at 86 stations throughout South Korea and are summarized monthly and yearly. Most of these stations are located on small hills in or near large towns and cities. Wind velocities are not available for the offshore islands or for peaks and ridge tops on the mainland, which are presumably potential sites for wind-generation systems. Average wind velocities are low to moderate (0.9-4.5 m/sec); the greatest average velocities are found along the southwestern and southern coasts.

Wind energy traditionally has been used on a small scale in South Korea to provide mechanical power for such uses as grinding and water pumping. Until 1975, wind power was not used for electricity generation, but, as a result of some recent developments by the Ministry of Science and Technology (MOST), the government is now considering wind machines for electricity generation on the islands, where wind is already competitive with alternative power systems such as diesel engines. In some regions (e.g., on the southwestern coast), average annual wind speeds are suffi-

cient to generate large quantities of electricity with large-scale wind machines.

Because most of the mainland is already connected to the main electric grid, the major market for wind systems smaller than 50 kW will be the offshore islands, which are too sparsely populated or too far from the mainland to make grid connection cost-effective. The government is currently preparing a census of the offshore islands to estimate the potential of small wind systems for providing electricity and mechanical power. The preliminary results of this census indicate that the optimal size for a small system is 10 kW.

A successful small-scale wind system must meet several technical and economic criteria. From a technical standpoint, these machines must be carefully designed to resist the frequent typhoons that destroyed previous wind-energy systems. Imported machines cannot be used because they are not adapted to Korean wind conditions. From an economic viewpoint, small wind machines on the island must be competitive with diesel for electricity generation.

For both small- and large-scale wind-energy systems, economics are the primary concern. The economics of the two types of systems are basically different. Unlike small-scale systems, large-scale wind-energy systems must be competitive with pumped hydro or thermal plants. On a cost-per-kilowatt-hour basis, wind systems would be competitive for average sites in South Korea only if large economies of scale could be achieved.

Small wind machines must compete with small diesel engines, which have high generation costs. Although generation costs for small wind-powered systems are generally highly competitive with diesel, the storage capacity that is needed for 2-3 consecutive days without wind, which occur fairly often, greatly increases costs and makes the economics of small wind systems less favourable.

The market for 10-kW wind machines is expected to be 1000 units in 1990. However, the machines, which are considered optimal for average electricity demand on the islands, cannot be standardized because of the variations in wind characteristics. For example, a 10-kW machine installed at Choongmu, where the average wind speed at 10 m is 2.73 m/sec and the maximum available power is 278 kWh/m² annually, should have a diameter of 12.6 m, whereas a 7.61-m diameter machine located at Mockpo, where the average wind speed is 4.37 m/sec and the maximum available power is 784 kWh/m² annually, would suffice. This simple comparison shows how difficult it would be to lower manufacturing costs by economies of scale.

In addition to economics and market potential, the potential for wind-energy systems will be affected by government policies, resource requirements, and environmental impacts. A major objective of the government is to provide electrical supplies to the islands. Alternative energy resources, especially wind, may play a major role in achieving that objective, because they will be economic in the near future. At present, however, there are no financial incentives to develop wind systems. Korea Electric Company (KECO), the state monopoly, has not pursued wind-energy systems because they are not competitive on a marginal-cost basis with alternative sources of electricity.

A small-scale wind machine industry would not be constrained by a shortage of materials, because the market for small-scale systems appears limited. Training personnel to design and operate the machines and to select the sites can be easily accomplished.

Wind power does not present major environmental problems; however, there is an aesthetic impact associated with installing large wind farms. Each large wind machine requires 0.3 ha plus land for access roads and transmission lines. Such extensive land use may not be possible, especially in the plains areas because of competing land uses, such as agriculture or housing. Finally, some preliminary studies suggest that large wind-powered generating machines have physiologic effects on nearby populations, because of their low-acoustic frequencies. However, such impacts have not yet been fully evaluated.

There is currently no research program on large wind machines in South Korea, but KECO has expressed interest in coupling wind-energy systems with pumped-storage hydro projects. The Korean Advanced Institute for Science (KAIS) and KIST are currently performing a limited research program on small-scale wind machines from 2 to 10 kW, for electricity generation, water pumping, and lighthouse operations.

Biomass

The country's biomass resources include human and animal residues; agricultural crop residues; and forest fuels and residues. Solid and liquid urban wastes do not appear to constitute a significant resource at present. The annual net energy recovered from these biomass resources is estimated to be 6.8 PJ; as much as 41.6 PJ were potentially available in 1978. By 1986, the potential is estimated to range from 50.7 PJ/year to 89.6 PJ/year, and by 2000, 42.6-115.0 PJ/year.

This estimated increase in the resource base would result if the expected switch from traditional fuels (wood, agricultural residues) to more convenient fossil fuels takes place and if expected increases in forest outputs are realized. However, available technology for the use of traditional fuels could provide convenience similar to that with fossil-fueled technologies and would have the advantage of using local resources.

Biogas from animal residues could replace about 32% (on a net-energy basis) of the coal used in the rural residential sector. By 1986, crop wastes burned in district heating systems and biogas from animal residues could replace about 67% of the coal, kerosine, and gas projected to be needed by the rural residential and commercial users.

A large percentage of the fossil fuels could be replaced if some of the residues not currently burned could be recovered without environmental damage or detriment to farming activities. The same resource base could replace more than 50% of the fossil-fuel requirements for the rural residential and commercial sectors by the year 2000. Wood-fired boilers or gasifiers could replace 3.6% and 5.7% of the energy supplied by oil to industrial users, by 1986 and 2000, respectively.

Direct combustion of biogas could supply heat for cooking or space heating. The useful energy potentially available from direct burning, at a heating value of 5500 kcal/m³ and a conversion efficiency of 60%, is 6.8 PJ/year. The energy required by a family of five for daily cooking has been estimated at about 3600 kcal. Therefore, the net energy recoverable from biogas combustion could supply the yearly cooking needs of 1.24 million households, or about 56% of rural households. Alternatively, biogas could supply the cooking and heating needs of about 150 000 households during the winter months.

Biogas could also be used to generate electricity. Experiments conducted in other countries indicate an efficiency of about 20%. In this case, the cooling water can supply the heat required to maintain the digester temperature and some process heat (hot water). It is assumed that 60% of the heat that would have been rejected can be recovered as process heat.

Grain straws can be used to produce energy through direct combustion, gasification to low-Btu gas, anaerobic digestion, or ethanol production. Of these processes, ethanol production, which involves preprocessing of the feedstock (i.e., chemical or enzymatic hydrolysis) to release the fermentable sugars, has not yet been com-

mercialized. Gasification to low-Btu gas was extensively demonstrated during World War II for automotive transportation and is now being revived. The efficiency of anaerobic digestion of crop residues may be limited, because of the liquor content of the feedstock and its sometimes unfavourable ratio of carbon to nitrogen. This problem can be corrected in part through the addition of animal urine. Chopping the residues before they are introduced into the digester is recommended to increase digestibility. Chemical pretreatment can also improve digestibility but is probably justified only for large-scale operations.

Wood fuel can be used in direct combustion systems, converted to low-Btu gas through gasification, or converted to methanol fuel.

With the present technology in South Korea, residential direct combustion results in a net utilization of about 30% of the energy content of the fuel. With state-of-the-art technology, the efficiency of residential stoves could probably be increased to about 50%. Small industrial boilers that are wood fired could be used for process heat for small industries: they have overall efficiencies of about 70% — comparable with that of oil- or gas-fired boilers. Thus, forest products can be burned more efficiently by industrial boilers that have been converted from oil or gas fuel than by the stoves in most homes.

Gasification of wood to low-Btu gas for local use has been demonstrated. The current operations of pilot processes in the United States suggest that about 70% of the energy content of the wood can be recovered if the gasifier is closely coupled to the end user.

Methanol fuel produced from wood can be used directly in vehicles or converted to synthetic gasoline by the Mobil process, although there are currently no operations of this type. Analysis of the economics of this process indicates that plants with capacities to convert about 900 Mt of oven-dried wood daily would be required to achieve economies of scale. At present, annual productivity levels (i.e., 0.6 m³/ha), about 1 Mha of forest would have to be earmarked to sustain one such methanol plant, and such plants are not feasible for South Korea.

Biogas production technology is well established, the potential of the technology being based on adequate operation of the digesters. To achieve the full benefit, the government would have to introduce training programs for village leaders and employ the services of trained extension agents. Government incentives could also be offered to induce villagers to set up village-scale biogas digesters. The ongoing rural development

program could be a vehicle for such incentives.

Treatment of residues by anaerobic digestion reduces pathogen content while maintaining nutrient value. Collection of the residues within a village for delivery at the biogas facility may create a risk of disease, although it would probably be no more serious than that incurred by the spreading of raw manure on fields.

Biogas can be stored and distributed; it offers the same convenience as oil or natural gas and is more convenient than coal for household users. Therefore, the anaerobic digester should be readily accepted if its introduction is preceded by adequate information.

Crop residues could make a significant contribution to meeting energy demand in rural areas. Biogas derived from them is expected to compete well with energy from other sources and may have significant market potential. Institutional and environmental constraints should not present serious problems.

Both energy from combustion of residues and biogas produced from residues are best utilized in the rural residential and commercial sectors, because the feedstock resources are close to the users and because the technologies can be integrated into the agricultural environment (e.g., through the recycling of ashes and sludge to the land).

The implementation of heating systems may require the formation of cooperative utilities or the extension of the charters of existing utilities to provide this service. As with utilization of animal wastes, use of crop residues would require an infrastructure of trained personnel to maintain and operate the technologies. Also, incentives may be required to induce businesses to manufacture the appropriate technology and equipment.

The major environmental risk of using crop residues for fuel is the soil deterioration and loss of nutrients resulting from the removal of the residues. The risk may be decreased somewhat by the recycling of digested sludge to the land.

The best candidates for using the wood-to-energy technologies are industries in rural or semirural areas. Wood fuel could supply 3.6% and 5.7% of the net energy obtained from oil in 1986 and 2000, respectively. Oil displacement could be increased if the fuelwood resource base were expanded.

Except in the forest products industries, wood is not a common industrial fuel. Technology-transfer programs to promote use of fuelwood could be initiated. The best vehicle for such a program is likely the Office of Forestry. Tax

incentives for promoting the use of renewable fuels may also increase adoption of the technology. Also, wood utilization is labour intensive, and a fuelwood program would create stable jobs in rural areas.

The major environmental concern is adequate management of the forests to sustain productivity and to avoid the environmental damage that results from deforestation. This concern is particularly acute in mountainous areas where the danger of erosion and runoff is great.

Geothermal Energy

The geothermal-energy resource in South Korea does not appear to be sufficient to make a significant contribution to the country's energy requirements. It is limited to low-temperature springs and wells. The Korean Institute for Geology and Minerals has identified 20 sites on the mainland with outflow temperatures greater than 20°C. The maximum temperature observed was 73°C, and only five sites have temperatures greater than 50°C. Moreover, all these resources flow more slowly than 8000 m³/day and exhibit moderate to severe drops in their water tables even at modest pumping rates.

Most of the hot springs identified are in southeastern Korea, although a survey indicated geothermal resources on the island of Cheju. The four volcanic eruptions on Cheju in the last 1000 years (in 1002, 1007, 1455, and 1670) suggest large volumes of hot rock and molten magma at shallow depths, good sources of geothermal energy. Similarly, the volcanic island of Ulreungdo may have potential.

High-temperature geothermal resources can be used for electric-power generation. South Korea does not appear to have exploitable resources of sufficient temperatures (200°C or greater) for these systems, although some may be discovered on Cheju. Lower-temperature resources can be used for space heating by "district-heating" systems, in which the hot water would be pumped to nearby residential and commercial buildings, and used for space and hot-water heating. However, district-heating applications are difficult at the low temperatures of most of the springs in South Korea because of the large volumes of water and the large, well-insulated, expensive piping required. In addition, geothermal use will accelerate the water-table drop at these sites.

Ocean Energy

The oceans can provide tidal power, thermal power, and wave power. The use of tidal power

for electricity generation at six sites along South Korea's northwest coast appears promising. These sites have a combined annual output of 12 000 GWh. Although a number of implementation issues remain unresolved, one of the six sites has already been selected for detailed study by KECO, with the aim of building a tidal power plant in the near future. Ocean thermal systems operating in the warm waters of the mid-Pacific about 2200 km south of Korea may also be economically used for ammonia generation, although electric-power production does not appear economically feasible. Wave-power systems may be economically feasible near Hupo, but the cost performance of these systems is uncertain.

KECO identified 10 sites for tidal power with a total potential of 7050 MW and potential annual energy production of 18 675 GWh. However, development of some sites would interfere with development of others. In addition, several other factors affect the utilization of the proposed sites. As a result, only 7 of the 10 sites can be used for tidal-power developments. The maximum potential of these is 5000 MW, and their maximum energy output annually is 12 000 GWh.

Ocean thermal systems are potentially usable only off the east coast in the Sea of Japan, where temperature differentials (ΔT) between the warm surface waters and cold depths can be as much as 25°C during the summer months. Normally, a plant cannot be designed to operate efficiently for a range for ΔT greater than 10°C; if the plant is designed for a maximum ΔT of 25°C, it will not operate if ΔT is less than 15°C. Such a plant would operate in South Korean waters only from June through November.

According to these assumptions, such a plant would have an annual output of 772.3 GWh. Each plant would require an area of about 2000 km² to operate in a renewable mode, i.e., without affecting the water temperatures significantly or interfering with adjacent ocean thermal plants. The sea within 200 km of the South Korean shore has an area of about 100 000 km². This area would support 50 plants for an annual output of 38.6 TWh, which is 1.7 times the country's 1977 electricity consumption.

Wave power may also become feasible along the eastern coast. A study estimated the total wave energy around the coastline and major islands to have a maximum potential of 8620 MW. The power availability has a marked seasonal variation, most of the power being available in the winter months and relatively little in June or July.

For a typical wave-power system having a conversion efficiency of 50% and a capacity factor of 50%, the estimated maximum extractable wave-power potential is 4300 MW capacity, with an 18 800 GWh energy output.

Tidal-power plants, formed by the damming of large bays or sections of the ocean, can be operated in several modes. The simplest tidal-power plant uses fixed-blade turbines to generate energy from the flow of water from the basin to the ocean. In certain cases, it may be possible to use variable-blade turbines, which pump water into the basin against a low head at high tide, using power generated elsewhere in the electrical grid. Such pumping increases the reservoir water level above the normal high-tide level; the extra water is then released at low tide, against a much higher head.

Tidal plants can also be designed to generate power from both ebb and flood tides, using bidirectional turbines with adjustable blades. This design would increase the time the unit is available to the grid. In studying the inner Asan Bay project, we found that this method increased the operation time of the generators from 43% to 68%. However, the annual power output increased only 1%, from 1466 GWh to 1480 GWh, because variable-pitch turbines are less efficient than fixed-blade turbines, the average head being lower. In addition, because the method doubles the number of output pulses, it may mean increased maintenance both for the tidal-power plant and for cycling units in the utility grid. However, the method may be justified on the basis of the increased flexibility in integrating the tidal plants and the utility grid.

The tidal plants can utilize double-paned basins. One is operated as a high basin, generating power from the ebb tides; the water level inside this basin is usually higher than that outside it. The other basin is operated as a low basin, generating power from the flood tide; the water level inside this basin is lower than that outside. Through coordinated operation of the two basins, power can be generated at almost any hour in response to system requirements. However, the low basin generally provides lower energy than it would if operated as a high basin. Depending on the shape of the basin, the loss in energy may be as much as 20%.

Finally, tidal plants can utilize double-linked basins. In this scheme, two basins are connected with the ocean and share a common dike. One basin is operated as a high basin, the other as a low basin. The main advantage of this mode is that the basins can produce energy at any time.

The most appropriate mode for operating a tidal-power basin depends on the load on the system and the mix of modes used in generating electricity. In the short term, while a significant portion of the generating capacity is oil fired, tidal plants will probably be operated in the single-basin, single-effect mode to maximize their energy output and minimize capital costs. After 1995, nuclear and pumped hydro will be most important and oil- and coal-fired generating units will represent a smaller portion of the total generating mix; then, the operating modes that allow retiming of the energy will become more important and will need to be examined as part of a comprehensive study of plans for utility systems.

Two major ocean thermal energy conversion (OTEC) technologies can be used to generate electricity from the ocean temperature differences. One uses a thermodynamic "open cycle," in which the working fluid is sea water at 25–30°C pumped at the surface and then vapourized at low pressure. The vapour drives a large-diameter turbine. The cooler, deeper waters are brought to the platform by a long pipe and used to condense the turbine exhaust, producing fresh water as a by-product. This device is being studied by the French, who built such a plant off the Ivory Coast some 25 years ago. The other technology, a "closed cycle," uses an intermediate fluid, such as ammonia, to drive a much smaller and less costly expansion turbine. The latter technology has received the most intensive study.

The electricity generated at the plant can be either transmitted to the shore by expensive submarine cables or used in situ to produce a valuable, storable, and shippable product, e.g., ammonia, aluminum, or chemicals that require electricity for production. The in-situ approach would rely on "grazing" plant ships cruising warm waters at reasonable distances from South Korea (e.g., off the Philippine Islands), producing a storable fuel such as ammonia, which can be used domestically as a fertilizer or a fuel or exported to other countries.

None of the possibilities for ocean thermal power have been commercially demonstrated. Several countries, such as Japan, the United States, and France, are entering the pilot phase of OTEC development and expect to prove its economic feasibility in the next 10 years.

Likewise, technologies for using wave power have not yet been demonstrated on any large scale. Many concepts have been described, but almost no data are available on performances because no pilot plant has yet been built. The

dam-atoll consists of a large concrete dome with an open bottom. Waves are focused by the shape of the dome to the central point, where they form a vortex inside a tube that empties out the bottom of the dam-atoll. Inside this tube are vanes that are turned by the waves entering the top and used to drive a generator.

Development of all seven feasible sites for tidal power would require a capital investment of about U.S.\$11.5 billion. Domestic portions of the project construction costs are estimated to be 95%: 25% for electrical machinery (primarily the low-head turbines, blades, and controls) and 70% for the civil works (dam, roads, and other infrastructure) and other items.

Tidal-power plants would interfere with land reclamation projects. The high-basin systems, which are most economic, would flood lowlands in the basin area; in addition, any reclaimed areas would reduce the volume and thus the potential energy output of the basin. However, low-basin schemes may not entirely preclude land reclamation. Selecting the optimal trade off between tidal-power production and land reclamation requires a careful cost-benefit analysis for each site.

Cost estimates of OTEC plants both for power generation and for ammonia production exhibit tremendous variation. A U.S. government design for a 325-MW power-generation plant is estimated to cost U.S.\$2100/kW in 1993–95. In addition, a power-transmission cable must be constructed from the sites to the mainland, about 100 km. The cost of this cable would be U.S.\$1 million/km. Therefore, the total plant cost would be U.S.\$782 million. With an annual fixed-charge rate of 0.113 (6% capital cost, 30-year life, 4% annual maintenance costs), the energy cost would be 114 mills/kWh, or 55.4 won/kWh. This energy cost is not competitive with projected costs of oil-fired generating units.

Estimates of wave-system costs also exhibit tremendous variation, primarily because of the wide variety of proposed systems and the lack of actual operating experience. These estimates range from a low of U.S.\$2500/kW for the Lockheed dam-atoll system (for the period 1990–2000) to \$14000/kW for a proposed British system.

Although detailed data on the Lockheed system are not yet available because no pilot plant has been constructed, the estimated costs, if valid, indicate that only at one site, near Hupo, is wave energy economically competitive with oil-fired electricity generation in the near future. However, if wave-power systems were combined with breakwaters for harbour development,

other sites along the eastern coast would be practical.

A detailed feasibility study of a tidal-power plant for the Garorim Bay site is being carried out. This study will pave the way for construction of a tidal plant in Garorim Bay between 1982 and 1988. OTEC research and development are not currently funded by the government, although wave-power research is receiving assistance at 30 million won a year.

Small Hydropower

Development of small hydropower systems in Korea is technically feasible and economically attractive. The small hydro resource base of 596 MW represents 18% of the total hydro potential, with an annual output of 5.2 billion kWh. Of this potential, the use of 1.51 billion kWh is expected to be economically favourable in 1985, and 1.93 billion kWh in 2000. This potential is small relative to the total hydro development planned by KECO and will be constrained by KECO's purchasing practices and by local demand, which is not always near the small hydro sites.

More than 85% of South Korea's total area is at least 100 m above sea level. Although the average height of the mountains is relatively low (maximum of 2000 m), the terrain is rugged with many streams and rivers.

Rainfall ranges from 979 mm at Pohang Station to 1440 mm at Cheju Station. This rainfall, if harnessed in an optimal hydro system, could provide as much as 30.2 billion kWh/year at an average altitude of 100 m. Small hydro systems comprise facilities with a generating capacity between 2 and 15 MW. The total installed capacity of small hydro systems was 9.5 MW in 1978.

MOST recently conducted a nationwide study of the mountainous catchment area and identified 2600 potential sites for small hydropower development, representing a potential of 582 MW.

The hydro resource has two major characteristics. First, 43% of its potential is concentrated in one province — Kangwon — and more than 75% in three provinces. Second, the resource base is highly seasonal. More than 50% of the yearly total precipitation occurs during the rainy season, from June to October, creating a high hydro potential. The winters are dry and would not fuel production to meet the high demand for electric power in the colder months.

The discrepancy between hydro supply and power demand makes small hydroelectric projects unattractive for electricity generation unless they are developed — as multipurpose applica-

tions — in conjunction with other projects in water-flow management and control, irrigation, or land reclamation. However, small hydro applications are not basically oriented toward mass electrical generation anyway. Essentially, small hydro applications consist of limited electricity generation for local needs in remote areas, isolated from the grid, and multipurpose applications (e.g., electricity production and water management). Many technical features are similar for the two types of application, and, as a general rule, if a small hydro project proves economic for electricity generation alone, it will be economic for multipurpose applications.

A small hydroelectric plant consists primarily of electromechanical-equipment installation and civil engineering (i.e., construction of dams, spillways, etc.). The civil engineering is highly dependent on the physical qualities of the site, but the turbine, which accounts for the major part of the electromechanical equipment, is selected on the basis of hydraulic considerations.

The net head available (the head less losses from water flow to and from the turbine) dictates what type of turbine is suitable for use at a particular site. The rate of flow determines the capacity of the turbine. Several types of turbines are designed for operating under the conditions common in Korea (i.e., heads from 10 to 40 m, and flow rates up to 100 m³/sec). Two types of turbines are particularly adapted to South Korea — the Francis and the Tubular turbines.

In addition, limited flow variation and proper site preparation are essential for maximizing hydro output. The only way to limit seasonal and daily flow variation is to develop storage capacity, the optimal size of which will depend on such factors as the flow duration curve, the type of reservoir and dam, the evaporation, and the soil permeability. The optimal amount of storage capacity must be determined. Site preparation is aimed at maximizing the available hydraulic head at the site. Water heads of 9–11 m can often be obtained from 3000 m river loops, where the river slope is 3–4 m/1000 m.

The extent to which small-scale hydro plants will be implemented depends primarily on their economics but is also affected by local utility regulations and utility purchasing practices.

The systems affect local farming. For example, a small hydro project proposed at Nong-Won will provide an additional 528 000 m² of farmland valued at 6600 won/m². The project will allow upgrading of an additional 805 000 m² from dry paddy to wet paddy, increasing their value by 3300 won/m². The additional costs of these improvements (i.e., clearing, landscaping, build-

ing irrigation ditches) have not been estimated. Moreover, use of the site for irrigation may reduce its power output. There is no simple way to evaluate these peripheral impacts.

Local demand may be insufficient to utilize the total capacity of the plant. In Nong-Won, the local electrical requirements (primarily for lighting) are about 100 kW, while the plant capacity is 1000 kW. Attracting small-scale industry to local areas may be feasible, but this process is long and involved. Excess energy cannot readily be sold to KECO, which is not interested in promoting small hydro systems for a number of reasons, e.g., powerline costs, synchronization system reliability, and maintenance. As a result, KECO will pay only 15–20 won/kWh for excess hydropower; small hydro generation costs exceed this level.

The turbines and associated equipment may have to be imported. At present, the government is considering development of a domestic capability to manufacture Francis and Tubular turbines in sizes under 1000 kW. For higher power, the South Koreans will need to turn to imports, at least temporarily. In the absence of a domestic manufacturing capability, the cost of turbines will be increased about 30% (as a result of transportation costs).

The primary environmental impact of small-scale hydro development is the increased risk of flooding in the surrounding areas, which may be inhabited or devoted to agriculture. This risk must be assessed on a case-by-case basis. There is no formal research program for this energy source because small-head hydro technology is relatively mature. The government is financing studies of potential sites for small-scale hydro-power development.

Conclusions

Keeping a proper balance between energy supply and demand is essential for the future economic growth of South Korea. As the country is poorly endowed with energy resources, all possible efforts for using renewable energy should be explored. For the optimal application of renewable energy, new technologies need to be developed, and older ones adapted. The development of a national renewable energy plan as well as the creation of laws to enforce it is essential. To broaden the opportunities for the use of renewable energy sources, the government must also enhance research and development programs.

Under the direction of the South Korean government, a vigorous solar-energy research and development program has been formulated,

and substantial progress has been made in recent years. By July 1981, more than 500 solar-housing units had been constructed, and 25 000 have been projected for construction by 1986. Hundreds of lighthouses in remote islands already use photovoltaic cells for their power source, and the government is providing tax and loan incentives for solar houses in rural areas, tax incentives for imported materials to be used in solar systems, and loan incentives for solar products.

Wind energy traditionally has been used on a small scale in South Korea to provide mechanical power. Current development efforts are oriented toward electricity generation on the islands. At present, wind-energy installations in the country are relatively new. Most of these systems have been installed by the scientific organizations for demonstration purposes. The systems of small capacity (10kW) could serve as power sources in remote areas. The market for 10-kW wind machines is expected to be 1000 units in 1990.

Anaerobic digestion of animal wastes and gasification or pyrolysis of wood and agricultural residues are being examined for use in rural areas. The objective is to make more energy-efficient use of those materials and make rural areas more self-sufficient. These resources, however, have only limited potential in South Korea. The major increase in the utilization of biomass will come from improvements in the end-use conversion efficiencies.

Unlike biogas, ocean energy has considerable potential in South Korea, although only tidal power is feasible for use in the near future. The Korean government has started a feasibility study on the construction of a tidal-power plant with a 400-MW capacity, which is expected to be finished by 1988.

The contribution of small-scale hydro potential to the country's total energy needs is small. Nevertheless, such resources could play a significant role in the development of rural areas in South Korea. Currently, three small hydro plants are operating with a total capacity of 40 MW.

At present, the widespread use of renewable energy in South Korea is hindered by:

- Lack of a system-design capability, of a system-construction technique, and of system-maintenance personnel;
- High initial investments;
- High maintenance costs;
- Lack of knowledge among consumers and a need for education about renewable energy; and
- A bad public image caused by problem installations.

Discussion

Romeo M. Bautista: The Lee and Kim paper complements the Smith and Saddler paper to some extent. Smith and Saddler give a theoretical treatment of the substitution of nonexhaustible resources for exhaustible and the implications for trade and investment flows, whereas Lee and Kim focus on the prospects of the development of renewable-energy resources in an energy-poor developing country.

Smith and Saddler start with a simple model, in which energy is considered a homogeneous product derived from either an exhaustible source or a nonexhaustible source. Costs for extraction are assumed to be zero for the exhaustible resource. I suppose this assumption is in recognition that extraction accounts for only a small fraction of the fossil-fuel price. But this is true only for developed oil fields; large investments are made in wells that are still being prospected, and standard cost calculations make some annual allowance for development. Smith and Saddler do make allowances in the model for the costs of employing factors of production to convert nonexhaustible resources (geothermal, gravitational, and solar) into usable forms. They assume that energy-pricing policy follows the Hotelling rule (a rather odd assumption given present realities). They also assume constant energy demand and a fixed supply curve relating to the nonexhaustible resource, the eventual ("ceiling") price of energy being determined by the total stock of the exhaustible resource and the price at which it becomes economic to start production from the nonexhaustible source.

The authors introduce complications by allowing nonhomogeneity of product in an attempt to distinguish between alternative energy uses and also by allowing product substitution. These supply-demand models are clever and, based on the authors' assumptions, are logical. But they fail, in my view, to capture some of the characteristics of the existing energy market. For one thing, I think it unrealistic to assume a fixed stock of the exhaustible resource (fossil fuel), considering the massive oil exploration activities that have been going on and attendant changes in the estimates of oil reserves in many countries. Rising oil prices provide the incentive for countries to initiate or expand oil-exploration efforts, which for some of them have yielded significant

increments in domestic oil production. In other words, increased supply of the supposedly exhaustible resource is, at least in the medium term, as much a response to higher oil prices as the development of alternative (nonexhaustible) energy sources.

I found very illuminating the discussion by Smith and Saddler on actual substitution possibilities and on trade and investment issues. The distinctions — between concentrated and diffuse energy resources, between tradable and nontradable energy resources, and between forms of energy that are highly substitutable and those that are not — are highly useful. Such distinctions provide guidelines for policy intervention at the national level as well as for international economic cooperation and policy coordination. Nonetheless, the Smith and Saddler discussion could have benefited from an examination of the actual changes in trade and investment patterns since 1973 as a means to validate the speculative statements concerning future changes. A complicating factor is, of course, the uncertainties relating to future technological developments that may make obsolete some of the parameters that Smith and Saddler used in their predictive judgments.

The Lee and Kim paper is competently written and highly informative. However, I would have liked to have found rate-of-return estimates in the paper. Because I did not find them and because I suspect that such calculations were in fact not done by the South Korean authorities, I am led to think that South Korea is adopting what seems to be a typical approach to the energy-security problem in resource-poor developing countries. The development of indigenous-energy sources is such a priority in these countries that it is pursued without regard for efficiency considerations. For diversification and security reasons, domestic capability in providing new and renewable sources of energy has been elevated to a position of primary importance.

It is worth noting, however, that South Korea is, in fact, planning to increase energy imports relative to total energy consumption — from 69% in 1980 to 79% in 1986. In shifting away from petroleum imports (which nonetheless will continue to be the largest energy import) to imports of coal and liquefied natural gas, South Korea

achieves substantial diversification of import supply, presumably contributing to an improvement in the perception of energy security.

It speaks well of South Korea's energy program, I think, that it is widely discussed and that two research and development institutes, the Korea Institute of Energy and Resources and the Korea Institute of Science and Technology, are actively involved. These two institutions, given their resources and technical capability, do not have effective counterparts in most other energy-poor developing countries. The authors make reference to the major problems South Korea faces in the development and utilization of new and renewable-energy sources, namely, uncertain economic feasibility, engineering constraints, and lack of infrastructure investment. To some of us who are familiar with the planning and implementation of similar programs in other developing countries, it appears that South Korea will be relatively able to cope with its problems.

The dilemma confronting energy-poor developing countries is a serious one. It concerns, on the one hand, the need to expand domestic capability in providing energy supply and, on the

other, a need to invest their precious physical and human capital wisely. To what extent and in what forms should the enhancement of energy-supply capability be undertaken? In deciding their priorities, they would be aided immensely by an analysis of the socioeconomic impacts of alternative-energy programs. Such analysis would need to examine the extent of substitutability among various energy sources and possibilities of trade in energy products, as suggested in the Smith and Sandler paper. To some extent, infant energy industries may need to be subsidized, but where to draw the line represents a difficult policy decision.

The policy decisions are, in fact, what I would have liked to have seen examined in South Korea's energy program. In their paper, Lee and Kim give a useful description of the resource base, potential technology applications, and implementation considerations of each component of the renewable-energy program. It would have made more interesting reading for me, as a general economist, if the economic factors underlying the allocation of budget funds to the various projects involving the development of renewable-energy sources had been treated more explicitly.

Energy Constraints and the Open Economic Strategy in China's Modernization

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The People's Republic of China is in the midst of transition — opening its doors to the outside world and reorienting its policies toward upgrading the standards of living of its people. The changes are extensive and have profound implications for all sectors, including energy. The major implications are that China will be expanding its exports substantially and increasing production and marketing of consumer goods, especially from light industries. It will be looking to the rest of the world for markets and for technical expertise. The country has a long history of using resources other than crude oil for energy. Sun, wind, biomass, and water power are used extensively throughout the country. Currently, however, energy is being consumed inefficiently. The available resources and some programs to use them effectively are presented in this paper.

La république populaire de Chine vit une période de transition qui se traduit par une ouverture sur le monde extérieur et la réorientation de ses politiques vers l'amélioration du niveau de vie de la population. Il s'agit d'une évolution profonde dont les répercussions s'étendent à tous les secteurs, notamment l'énergie. Les effets majeurs de ce changement impliquent une augmentation considérable des exportations ainsi que l'accroissement de la production et de la commercialisation des biens de consommation, surtout de l'industrie légère. La Chine a l'intention de prospecter les marchés internationaux et de solliciter les conseils d'experts étrangers. Depuis toujours, elle utilise de nombreuses sources d'énergie autres que le mazout; le soleil, le vent, la biomasse et l'eau sont exploités à l'échelle du pays. Cependant, l'utilisation de l'énergie n'est pas toujours fonctionnelle et le présent document propose divers programmes visant à corriger cette situation.

The Sixth Plenum in Beijing recently reviewed economic policy and progress in China since the establishment of the People's Republic. The findings are noteworthy. In presenting them, we will focus on recent problems of economic development, although we do not wish to give the impression that development in new China has been without its achievements. Since the People's Republic was established and throughout the past 30 years, agricultural production and farming methods, for example, have improved markedly. More than 400 000 industry and transportation enterprises have been established, and a relatively integrated system of industry and national economy has been founded. Between 1952 and 1979, the total value of industrial and agricultural production has increased 8 times, fixed assets of state enterprises have increased 21 times, national income has increased 4 times, and the standard of living has doubled, after allow-

ance has been made for inflation. But for all this, China remains a poor country. In 1980, per-person GNP was about U.S. \$270.

In the past, the country put forward good ideas for development planning, such as taking agriculture as the foundation and industry as the leading factor; mapping out the national economic plans in the sequence of agriculture, light industry, and heavy industry; giving energetic support to agriculture. However, it implemented many incorrect policies. First was the failure to persevere in modernizing the economy and the failure to bring about improvements in the people's material and cultural life. The scientific bases of economic plans, policies, and measures were ignored — a fact that resulted in waste and losses. The country not only failed to abandon the highly centralized system of management but also pursued unbalanced development, giving priority to heavy industry to the detriment of that of agriculture

and light industry. It also set high targets and sought excessively high rates of investment, well beyond its real capabilities. In addition, the constant transformation in the relations of production slowed progress and greatly damaged the economy. In the past decade or more, the investment rate (including fixed assets and circulating capital) exceeded 30% of national income, a rate much higher than that of many developed countries. Capital, squeezed from agriculture and light industry, was mainly invested in heavy industry. During 1950-80, heavy industry increased its production by 64 times and light industry by 20 times, whereas agricultural production only doubled. Improvements in people's living standards were substantial but were held back by the low level of production of consumer goods.

The first 8 years after the founding of new China witnessed rapid progress in both production and people's livelihoods — a fact that contributed to enthusiasm among the working people. However, the country's economic development suffered two major setbacks: the Great Leap Forward, which lasted 3 years beginning from 1958, and the Cultural Revolution, 1966-76. These two events — along with the high rate of investment in industry — made it impossible to improve people's incomes appreciably. Thus, their initiative in production suffered.

China could have reoriented its economic development after the downfall of the Gang of Four in 1976, but only recently has it fully assessed the damage done during the 10 calamitous years of the Cultural Revolution and the dangers inherent in investing such a high percentage of national revenue in one sector. A number of impractical, overambitious goals and slogans were put forward in 1978, when the savings rate was as high as 36.5% and the appropriation of funds for investment was 50% greater than in 1977. The scale of capital formation was further expanded, particularly as a result of the government's hasty entry into many contracts for imports of equipment from abroad.

Since the Third Plenum of the Central Committee in 1978, the country has been summarizing the experiences and lessons of its economic development since establishment and has identified several mistakes in its past approach; these include overestimating the capability of economic strength, ignoring the actual conditions, neglecting the people's livelihood, and being too anxious to get quick results. By recognizing these weaknesses, it has laid a good foundation for economic readjustment and modernization.

The Readjustment

Based on the experiences and lessons of the past, the Chinese government, in 1979, put forward a policy of readjusting, restructuring, consolidating, and improving the national economy. This policy aims to build a Chinese model of socialist economic construction. It recognizes, first and foremost, that the aim of socialist production is to satisfy, to the greatest extent possible, the people's material and cultural needs and that production is not for production's sake. A major premise, therefore, was that the former practice of constantly redoubling the production of heavy industry while allowing stagnation in light industry and agriculture and failing to satisfy the basic needs of the people had to be reversed. In future, the government will focus on the relationship between economic investment and the people's livelihood. Peasants account for the greatest proportion of China's population; improvements in their livelihood are the key to stability. Past development efforts neglected improvements in the people's living standard and emphasized savings to the neglect of consumption. In future, investment must be balanced with better living conditions.

With such a guiding theory, the country is now working to readjust the ratio between the various branches of the national economy, slowing the growth of heavy industry, and laying more emphasis on developing light industry and agriculture. Significant progress has been made in this respect. Agricultural production has been developing rapidly over the last few years. Production teams have exercised more decision-making power, and purchase prices for farm products have been raised. Whereas, in the past, the growth of light industry had been slower than that for heavy industry, for the last 2 years it has outstripped the latter. In fact, for 1980, production increased by only 1.4% in heavy industry but by 18.4% in light industry. The people's purchasing power has greatly increased in the past 2 years, and a shortage of commodities has been mitigated by increases in production of consumer goods. The goal of improving the people's livelihood has meant a shift in economic development such that investment production develops in harmony with consumer production. Increases in peasants' incomes have allowed them to purchase not only basic commodities but also some goods earlier considered luxuries, such as watches, radios, and TVs. The increase in the demand for consumer goods has boosted production; both the heavy and the defence industries, after having met their own quotas, shift unused capacity to the

production of consumer goods such as cameras, electric fans, record players, radios, and furniture. Formerly, it was inconceivable to produce such goods in defence industries.

Energy

The changes do not mean that China is not going to develop heavy industry. Some branches of heavy industry will continue to expand, while the production of others will be scaled down. The energy industries, for example, will receive continued investment, the energy supply in China being rather tight at present. Efforts will reflect large, capital-intensive investments in essential energy and smaller, more labour-intensive investments in noncommercial energy. The latter will include investment in renewable energy resources, which are of considerable importance to the maintenance of adequate energy supplies to the end of this century.

In the past few years, the country has concentrated on fulfilling annual quotas in energy production and has slackened efforts in oil and coal exploration. To set right the disproportionate ratio between extraction and reserve, it will not increase energy production for several years to come. Rich in energy resources, China is the third largest coal producer in the world with an annual output of 600 Mt and is the yearly source for 100 Mt crude oil, ranking ninth in the world.

Huge amounts of energy have been wasted in production. The annual energy consumption in China is roughly the same as in Japan, although the value of total output is only one-quarter that of Japan. There is great potential for increasing efficiency in the use of energy; the shift of emphasis from heavy to light industry will make considerable difference because a given amount of energy can support several times more output of light than of heavy industry.

But, even if China takes advantage of all economic opportunities for increasing output of large-scale commercial energy and for reducing consumption, the energy constraint on modernization will remain. For this reason, and also because energy can directly contribute to raising living standards in rural areas, much emphasis is being placed on the development of renewable, largely noncommercial energy.

Noncommercial energy is already important in China, contributing about 270 Mt of coal equivalent, or 0.3 t per person; these figures compare with commercial energy's contribution of about 567 Mt or 0.6 t per person. Virtually all of the noncommercial energy is from renewable sources, whereas about 10% of the total commercial elec-

tricity production is from renewable (hydropower) sources.

Massive utilization of energy sources like biomass, the sun, wind, and water has a long history in China. The people have long depended on cattle for cultivation, firewood for cooking, horses for travel, junks for sailing, water power for milling, wind power for pumping, solar radiation for fire, and hot springs for health treatment. China has abundant hydropower resources. A recent survey indicates that the hydropower potential is 680 000 MW, of which 133 000 MW have been tested. However, 70% of the hydropower resources are located in the sparsely populated southwest. Only 3% of the potential has been utilized. There is, thus, great opportunity to expand hydropower production in China; current plans are to build large hydropower bases in the form of staging stations on some river sections and to complement these by the development of small hydropower stations. At present, 18 large (more than 250 MW) hydropower stations contribute more than 40% of the total hydroelectric capacity. Nearly 90 000 small (less than 12 MW) hydropower stations already exist in China and contribute more than 30% of the total hydroelectric power.

The largest hydropower station in China is Liujiaxia, on the upper reaches of the Yellow River; it has a 1225 MW installed capacity as well as an annual electricity-generation capacity of 5.7 million MW. The Gezhouba hydropower station, being built on the Yangtze River, has an estimated installed capacity of 2700 MW.

Capital and management for large hydropower stations are provided by the central government and for medium ones by the provincial, regional, or central government. Minihydro requires less technology and investment so that small-scale stations are built and managed by the counties, communes, or production teams. The government provides an appropriate subsidy or loan for minihydro and practices a policy of "owned, managed, and profited by those who build them." More than 1500 of 2000 counties in China have built minihydro stations, covering some 40% of rural electricity consumption. Now, about 12 000 minihydropower stations are under construction with a design capacity of 3500 MW.

China's 18 000-km coastline provides tremendous potential for tidal power — an estimated 28 000 MW. However, only a few pilot power stations have been built along the coast of Guangdong, Zhejiang, Jiangsu, and Shandong provinces, with a total capacity of 6.3 MW. The Jianguxia tidal-power station recently built in

Zhejiang province has a designed capacity of 3 MW.

Biomass is also an important renewable energy resource in China; in fact, it constitutes the main source of energy consumed in China's rural areas. In 1978, the total energy consumed in the rural areas was 320 Mt of coal equivalent, of which 84.1% came from biomass resources and 15.9% came from commercial sources. Biomass is commonly burned directly, at a heating efficiency of only 10%. Direct burning causes a loss of organic fertilizers, reduction in soil fertility, destruction of the ecosystem, and pollution of the environment. In some regions, such as Guangdong and Jiangsu provinces, organic matter is fermented to produce biogas as part of the fuel for daily life. In 1975, 460 000 and by 1978 6.39 million small digesters for domestic use were built in various places. Some large digesters for power generation were also available by 1978. The National Leading Group for Biogas Development and National Office for Biogas were set up in 1979. The development of biogas had been incorporated in China's national economy program as an important part of the modernization of agriculture. The present annual output of biogas is about 7×10^8 m³, a much more environmentally acceptable source of energy than direct burning of biomass. A 10-m³ digester can generate enough gas to satisfy the energy needs for cooking and lighting for a family of five.

Biogas is merely one aspect of the important biomass branch of new and renewable sources of energy. In recent years, China has been cultivating high-energy plants and firewood forests in addition to vigorously developing the biogas program.

In a broad sense, biomass energy resources are one application of solar energy, a resource China has in abundance. With an annual insolation of more than 2000 hours, two-thirds of China has annual solar radiation greater than 140 kcal/cm².

There is a clear intention to put technologically and economically feasible solar devices into wide use. A great deal of scientific research in solar energy is being carried out. However, the energy technology is still generally in an experimental stage. Its application started in the middle 1970s: two national solar-energy application conferences were held in 1975 and 1979, at which a research and development program was worked out. Since then, solar-energy research has been undertaken in most provinces, and a couple of solar-energy demonstration plants have been established. A number of factories have been set up to produce solar collectors, solar cookers, and photovoltaic devices.

Solar cookers are widely used in rural areas that are rich in sunshine but poor in fuels. These cookers are locally manufactured with local materials. They can be afforded by most peasants. Already there are more than 2000 solar cookers in daily service, and their numbers will be further expanded.

Solar heaters are also becoming popular. In large cities, solar collectors are now being used for hot-water supply to public bathrooms, hotels, hospitals, and offices. There are about 100 000 1-m² solar collectors in service at present, and various solar dryers are being tested for food drying. Plastic solar greenhouses are being used in vegetable plantations, covering a total 6000 ha. These facilities are both technologically and economically practical and are steadily being expanded.

China has a long history of wind-energy utilization. In central and southern China, some civil transportation networks in the river still rely on sailboats, and about 600 000 t of cargo were transported by junks in 1979. Some small wind turbines have been developed in Inner Mongolia, Gansu, and Zhejiang, with their power varying from 100 W to 0.01 MW. The state of technical and economic development in China suggests that the first priority of government should be to produce simple technologies for energy generation that can be applied by virtually all households in the country. Wind energy is an ideal source for remote regions lacking conventional energy resources. Animal power is also extensively used in the country. Cattle, horses, mules, donkeys, and oxen have played an important role in moving carts, transporting goods, tilling farms, etc. The use of oxen on farms is still quite common in Chinese villages, especially in hilly areas and irrigated farms with varied topography. Most farm products are still transported by horse-drawn carts in the northern rural areas. China's geographical features and technical and economic conditions dictate that animal power will continue to be important for a rather long time, particularly since it would not be possible to meet rural transport needs through the supply of petroleum products. Fifty million draft animals are in use currently, and the number will grow in future in line with agricultural production.

The scale of investment over the past 20 years in China has been larger than capabilities. The level of investment that can safely be undertaken is the portion of a year's aggregate social product that remains after the deduction of depreciation, of public spending including that for administration and defence, and of consumption at a level that allows an appropriate rise in the people's

living standard. Based on this definition, the government, among other things, reduced investment by 40% (it had accounted for 40% of the total budgetary expenditure in the past); defence and administrative spending has also been cut.

The allocation of investment to different sectors of the national economy is set forth in the state plan, increases currently going to agriculture, light industry, communications, and energy as well as the service sectors. Investment in heavy industries other than energy has been reduced. Some increase in expenditures on consumer goods has been necessary in an effort to bring supply in line with demand and to avoid problems that recently have resulted from purchasing power exceeding the supply of consumer goods.

Another readjustment for China is the expansion of the role of the market. A number of concrete steps are being taken. The first is the abolition of the system by which the state purchased and sold all commodities, although some commodities — grain, cotton cloth, and others that are in short supply — will still be controlled by the state. The commercial departments may map out procurement plans according to market demand, and factories will arrange production to conform with the commercial procurement plan. Some commodities can be sold at stores set up by factories themselves. The capital goods rationing system is to be gradually changed, with some goods entering the market for exchange. Other common commodities can be exchanged freely. Remarkable results have already been achieved, some machinery and electric products entering the market in 1979 and easing some of the shortages.

The second step is the abandonment of the system of "sole dealing" where the state acts as sole agent. Under the new system, a producer wanting to sell products may now directly approach customers. The rural communes and the production teams can market their products in city fairs. Many commercial units of collective ownership and a certain number of small private shops in addition to the state-owned commercial departments are being developed. Competition among them is allowed, and the government encourages individuals, especially youths, or families, to set up small shops such as bicycle-repair shops, inns, restaurants, and tailor shops to open employment channels. The service and light industrial sectors have provided employment for 29 million youths in recent years.

The third step is the drafting of a long-term program for price adjustment, within which

prices are more flexible. Except for those products allocated by the state plan, local authorities and enterprises will likely be given some flexibility to readjust prices of their commodities. The prices of many goods ought to vary, and seasonal, regional, and quality price differences fulfill a useful social role.

The successful expansion of the role of the market will require adjustments in the arrangements for tax and bank credit. In the meantime, the market administration will be maintained as a necessary control on speculation and prices. More attention will be attached to the development of labour-intensive, energy-economizing, and raw material-saving industries or products that can make use of available resources.

The new economic program emphasizes the control of population growth. Certain privileges will be awarded couples who have only one child — for example, monthly payments of 5 yuan. In the city, such inducements can be effective, but in rural areas traditional attitudes are still powerful. The old adage that "having children is like accumulating grain to ward off hunger" has to be overcome by policies that provide security for old people.

During the current economic readjustment, China must correctly handle the relationship between readjustment and reform. Although both readjustment and reform are intended to place the economy on a more rational basis, during implementation, they supplement and complement each other in some ways and contradict one another in others. As a result, in a period when readjustment is more important, reform must play a supplementary role. It must help the readjustment and not hinder it. The current requirement is to sum up the country's past experience of reform and to analyze and solve the new problems that have appeared during the reforms. In sum, during readjustment, the pace of reform must be slow, steady, and accurate.

The Open Economy

To achieve modernization, China must adhere to an open policy on foreign economic relations. Both foreign and domestic experience suggests that, under the current global conditions of international production and division of labour and of rapid development of science and technology, the adoption of a closed-door policy will only bring serious harm to the national economy and culture. Therefore, the implementation of an open policy on foreign economic relations is an important long-term decision for China.

The new approach to foreign economic policy will mean that China's relations with the rest of the world will become much more important. The adjustments in domestic policies will have a much greater impact on the rest of the world than did earlier policy changes. China will become a market for goods and services that are necessary for modernization; its foreign exchange will come partly from increased capital inflow but mainly from increased exports of goods and services.

The change in policy over the last few years will generate levels of capital inflow that are larger in quantity and more varied in form than at any time since the establishment of the People's Republic. Substantial commitments of credit have come from foreign governments and international agencies. Joint ventures with foreign corporations have become important: more than 20 joint ventures have been signed with Western corporations for the production of machinery, textiles, tourism, and other services. Four joint-venture contracts have been signed with French and Japanese companies for offshore oil prospecting and exploitation. Compensation trade, processing, and assembling have gained new status as a vehicle for the transmission of foreign capital and expertise, with agreement having been reached on about 350 small and medium-sized compensation trade ventures and more than 8000 contracts for processing and assembling imported materials and equipment. International joint ventures have been established to allow the leasing of equipment.

China's exports over the next few years will expand annually at about 4%, or roughly the expected rate of growth of total world trade. Later, from about the middle of the decade, they will grow substantially faster than world trade, at about an annual rate of 13%.

China's new policy of building on its greatest competitive strengths, and emphasizing light industry ahead of heavy industry, will mean that exports will grow much more quickly for some products than for others. Exports of all mineral products will grow only at 4-5% annually throughout the decade.

The strongest export growth will be for light manufactures. Although much of the increase in production of light manufactures will go to raising consumption standards of China's people, industries will be much more oriented toward export markets. In 1980, only 3% of China's production of manufactures was exported, but, by 1990, exports will be increased to 7%. Exports of

manufactured goods are expected to increase at an annual average between 15 and 20%.

Total exports of manufactured goods, mostly from light industry, were valued at about U.S. \$5 billion last year. At prices operating last year, these exports are expected to rise to \$15 billion in 1985 and \$31 billion in 1990. The increase in exports of light manufactures throughout the decade will approach the combined volume of exports from Taiwan and South Korea in recent years.

The changes in the level and composition of investment in the course of the readjustment of domestic policy will profoundly affect China's imports. Processing enterprises that cannot be operated because of shortages of energy and of supplies of raw materials will be closed down, and imports of large equipment will be reduced in the next years. However, there will be increases in the import of materials, technology, and equipment needed for transforming and developing existing industries, especially the industries that have been given high priority. China will be selective in introducing advanced technology and modern managerial methods. The imports of equipment, technology, and raw materials that will add to its export capacity will be given priority. Large amounts of foreign funds and technology are needed for improvements in port, railway, and telecommunications facilities and urban infrastructure, which are lagging far behind the needs for expansion of external trade.

One should not pretend that China's modernization and new open policy can be implemented without problems. In the days shortly after the downfall of the Gang of Four, little attention was given to the feasibility and overall balance of projects set forth in new development plans. The adverse effects became so apparent last October that a thorough readjustment was considered essential for the future of the national economy. Thus, some projects were pared or suspended, although the government adhered to the principle of respecting contracts and commitments.

Another example of problems in implementing the new approach is apparent from complaints by foreign business executives that China has too many departmental and administrative tiers in foreign trade and that responsibilities are not clearly defined, the result being slow response and low efficiency. These shortcomings exist because China was once a closed society, and, when it opened to the outside world, the old management system, its organization, and personnel were not able to adapt. At present, China is trying to establish a foreign economic and trade

management system suited to both international customs and domestic conditions. The general direction of reform in China's foreign trade system is to grant autonomy to enterprises and incorporated entities in foreign trade, within a framework of strengthened central coordination to ensure consistent approaches to foreign trade.

Conclusions

The success of the new policies will require adjustments not only in China but also in other countries. The cooperation of the industrialized countries, and especially those of the Pacific area, is vital to the new modernization program in several ways. Only through cooperation will China be able to expand light industrial exports that will provide foreign exchange and permit the domestic economic restructuring that is essential for higher rates of industrial growth. Also international cooperation is vital if China is to enlist foreign technology, capital, and expertise in the modernization of large-scale production and transport of energy, and in the modernization of production more generally.

International cooperation in energy development and research is beneficial to the economic

development and scientific and technological progress of all participants. China has carried out technological exchange and cooperation in economic and scientific research in energy development with countries who are willing to do so, on the basis of equality and mutual benefit. In the field of renewable energy resources, China has begun building hydropower stations with loans from Japan and is exploring possibilities with the World Bank for cooperation in building other hydropower stations. The United Nations has sanctioned yearly training courses in China for the developing countries and exchanges of technology and experience, with a view to solving the rural-energy problem by promoting the development of biogas in these countries. In cooperation with West Germany, China will establish a village operating on nonconventional sources of energy. Realizing that increased supplies of conventional energy alone will not solve the energy problem, the Chinese government is undertaking research and development of renewable sources and focusing on advanced technologies and experiences from other countries. It is particularly keen to cooperate in these efforts with Asian and Pacific countries.

Discussion

Jan J. Solecki: First of all I wish to say how much I enjoyed reading the paper by Li and Luo. Most of you probably are unaware that I was born in China, in fact in Inner Mongolia, and lived there the first 20 years of my life. Last summer, my wife and I (incidentally my wife too was born in China) revisited the country of our birth and were able to see for ourselves the improvements that have taken place during the past 40 years and sense the changes that were taking place that are reflected in the open economic strategy, discussed in the paper.

I am greatly honoured to be called to comment on the Li and Luo paper. I have read it with great care and found it interesting and informative. The most important feature of it is that it contains pragmatic assessment of the current situation in the People's Republic of China and indicates the path of the expected future developments.

The theme of the paper — the energy constraint — is familiar to us in North America, because we too have had to face the problem of

energy constraint, although to a lesser degree and in a different form. Our attempts to solve our own problems in many areas parallel those in China, and, for this reason, the present meeting by offering an opportunity to exchange views and experiences is of particular importance. Let us hope that it will help in the organization of systematic exchange visits by scientists and experts, who, by studying on the spot what has been achieved in other countries, will be able to transfer the knowledge to their own country.

Here in Canada we are particularly fortunate that along with being well endowed with resources, through free exchange of information with the United States and other developed countries, we have access to the latest technology, some aspects of which are transferable to China. Similarly, as in China, scientists here have been working on harnessing hydro, solar, tidal, and biomass energy. Efforts have been made at energy saving through insulation (I might say not always to everyone's satisfaction), through novel designs, as for example in the case of houses

being built almost entirely underground to conserve heat, through heat collectors, reflectors, and conductors. It is paradoxical that Canada, so well endowed with forest resources, should be one of the leaders in the fields of full and integrated wood and other resources utilization and energy conservation. The secret, of course, is in producing specifically for consumers. Under such a system, misdirected capital investments are rechanneled as a normal part of economic functioning of the system. Production capacities are augmented or reduced as need arises. It is highly gratifying, therefore, that in China too the policy is to move the economy in the direction of greater flexibility and more decision-making at the production levels.

China's efforts to develop hydroelectric power are of particular interest to us in British Columbia because more than 90% of our power supply comes from water resources. As in China, our hydro resources lie away from the population centres, resulting in construction of long-distance transmission systems.

China's studies of tidal power sound very interesting. As the report states, China's long coastline provides enormous possibilities, and, furthermore, it is likely that new ways of tidal-power utilization will be discovered and developed in the near future. The Jiangxia tidal-power station, with a design capacity of 3 MW, is indeed a surprise, especially because, as the report states, a 0.5-MW generation set is already in operation.

While in China last year, we were shown biogas systems used for cooking. We were pleasantly surprised that the system was efficient, odourless, and inexpensive to install. Construction of more than 6 million such biogas units must have resulted in a saving of millions of tonnes of fossil fuels and what is equally important in many millions of hours of human labour that would have been needed to collect fossil fuel or firewood, transport it, make and keep up domestic fire stoves, and remove the effects of the pollution produced by them. The importance of this development can only be appreciated when one is familiar with the enormity of the effort needed to prepare food for the large number of people in China.

I am disappointed that, apart from a passing remark, the report does not deal with such an important renewable resource as forests, especially as China has done so much in reforestation. My interest in the subject is understandable, the forest industry being the most important one in British Columbia.

The latest report from China shows that, in 1980, China logged 53.6×10^6 m³ of wood, which

was 1.5% less than in 1959. Both these figures indicate to me that China's attitude to this valuable renewable resource is realistic and sound.

May I be permitted to say a word on another subject — one that is excluded from the paper presented by the nature of its theme but that, I think, is of great interest to those present here, namely China's fishing industry. China's 1980 output of aquatic products was 4.5 Mt, which is less than one would expect for a country with such a large population and an extensive coastline. One can, therefore, expect, in the light of the present stabilized conditions, a vigorous expansion in the development and utilization of aquatic resources both in inland waters and on high seas. It would be reasonable to expect China to double its fishing efforts during the current decade.

But to return to the report, I note that China suffers, although probably less acutely, from the West's illness when "purchasing power exceeds the supply of consumption goods." With an increase in flexibility of the economy, the problem will probably grow more serious. In Canada's economy, provision of services to the population results in a reduction of pressure generated by the excess of purchasing power.

The open policy on foreign economic relations stated in the report is welcome to all, but in the climate of present-day low-level economic activity in the developed countries, it will not be an easy thing to sustain. A look at hopelessly struggling Poland is enough to serve as a warning. Relying on being able to secure new markets for Chinese manufactures may bring disappointments because of the large number of other countries trying to do exactly the same. China, with its rich and unique historical and cultural heritage and its extensive variety of natural conditions, should be able to expand tourism, to provide a wide range of services based on unrestricted contact between the population and tourists. Italy could serve as a good model.

Trade and production relations through international agreements, joint ventures, compensatory deals for delivery of plants are, of course, important but will probably be more difficult and more time-consuming to realize. The key issues will be, as the paper points out, an access to markets and the keenness of competition, which determines the profit margin. As in the domestic economy, an important factor in China's foreign relations will be an increase in flexibility in dealing with foreign enterprises.

The paper sums up by stressing that essentially what China needs from abroad is up-to-date technology to modernize and an access to foreign

markets. For a long time, China had cut itself away from close association with other countries and, as a result, it will have to redevelop its "feel" for foreign markets. Technology largely can neither be sold nor given; it must be learned, assimilated. What is essential is understanding, which can only be developed through exchanges and frank discussions of views; this, as the absence of Li and Luo at this meeting shows, is not as simple as one would wish.

Lawrence B. Krause: I greatly welcome the paper by Li and Luo. It is interesting, informative, and professional. There are three parts to the paper: an overview of the macroeconomy of China; a discussion of energy; and some comments on several strands of current policy.

As the authors note, China is still a poor country, having an income of only U.S.\$270 per person in 1980. However, China has had rapid growth, 5.2% a year during the 1960s and 5.8% a year during the 1970s. What is quite impressive is that the adult literacy rate of 66% of the adult population is above that of Indonesia and the life expectancy from birth, 64 years, is about the same as South Korea, a country with six times the per-person income.

Nevertheless, as the authors note, mistakes have been made in the past. The question to be asked is whether mistakes are still being made. The forecast for 1981 indicates growth of only 4%, which is less than earlier. Because economic mistakes cause political change in China, one can question whether China will be politically stable over the next several years, as it goes through economic readjustment.

The recognized mistakes of the past include the failure to raise people's income standard, excessive priority given to heavy industry, and investment in general, and frequent twists and turns of policy, which have left the bureaucracy traumatized and which will continue to cause problems in the future.

With respect to energy, China recognizes it has a problem, as supplies are short, particularly of electricity. Despite this and the favourable potential in oil and coal, efforts to develop energy have slackened in recent years. Why? One answer may be that developing new sources, particularly of petroleum, requires technology not available in China. As this must be obtained through the

cooperation of foreign firms, it has strained the capacity of the Chinese bureaucracy. Deals can be made, but not quickly, given the inexperience of the Chinese.

The Chinese efforts in renewable, noncommercial sources of energy are very interesting, and their experience might be of great value to developing countries of the Pacific, such as the Philippines and Thailand, if China is willing to share it with them. The question one must ask is what is the cost of producing energy from sources like minihydro or large biomass digesters. Even draft animals might be expensive, as they are known to be land intensive.

Two current policies are of great interest: the enhanced use of the market mechanism and the opening of China to world markets. Although the direction of policy change seems eminently sensible, there is a question of whether the exceptions might ruin the policy. For instance, as the market will not be permitted to allocate grain, cotton cloth, or major commodities in short supply, it would appear that China will not rely on the market when it is needed most. Furthermore, the banning of speculation and so-called improper pricing suggests that the market will not be permitted to work.

The opening of China to foreign trade and investment is very encouraging. One can wonder, however, why China is so cautious in borrowing abroad. Is this another sign of the bureaucracy being traumatized? Many problems remain in establishing joint ventures and compensation deals. Also, the increase in trade anticipated in manufactured goods is so large as to raise concerns. Only South Korea has achieved such growth rates in the past. The discussion of the administration of foreign trade also sounds as if China is trying to achieve irreconcilable goals in wanting to grant more autonomy to enterprises and also trying to strengthen central coordination.

There is clearly mutual benefit to be gained from Chinese cooperation with other countries of the Pacific. China can obtain assistance in technology but also share its knowledge with others. China should also be aware of the economic impact it is likely to have on other countries as it buys materials on world markets and sells manufactured goods on those markets. This suggests that some institutional arrangement for consultations would be mutually beneficial.



Policy issues



Location of Mechanical Processing of Tropical Hardwood¹

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Two characteristics of mechanical wood-processing industries favour the location of these industries in the log-producing developing countries — their labour-intensive nature and the potential savings in transport costs brought about by their bulk-reducing nature. Historically, government interventions have played a decisive role in the determination of their location — direct and indirect subsidies, tariff escalation, and aggressive industrial export-promotion policies — in log-importing countries. Recently, however, major log-producing countries have taken steps to discourage or restrict log exports. The paper analyzes cost data for plywood production at various locations, policy measures affecting location of these industries, and the pattern of tropical hardwood trade and discusses policy options for log-producing developing countries.

Deux caractéristiques inhérentes aux usines de conversion du bois soit économie de frais de transport par la réduction du volume des charges et forte proportion de main d'oeuvre — militent en faveur de leur établissement dans les pays en développement producteurs de bois en grumes. Le choix du site des industries a traditionnellement été influencé par les gouvernements intéressés, subventions directes ou indirectes, escalade des tarifs et politique agressive de mise en valeur des produits d'exportation dans les pays importateurs. Cependant, les pays producteurs de bois en grumes les plus importants viennent de prendre des mesures pour décourager et réduire les exportations. La présente communication analyse les coûts de production de contreplaqué à divers endroits, les politiques influant sur le choix du site de ces industries; le modèle du commerce du bois de feuillus tropical ainsi que les formules possibles pour les pays en développement producteurs de bois en grumes.

There are two apparent factors that favour mechanical processing of wood in the log-producing developing countries. First, the activity is considered relatively labour-intensive (Lary 1968; Balassa 1977) and, therefore, is thought to be a suitable (comparatively advantageous) industrial activity for areas where the opportunity cost of labour is low. Second, the first stage of the activity — i.e., production of sawnwood, veneers, and plywood — is highly bulk- and weight-reducing and, hence, should markedly cut the cost of moving the product from the log-producing to the importing countries. Despite

these two factors, major log-producing countries in the Asian-Pacific region continue to export an enormous volume of logs (about 80% as of 1978).

A majority (65–70%) of the logs exported from the producing countries are veneerlogs that are used mainly for plywood making in the importing countries. The value added to the material is generally higher in plywood production than in sawnwood production, and, therefore, there is a greater interest in plywood manufacturing than in sawmilling on the part of the major log-exporting countries.

That the cost of ocean transportation of logs is relatively high is illustrated by the fact that freight cost accounted for roughly 25% of the CIF unit value of Japan's imports of lauan logs from the Philippines in 1958–67 (Japan, Ministry of Finance 1958–67; Japan, Bureau of Forestry 1970). The logs are mostly transported from the log-producing regions in Southeast Asia to Japan and other wood-processing regions by

¹This paper is a summary of the results of a research study: "Mechanical Processing of Tropical Hardwood in Developing Countries: Issues and Prospects of Plywood Industry Development in the Asia-Pacific Region" to be published by the World Bank as Division Working Paper 1982-1.

special log carriers on a charter basis. As only about one-half of the log volume is actually recovered in sawnwood and plywood, one may presume that, if processing were done in the log-producing regions, substantial savings in transport cost would be made. However, if shipping of processed products were done on a liner basis, these savings would not materialize. Only if the flow of processed products from a producing region to a consuming region were large enough to justify shipping on a charter basis, would transferring processing facilities from Japan, Korea,² the Province of Taiwan, etc. to the log-producing areas result in cost savings.

Plywood Trade in the Pacific Basin

In Asia, plywood was produced in Japan, India, Korea, and the Province of Taiwan before 1945. The details of early plywood operations in these regions are not known, but, at least in Japan and Korea, the history of plywood production goes back to pre-World-War-I days (AID 1972; Kitamura 1976). It can also be safely assumed that plywood was produced in India well before 1940 and in the Province of Taiwan, at least during the Second World War (although under Japanese management).

In the immediate post-World-War-II years, plywood production expanded very rapidly in Japan, rose at a modest pace in India, and reestablished itself in Korea and the Province of Taiwan. In the few years immediately after World War II, plywood production in Asia (Japan, India, Korea, and the Province of Taiwan) was primarily for domestic consumption, and exports were only incidental.

Beginning in 1948, Japan started to import lauan logs from Southeast Asia (mainly the Philippines). The importation of logs was urged by the United States military-occupation forces to meet their needs of hardwood plywood at their facilities in Japan. Log exports from Southeast Asia expanded rapidly as plywood producers received priority allocations of foreign exchange. Japan started, also, to export plywood in the late 1940s. The main destination was the United States. Small quantities of plywood produced in Malaysia began to be shipped to the United Kingdom.

During 1946–60, Japan was the only country in Asia where the government undertook a rigorous, all-out export-promotion policy, taking positive measures to promote exports (Krause and

Sekiguchi 1976). In contrast, the Province of Taiwan, Korea, Malaysia, Philippines, and Indonesia were still consolidating their nation-statehood, having become independent only after the War. They were following the so-called inward-oriented trade and industrial policies.

After peaking in 1959, Japanese exports of plywood stagnated at about 350 000 m³ during the 1960s, except for the second peak year of 1968. In the meantime, Philippines' exports increased to about 150 000 m³ in the mid-1960s and further to a peak of 390 000 m³ in 1973.

A new development in the early 1960s was the emergence of, first, the Province of Taiwan and then the Republic of Korea as major exporters of plywood. Their exports kept on increasing rapidly until the boom year of 1973, when the Province of Taiwan and Korea exported 1.1×10^6 m³ and 1.3×10^6 m³, respectively. The exports of plywood from Japan, the Philippines, the Province of Taiwan, and Korea during this period were closely geared to the U.S. market. The leadership in plywood exports to the U.S. dramatically changed (Fig. 1).

One important factor that led to dramatic increases in the exports of plywood (and other "light" manufactures such as textiles) from the Province of Taiwan and Korea in the 1960s was the industrial policy reforms carried out around 1957–62 (Kim 1975; Hong 1979; Ranis 1979; Lee and Liang, forthcoming). Their new export-promotion policies involved substantial, effective export subsidies as well as various non-quantifiable incentives for exports of manufactures. Both in the Province of Taiwan and Korea, plywood exports benefited from substantial subsidies.

In the Province of Taiwan, perhaps the most important incentive from the viewpoint of plywood exports was the provision that allowed firms to retain rights to foreign-exchange earnings so that they could import raw materials and machinery: this provision included the privilege of selling such rights to other firms. In Korea, a significant change among the series of new policy measures was the devaluation of the exchange rate in 1964 to about half, even though the real, effective exchange rate has been maintained since 1965. Another factor that contributed to the success of Korea in expanding its plywood exports to the U.S. market during this period was lower ocean-freight costs than were enjoyed by the Philippines, the Province of Taiwan, and even Japan (UNCTAD 1970).

In contrast to policies in both the Province of Taiwan and Korea, industrial policy in Indonesia

²Korea in this paper refers to the Republic of Korea unless otherwise noted.

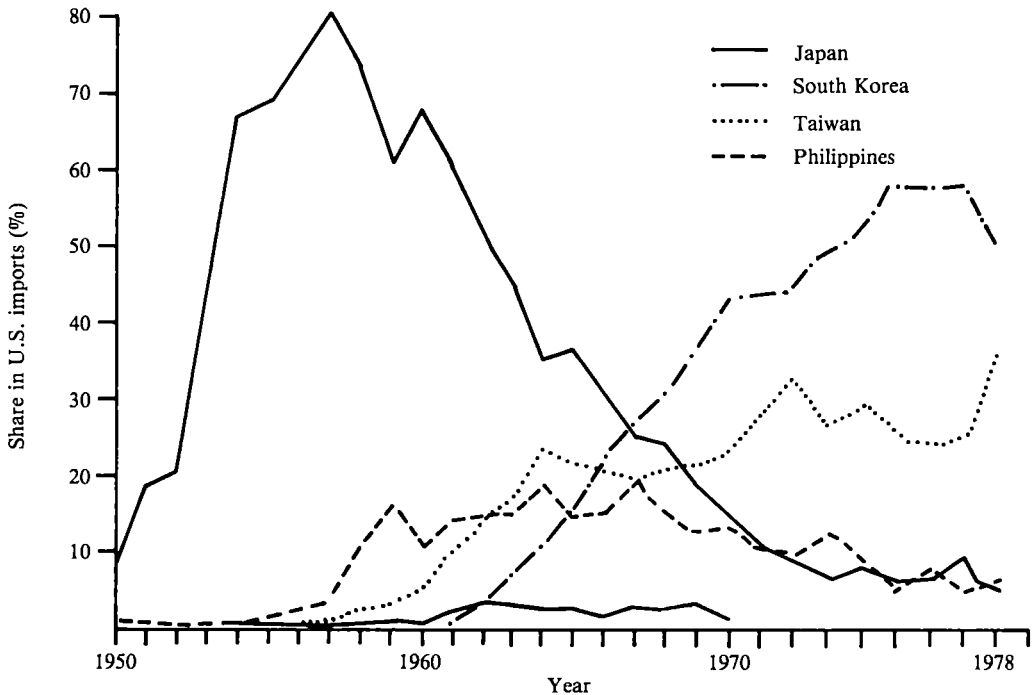


Fig. 1. Share of major Asian suppliers in total U.S. imports of hardwood plywood 1950-78.

continued to be extremely inward-oriented, and, although the government in the Philippines did make some attempts to encourage industrial exports, overall policy remained inward-looking (Power and Sicut 1971).

By the mid-1960s, plywood exports from Malaysia and Singapore were modestly significant and have risen steadily since. The United Kingdom has always been an important destination for them (partly because of the Commonwealth preference). Most of Malaysia's plywood exports have been from Peninsular Malaysia, not from Sabah and Sarawak, which have been the more important sources of log production.

An important factor that affected developments in the plywood trade during 1960-73 was the growth of domestic demand in Japan. In 1972, Japan accounted for 19% of world-plywood consumption (Fig. 2); by 1973, the share of exports in total production had declined to less than 20% (Fig. 2). Because of the worldwide recession following the oil crisis in 1973-74, world export trade in plywood collapsed in 1975, and the recovery has been rather slow. Because of this stagnant growth in demand and the sharp appreciation of the yen against the U.S. dollar, plywood exports from Japan decreased sharply in 1973-75 and further declined subsequently.

The industry has been trapped in structural stagnation.

The Province of Taiwan's plywood exports also stagnated in 1974-77, but Korea's continued to rise. Similarly, exports of plywood from Malaysia (mainly Peninsular Malaysia) and Singapore increased steadily, with their exports to the Middle East rising rapidly. Their reputation for quality in the U.K. opened other European markets in the late 1960s. The timber industry boards in the two countries played a key role in promoting exports of sawnwood and plywood.

Recent Developments in Timber-Export Policies

Since 1978, the Philippines, Malaysia, and Indonesia have taken steps to restrict log exports, as their governments became increasingly aware of the possible exhaustion of prime tropical hardwood resources in their natural forests. They have reconfirmed their determination to step up local timber-processing industries to replace log exports with sawnwood, veneer sheets, plywood, and eventually with mouldings, doors, window frames, flooring materials, and "knockdown" furniture. Having observed the spectacular success of the oil-producing countries in petroleum exports, the major log-exporting countries have

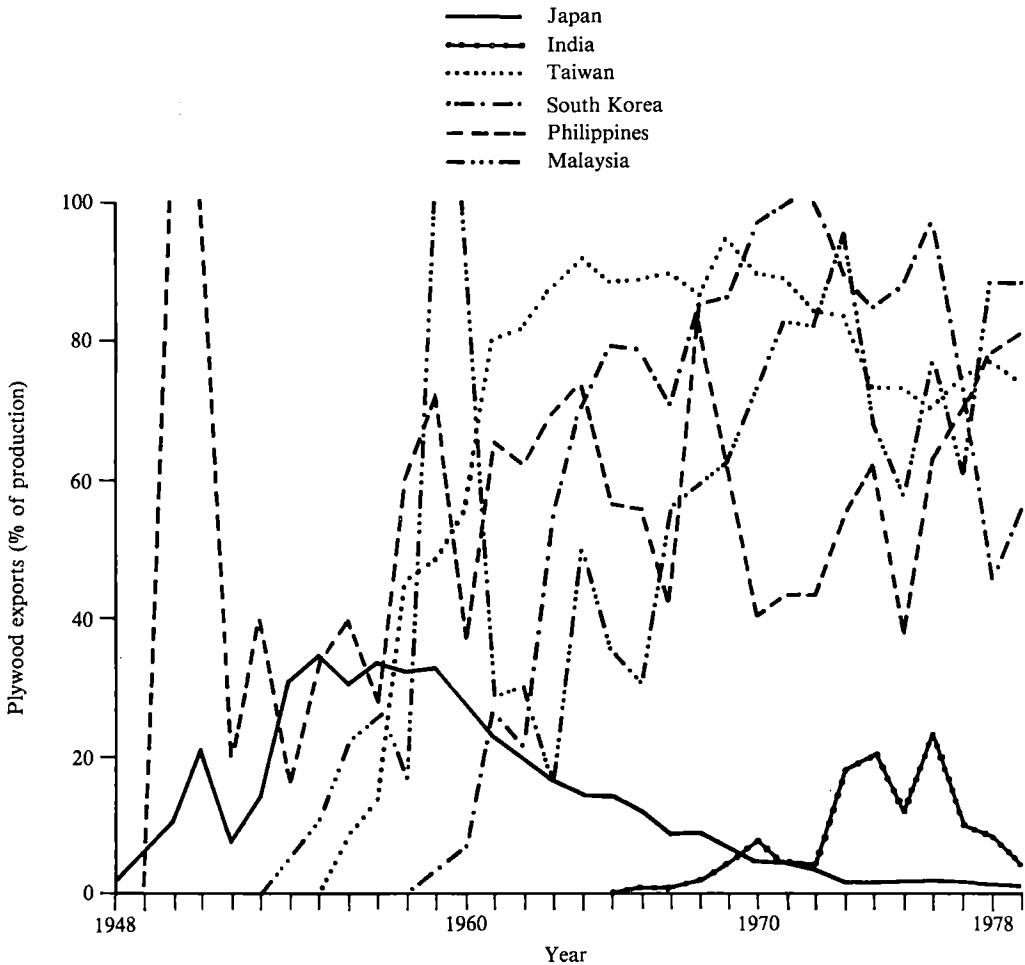


Fig. 2. Plywood exports as percent of production from selected Asian producers.

come to realize the opportunities to extract greater economic rent from their forest resources.

In the Philippines, the government decided in 1972 to ban log exports in principle and to phase them out by 1976.³ However, balance-of-payments difficulties have forced the government to permit log exports on an exceptional basis by quota allocations. Nevertheless, according to the official statistics, the Philippines' exports of logs declined from $9.6 \times 10^6 \text{ m}^3$ in 1970 to less than $1 \times 10^6 \text{ m}^3$ in 1980.

Forest resources in the Philippines have been

depleted far more than the official data indicate. Unless a policy of strict conservation and rational utilization is implemented, forests in the Philippines will not be able to sustain any substantial growth of the wood-processing industry, or perhaps even the present level of capacity in the industry, beyond a few years (Anonymous 1980).

In Peninsular Malaysia, also in 1972, a ban was imposed on the exports of logs, although it was somewhat liberalized in 1977 to allow exports on a quota basis. Exports of logs from Peninsular Malaysia declined from $1.6 \times 10^6 \text{ m}^3$ in 1970 to practically nil in 1979, and the state has recently been suffering from log shortages. Although the overall level of log production in the area has not decreased since 1970, Peninsular Malaysia has now clearly become a log-importing region.

In the state of Sabah, exports of logs peaked in volume in 1973, declined during the oil crisis

³It is widely believed that unrecorded exports of logs have increased in recent years. Even if such "extra-official" exports are allowed for, it is undeniable that the Philippines' log exports have come down substantially over these years.

(1974–75), and then sharply increased to more than $12 \times 10^6 \text{ m}^3$ in 1976–78. In 1979, the state government adopted a policy to reduce log exports gradually, introducing export quotas and increasing royalty rates. The new royalty rates raised the share of government revenue in FOB log prices dramatically — i.e., from 32% to 60%. The declared objective of the Sabah government was to reduce annual log exports to $6 \times 10^6 \text{ m}^3$ by 1981 and to nil by 1985.

In the state of Sarawak, where logging conditions are not as favourable as in Sabah or Peninsular Malaysia, log exports declined in 1970–75, from $3.1 \times 10^6 \text{ m}^3$ to $1.3 \times 10^6 \text{ m}^3$, but they have been rising rapidly since 1976, reaching $6.7 \times 10^6 \text{ m}^3$ in 1980. There have been modest exports of processed timber, but they have not been increasing in volume terms. Sarawak has taken a rather liberal log-export policy. The government charges (royalty, export tax, etc.) have been rather low — about 10–15% of FOB prices, depending on species — and there is not much discrimination against log exports in favour of processed-timber exports. Commercially attractive virgin forests in Sarawak are estimated to last for another 20 years at the current rate of exploitation, but the second round of cutting is expected to yield substantially less than the first. If the present liberal log-export policy is continued, log exports from Sarawak could rise to $8 \times 10^6 \text{ m}^3$ by 1983.

In Indonesia,⁴ hardwood log production, having peaked in 1974 (at $26.2 \times 10^6 \text{ m}^3$) and plummeted in 1975 (to $16.3 \times 10^6 \text{ m}^3$), recovered to $26.9 \times 10^6 \text{ m}^3$ in 1979. Very recently, exports of sawnwood and plywood began to take off.

Indonesia's forestry-sector policy has been based on three principles — export quotas, selective cutting, and domestic processing. These principles were incorporated in legal decrees in the late 1960s and early 1970s. However, the government had not enforced these principles until 1978. In February 1978, the government increased the export tax (ADO) on logs from 10% to 20% of the government-determined "check prices." In summer 1979, a new export tax, at 5%, was imposed on roughly sawn timber to discourage the practice of exporting roughly squared logs. Currently, the government levies

about 11 separate charges on log exports, totaling as much as 40–45% of the FOB prices of logs. In April 1980, the ministers of agriculture, trade, and industry announced their decision to link the allocations for log-export quotas to the concessionaires' past and current performance in local processing.

The overall effects of these initiatives have been remarkable. Indonesia's log exports were down in 1980 and 1981; export-log prices climbed sharply in 1979, stayed at high levels until fall 1980, but declined subsequently because of lower demand. At the same time, a large differential developed between the prices of export logs and those of almost comparable logs in the local market. This price differential provides a powerful incentive for local processing as long as exports of processed products are subject to no or little tax. It is reflected in the rush of applications for government approval on wood-processing (especially plywood-production) projects. By May 1980, 22 plywood factories, with a total annual capacity of $1.1 \times 10^6 \text{ m}^3$ (plywood) were in operation — compared with 16 plants at the end of 1978; an additional 20 or so had been approved to bring the country's annual capacity to more than $2.1 \times 10^6 \text{ m}^3$ (plywood) by the end of 1982. Reportedly, another 50–80 projects have been proposed.

In April 1981, government authorities issued a decree (78/KPTS/DJ/I/1981) that log-export quotas would be allocated only to concessionaires who have processing facilities in operation or under construction. This means that concessionaires who have filed applications for approval on construction will not be permitted to export logs until the facilities are being built.

In Papua New Guinea, log exports peaked in 1974 and have been stagnating at about $0.4\text{--}0.45 \times 10^6 \text{ m}^3/\text{year}$. In early June 1979, the Ministry of Finance issued the Revised National Forest Policy, which reversed restrictions on log exports and called for revenue generation, national ownership, regional development, and political stability (PNG Office of Forests 1980). Whether or not log exports from Papua New Guinea could increase substantially in the future depends, among other things, on the government's success in establishing export-logging enterprises.

Other countries in the region are only minor exporters of logs. Thailand has become a net importer. Burma could potentially increase log exports but is likely to do so only gradually. Vietnam has a wood deficit. Thus, with the exception of Sarawak, Papua New Guinea,

⁴Statistics on forestry and forest industries in Indonesia vary widely, depending on the sources. It is difficult to reconcile production, export, local processing, etc. The figures cited are based on data reported by FAO (1979b).

Burma, and possibly Laos, countries in the region are likely to continue to reduce their exports of logs significantly in the future.

Government Interventions as Locational Determinants

Incentives provided by governments have played an important part in the development of export-oriented plywood industry in Japan, Korea, and the Province of Taiwan, especially during the takeoff stage. The most effective incentive measures involved linking foreign exchange allocations for raw-material imports to export performance of the industry; generous "wastage" allowances constituted an effective subsidy for plywood exports. Also, special ties with the U.K. played a significant role in facilitating exports of processed products from Malaysia and Singapore. Yet another important noncost factor that helped expand processed-timber exports in Malaysia and Singapore seems to have been the work of timber-industry boards in quality control.

Furthermore, there are other government interventions that affect the location of processing through cost of production. Tariff escalation in major importing countries has played a role in influencing the location of processing. More recently, differential government charges (export taxes, royalties, etc.) on logs for export versus logs for local processing as well as restrictions on log exports also appear to have had significant influence.

The Cost of Production Structure — an Intercountry Comparison

Rough cost data have been collected for six locations — Indonesia, Peninsular Malaysia, Sabah and Sarawak (Malaysia), Philippines, Singapore, and Japan. The data are fairly recent — within the last 2 years. However, the conditions affecting wood material supply, demand for plywood, and profitability of the plywood industry in the region have recently changed radically. Therefore, comparing and interpreting the cost data must be done with extreme caution.

Estimates for entry costs in mechanical processing of tropical hardwood vary considerably; they depend on the type of machinery used, the process (e.g., whether or not kiln drying is involved in sawmilling), the number of working hours assumed, and the extent of need for supporting facilities (transportation, housing, medical services, etc.). On the whole, in the Asian-Pacific region, costs to start minimum economic opera-

tions in sawmilling and veneer/plywood production do not seem to have been the key obstacle to the establishment of processing plants. In contrast, entry costs in starting economic particle-board production are substantial and have been at least one of the major problems — although not the most important problem.

Costs of producing plain plywood to be delivered to the Japanese market have been estimated (Table 1). In all cases other than Japan, the production cost up to exfactory accounts for about 68–75% of the total cost of plywood delivered to Japan. This means that overseas producers are "handicapped" by postfactory costs of roughly 30% in competing with domestic producers in Japan.

Fixed Cost

The fixed cost — consisting of depreciation, interests, and general management — varies widely, ranging from U.S.\$25/m³ to \$57/m³, 6–15% of total cost. The financial charges (depreciation and interests) are relatively small for the plants in Japan, Singapore, and the Philippines, which have been operating for at least 7 years and are well depreciated by now. The plants in Indonesia, Sabah, and Peninsular Malaysia are either recently established or proposed projects. While the differences do affect the competitiveness of individual producers, costs of the new projects are more suitable for discussions on the location of processing. "General management" accounts for 3–6% of total cost except for the plant in the Philippines, where it includes a high cost for the "office in Manila."

Variable Production Costs

The most important cost in all cases is raw-material logs, accounting for 41–53% of exfactory cost in the log-producing countries and for 60% and 71% in log-importing Singapore and Japan, respectively. The enormous variation in the costs of logs is striking in view of the fact that all the plants are using similar material (species and sources). The prices of logs, rather than the wood-recovery rates, make the difference. For the producers in log-producing regions who obtain logs from their own logging concessions, the pricing of the logs they "buy" is a rather arbitrary accounting decision, whereas producers who actually buy from arm's-length suppliers must pay the going prices. Also, producers in log-importing countries such as Singapore and Japan must pay international market prices, which are substantially higher (even on an FOB basis) than local-market prices. Because of the dwindling availability of logs and increased

Table I. Estimated cost (U.S.\$/m³) of production for plain plywood at selected locations in Asia as of early 1980.

	Indonesia: a hypothetical plant, East Kalimantan ^a	Sabah, Malaysia: a plant operating at 65% capacity ^b	Peninsular Malaysia: a model plant to operate at 70% capacity ^c	Philippines: an operating plant (perhaps not so typical) ^d	Singapore: a plant operating at full capacity ^e	Japan: "typical" cost conditions of existing plants ^f
Plywood capacity (m³/year)	36000	43000	110000	80000	5000	Not available
Product size (mm × m × m)	4 × 1.2 × 2.42	4 × 1.2 × 2.42	4(?) × 1.2 × 2.42	4(?) × 1.2 × 2.42	3.0–3.6 × 1.2 × 2.42	12 × 0.91 × 1.82
Wood recovery rate (%)	52.7	52.0	45.0	50.0	50.0	67.0
Final cost	57	53	41	53	38	25
Depreciation ^g	24	21	11	5	13	5
Interests	14	20	12	6	5	4
General management ^h	19	12	18	42	20	16
Variable cost	233	237	173	203	304	377
Logs	152	127	100	99	201	286
Glue	28	30	28	34	26	32
Other supplies	22	38	8	22	27	20
Labour, direct × service	24	20	24	25	35	36
Packaging	5	9	6	10	8	3
Transportation to the port	0	4	3	8	3	0
Charges at the port ⁱ	2	9	4	5	4	0
Sales tax	4	0	0	0	0	0
Total cost up to FOB (Export price)	294 (323)	290 (310)	214 (270)	256 (303)	342 (358)	402 (385)
Ocean freight and insurance to Japan	43	26	31	23	26	–
Ocean freight	40	23	28	20	23	–
Insurance	3	3	3	3	3	–
Japanese import duty	73	67	60	65	77	–
Cost of plywood, delivered Japan						Not wholly comparable due to difference in product (size)^k
Without Japanese import duty	337	317	245	279	368	
After import duty (20%) ^j	410	383	305	344	445	

^aA hypothetical project in East Kalimantan. Most of the log input is to be supplied by the associated companies engaged in logging. Assumes 3-shift operations. More than two-thirds of output is to be exported. Wood residues are to be used as fuelwood at the plant.

^bA joint-venture company operating in Sabah. The plant is located in the vicinity of a port. All output is exported. About 55–60% of log input is from the company's own logging concession in Sabah. The plant is operated on a 2-shift basis. Wood residues are used as fuelwood at the plant.

^cEstimated cost data provided in the "Report on Industrial Strategy Studies," prepared by Michael Roemer and Malaysian Economic Planning Unit, are used to obtain the estimates in 1980 dollars. The model plant is assumed to be located about 60 km from Kuala Lumpur, in Seremban.

^dEstimates based on data supplied by a consulting company, with a warning that the data's reliability is questionable. The data provided have been adjusted for inflation to obtain the estimates in 1980 dollars. Log inputs are supplied by the firm's own logging concession. The unusually high general management cost must be noted; 27% of it is attributed to "office in Manila"; 80% of output is exported. The plant is operated on a 2-shift basis.

^eA plant in operation for more than 5 years. Operated on a 3-shift basis. Log input is entirely imported.

^fEstimates based on the partial data provided by industry and government sources in Japan. Most of the log input is presumed to be "South Sea" tropical hardwood. The product is used mainly for concrete forms. Therefore, the quality of logs used tends to be below average.

^gIncludes amortized preinvestment expenses.

^hIncluding some "welfare" costs such as health room facilities and technical fees (e.g., outside engineers).

ⁱIncludes the cost of loading the ship.

^jThe amount of duty is calculated on the "import price" (i.e., the export price plus freight and insurance), not on the cost up to FOB plus freight and insurance.

^kSomewhat more comparable price would be that for 4 mm thickness plywood, whose wholesale price averaged \$468/m³ in January–July 1980. But note that the Japanese size is 0.91 m × 1.82 m rather than 1.2 m × 2.42 m.

government charges on export logs from traditional sources, international log prices rose sharply in the last 2 years. The national average price of lauan, or meranti, veneerlogs delivered to mills in Japan, thus, rose from U.S.\$92/m³ in 1978 to \$211/m³ in April–June 1980. The “two-tier” prices of logs resulting from the policies to promote local processing critically affect the cost-competitive positions of plywood and other processing industries.

Another important aspect in the plywood-production cost structure is wood-material recovery rate. The wood-material recovery rate in Japan (67.0%) is substantially higher than that in other countries (45.0–52.7%). The main reason, according to industry experts, is the difference in the size of the products. The unique specifications of Japanese building designs result in the bulk of Japanese demand being for 0.92 × 1.82 m plywood. Recovery is much higher for this size (so-called three by six) than for 1.22 × 2.42 m (so-called four by eight) plywood — the standard elsewhere. According to Japanese industry sources, if 1.22 × 2.42 m plywood were made in Japan, the wood-material recovery rate would be as low as 54%. This difference in recovery rate reduces the cost of logs per cubic metre of plywood output substantially (perhaps by as much as 25%).

There does not seem to be a large variation in the cost of glue used by plywood producers in different locations. Whether the producers use locally produced glue or imported glue does not seem to make much difference. “Other supplies” usually include electricity, repairs and maintenance, machinery parts, tapes for mending damaged veneers, etc. The Peninsular Malaysian “model” calculation may have omitted these items and thus underestimated the costs here.

Energy costs seem to have been contained well everywhere because of both the swift change from oil-based fuels to wood residues and the introduction of energy-saving measures. Wood residues that had been either used in particle-board or pulp and paper production or simply thrown away are now being used as fuelwood for veneer drying, hot press, and sometimes electricity generation.

The labour costs are higher in Singapore and Japan than in Malaysia, Indonesia, and the Philippines. Although differences in labour productivity are difficult to calculate and to be properly allowed for, rough estimates of wages are available from industry sources (Table 2). A comparison indicates an enormous difference between Japan and all the other countries, and wages are substantially higher in Singapore and Malaysia than in the Philippines and Indonesia. Even within Indonesia, wages in East Kalimantan are 3.5–4 times the levels in Java.

Accurate comparisons of packaging costs are not possible because the data are not available. However, some observations can be made. As plywood made in Japan is usually delivered to nearby customers, relatively simple packaging for short-distance trucking is sufficient, and, thus, packaging can be presumed to cost less in Japan than for producers elsewhere who are shipping their products to cross-ocean destinations involving loading and unloading of vessels. However, the variations in the cost of packaging probably do not have a decisive impact on the competitive advantage of the countries considered.

Postfactory Costs

Beyond the exfactory costs including packaging costs, there are usually costs of transportation

Table 2. Wages (U.S.\$ / month) in plywood industry in Indonesia, Malaysia, Philippines, and Japan, as of 1980.

	Type of labour		
	Unskilled	Semiskilled	Skilled
Indonesia			
Java	16	24	40
East Kalimantan I	56	68	128–176
East Kalimantan II	60	72	127–175
Malaysia	102	na ^a	na
Peninsular Malaysia	102	na	na
Sabah (including housing)	114	155	273
Philippines	47	68	100
Japan	634	1062	na

^ana = not available.

Source: Estimates are based on information provided by industry sources; conversion of local currency data into U.S. dollars is based on official exchange rates.

to ports, and possibly some taxes, before the goods are on board oceangoing vessels. The reliability of estimates for these items is uncertain. They represent only broad orders of magnitude. The costs for the hypothetical plant in East Kalimantan may be somewhat underestimated because a part of such costs seems to be already included under "general management," "other supplies," and "labour." Differences in these costs do not seem to be important enough to make a critical difference in the determination of the competitive advantage of each location. Plants in Japan, of course, are presumed to enjoy some advantage in this respect over overseas suppliers.

Ocean-freight and insurance costs account for 6–10% of the total delivered cost of plywood in Japan. An interesting and relevant question is: Does the structure of ocean-transport cost encourage or discourage location of plywood production in the log-producing countries, other things being equal? Comparative calculations could be made for Sabah, for example. A wood-recovery rate of 54% would result in the use of 1.85 m³ of logs for each 1.0 m³ of four-by-eight plywood. The transport cost for 1.85 m³ of logs amounts to U.S.\$47.26. In contrast, the shipping cost for 1.0 m³ of plywood is U.S.\$26. Even if a packaging cost of U.S.\$9 were added, the transport-cost economics would favour the location of plywood plants in Sabah rather than in Japan for production of four-by-eight plywood. How do similar calculations work for East Kalimantan? The cost of shipping 1.852 m³ of logs from East Kalimantan to Japan works out to be U.S.\$57.78. This is to be compared with the shipping cost plus packaging cost for 1.0 m³ of plywood of U.S.\$48. If "liner rates" were used, the plywood-shipping cost would be higher by U.S.\$10–15. On the other hand, if many plants were located near the same exporting point so that the volume of traffic is increased and the port conditions improved, then the transfer-freight cost could be reduced by U.S.\$5–7/m³. Thus, although under the current conditions, the cost savings would not be great for shipping plywood instead of the equivalent volume of logs, at the margin, transport-cost economics seem to favour plywood production in East Kalimantan rather than in Japan.

The Japanese import duty of 20% on the CIF value amounts to 17.3–19.7% of the total cost of plywood delivered to Japan from the five locations in Southeast Asia. This tariff represents a rate of effective protection greater than 60%. Obviously, this is one of the key factors for the

continued survival of the plain-plywood production sector in Japan.

Benefits of Increased Processing in Log-Exporting Countries

Local processing of primary commodities that are being exported in raw form is desirable on the grounds of various macroeconomic benefits for the countries producing the primary products.

Value-Added and Linkage Effects

Some indications of the gross value added to logs by processing in Indonesia, Malaysia, and the Philippines are available (Table 3). The gross value added to logs is indicated by the difference between the FOB export-unit value for logs and the "log-equivalent" FOB unit value for the processed products. On this basis, the value-added is equivalent to 23–65% of the log-export unit value for sawnwood, 26–150% for plywood, and rather negligible for veneer sheets. There are several problems in such an approach. On the one hand, log-export prices contain substantial elements of resource rents that are not collected on logs locally processed. Thus, in this method, the value added to log material exported is underestimated by the amount of these charges. On the other hand, the approach ignores "leakages" in value added to foreign industries that provide materials to the processing industry. The leakages to foreign industries should not be a part of the value added locally.

To estimate the true gross value-added in plywood production, I have used cost data for the hypothetical plywood project in East Kalimantan (Table 1). I converted the cost data for plywood into costs per cubic metre of log input. For U.S.\$80/m³ of log cost, the gross value added to the log input is \$90.12/m³ of logs. From this amount, I obtained the amount of gross value-added in a standard sense by deducting the costs of inputs provided by other industries, including logs, from the total price, \$61.63/m³(r). Now even if the ownership of such an enterprise happens to be 100% local, there are some leakages to foreigners who often are a source of equipment and funding. So, domestic gross value-added works out to be about U.S.\$50/m³ of roundwood (Table 4). Currently, Indonesia, Malaysia, and Philippines together export about 36.7×10^6 m³ of logs (estimate for 1979). If one-half of this volume were exported in the form of plywood, it could mean \$1.1 billion worth of gross value-added, or some \$0.9 billion of gross value-added excluding "foreign leakages."

Table 3. Estimated gross value added (U.S.\$/m³ of logs; % of log unit value) to log material by processing in selected countries in Asia, 1977 and 1978.

Country and product	1977		1978	
	\$/m ³	%	\$/m ³	%
Indonesia				
Sawnwood	(-) 0.5	(-) 1.0	15.9	34.3
Plywood	124.6	82.6	na ^a	na
Veneer sheets	na	na	na	na
Malaysia				
Sawnwood	25.3	65.5	25.6	59.5
Plywood	58.4	151.3	60.3	140.2
Veneer sheets	(-) 8.6	(-) 22.3	(-) 17.3	(-) 40.2
Philippines				
Sawnwood	15.2	23.2	16.0	24.3
Plywood	17.0	26.0	28.6	43.5
Veneer sheets	3.3	5.0	2.7	4.1

^ana = not available.

Source: Data have been derived from issues of the FAO Forestry Yearbook (Tape), Rome, Italy, FAO.

As the plywood factory would purchase supplies (apart from logs) from other industries, these purchases represent partly the value-added of other industries—\$26/m³(r) from domestic suppliers — and may be considered to represent backward linkage effects.

Foreign-Exchange Earnings

In the East Kalimantan case, the FOB price of plywood is U.S.\$170/m³ (roundwood), compared with the log price of \$80/m³. If the price of logs were equal to the FOB price of export logs, then the extra value of \$90/m³(r) would represent the increase in gross foreign-exchange earnings, from which foreign leakage costs associated with plywood production would be deducted in calculations of net increase in foreign-exchange revenue per cubic metre of logs.

In reality, the calculations are not so simple because of the resource-rent taxes imposed on export logs but not on locally processed logs. For example, in Indonesia, currently, governmental charges made on each cubic metre of meranti logs exported amount to about U.S.\$50. Most of these are not required on locally processed logs. As a result, there is a price spread of U.S.\$50 or more between the FOB export prices of logs and the prices of logs sold locally. Therefore, until this kind of subsidy becomes no longer needed to promote local processing, net earnings resulting from local processing will be substantially less than the value-added calculations indicate. On the other hand, because of the steep resource rents and the stringent log-export restriction policies, FOB prices of logs have been raised markedly, which is a welcome effect from the viewpoint of the log-exporting countries.

Employment Effects

Estimates of direct-employment effects of plywood production are rather divergent, partly because of the divergent assumptions made about the operations and sizes of mills. The number of persons required for annual production of 1000 m³ of plywood ranges from about 4 to 14, including managerial staff. As for sawmilling, industry-source estimates indicate about 3.2–6.0 persons/1000 m³ of annual production of sawnwood under the current conditions of Indonesia, Malaysia (Sabah and Sarawak), and the Philippines.

Order-of-magnitude estimates for the direct effects of *complete* export substitutions can be made for local-employment opportunities in four log-exporting countries (Malaysia, Indonesia, Philippines, and Papua New Guinea). On the basis of rule-of-thumb labour requirements associated with typical plymilling and sawmilling operations in this region, *direct* extra employment, for the four countries as a whole, would be for 100 000–120 000 workers in plywood and 50 000–60 000 workers in sawnwood.

Regional-Development Effects

The deliberate policies in the Philippines, Sabah, and Indonesia to subsidize an expansion of local processing of logs at the expense of foreign-exchange earnings from log exports and resource rent on logs mean that the net effects of local processing on value-added and foreign-exchange earnings are not likely to be as large as they would be normally. Also, direct-employment effects of increased local processing of logs in the major log-exporting countries in the Asia-Pacific region are rather modest in the context

Table 4. Derivation of value-added in plywood production: a hypothetical case in East Kalimantan.

m ³ of plywood	Gross value-added (U.S.\$)										Backward linkage effect	
	Per-unit cost (U.S.\$)		100% domestic ownership ^a		50% domestic ownership ^b		100% domestic ownership ^a		50% domestic ownership ^b			
	m ³ of logs	Total	Domestic	Foreign	Domestic	Foreign	Domestic	Foreign	Domestic	Foreign	Domestic	Foreign
Depreciation	12.65	12.65	3.80	8.86	3.80	8.86	3.80	8.86	3.80	8.86		
Interests	7.38	7.38	4.80	2.58	3.69	3.69	3.69	3.69	3.69	3.69		
General management	10.01	10.01	10.01	0.0	7.00	7.00	7.00	3.01	3.01			
Logs	80.10	-	-	-	-	-	-	-	-	(152)		
Glue	14.76	-	-	-	-	-	-	-	-	14.76		
Other supplies	11.59	-	-	-	-	-	-	-	-	9.27		2.32
Labour	12.65	12.65	12.65	0.0	12.65	12.65	12.65	0.0	0.0			
Packaging (including labour)	2.64	0.50	0.50	0.0	0.50	0.50	0.50	0.0	0.0	2.14		
Cost from ex-factory to FOB	3.16	3.16	3.16	0.0	3.16	3.16	3.16	0.0	0.0			
Profits	15.28	15.28	15.28	0.0	10.70	10.70	10.70	4.58	4.58			
Total	170.22	61.63	50.20	11.43	41.50	41.50	41.50	20.14	20.14	26.17		2.32

^a Assumes 70% of depreciation represents imported machinery; 65% financing is domestic; all management staff is Indonesian.

^b Assumes 70% of depreciation represents imported machinery; 50% of financing is foreign; 30% of management is foreign; corporate-profit tax of 40%; 50% of after-tax profits go to foreign owners.

Source: Table 1.

of total population and total labour force in these countries.

Processing facilities, however, are likely to be established in the remote areas of these countries because of the location of forest resources. This means that sawmilling and plymilling activities could make a significant impact on employment and industrialization in areas (Kalimantan, Sumatra, Mindanao, Sabah, Sarawak, etc.) that need it most and for which there are few alternative opportunities.

Policy Issues and Prospects

In considering policy options for tropical-hardwood-producing countries in the Asia-Pacific region, one must take into account five important features of tropical-hardwood resources:

- Heterogeneity of the current stands, which contain hundreds of species, only a fraction of which are currently utilized commercially;
- Semirenewable nature of the resources;
- Strong long-term growth prospects of demand;
- The remote and undeveloped areas of the countries concerned (Mindanao, Sabah, Sarawak, Kalimantan, Sumatra, West Irian, Papua New Guinea, etc.); and
- The ownership of the resources, which are in the state-owned forests.

Furthermore, there are two important features of mechanical wood processing that also are noteworthy:

- It is a *relatively* unskilled, labour-intensive activity; and
- It is typically weight reducing and, in the long run, transport-cost saving.

Now, the ultimate policy question is how to utilize the resources to the best advantage of the countries that own them. In terms of current policy stance, the major areas producing tropical hardwood in the Asia-Pacific region can be divided into two groups: states attempting to reduce log exports (Philippines, Peninsular Malaysia, Sabah, and Indonesia) and those with liberal log-export policies (Sarawak, Papua New Guinea, other Pacific islands).

Policies of the Philippines, Peninsular Malaysia, Sabah, and Indonesia have recently been to apply quantitative restrictions on log exports, to increase government charges per unit of logs exported, and to promote local processing of logs. Their objectives are to conserve the semi-renewable resources, to collect maximum resource rent, and to secure benefits from

increased local processing of logs. Increased exports of processed products would presumably result in higher export earnings, higher value-added, higher employment, and regional development of "remote" least-developed areas. The measures taken in these areas seem to be making a significant impact on the market, bringing about the desired restructuring of tropical-hardwood trade in the Asia-Pacific region.

In contrast, policies of Sarawak in Malaysia, Papua New Guinea, and other Pacific-island countries have been to encourage log exports. As a result, these areas have been experiencing rising log exports and increasing foreign-exchange earnings but only a slow growth in processing and low government revenues from forest utilization.

A distinction must be made between two objectives: deriving benefits from local processing and deriving maximum resource rent from semi-renewable resources. The latter objective requires a careful consideration of the projected long-term increases in tropical-hardwood log prices in real terms and the fact that standing trees grow over time.

In Peninsular Malaysia and the Philippines, the appropriate policy direction to take is quite clear. There, forest resources have been exploited for more than 3 decades, and the remaining forest resources are severely limited. Wood-processing industries are well established. The appropriate policy prescription is to phase out log exports completely and to take measures to improve the cost-competitiveness of the processing industries. Experience in Japan, Korea, the Province of Taiwan, and Singapore suggests that the wood-processing industries would be strengthened if the government were to adopt more aggressive, outward-oriented industrial policies.

In Papua New Guinea, the liberal log-export policy seems to be clearly superior. The timber resources are commercially not as attractive as those of the Philippines, Malaysia, and Indonesia (excluding West Irian) because of the low incidence of commercially attractive species, difficult terrain, long distances from the main markets, etc. At present, therefore, it is more urgent to develop markets for the country's species.

In Sabah and Indonesia, which are currently the most important log-exporting areas, policy options are more open than in Peninsular Malaysia and the Philippines or in Papua New Guinea. Sabah and Indonesia (except West Irian) happen to have the richest forest resources in terms of commercially attractive species per unit area. The extraction cost per cubic metre of logs is lower

than in Sarawak or Papua New Guinea. Attracting necessary labour to these places is a problem. The infrastructure required to introduce processing in these areas would be a heavy financial burden. Until exports are built up, transport-cost economics work against such industries. Furthermore, substantial resource rent that could be collected from log exports will have to be foregone during the period of establishment of export-oriented processing industries. Nevertheless, Sabah and Indonesia may consider it politically desirable to develop some kind of industries in the currently "remote" regions for the sake of regional development. For this objective, timber processing is a good possibility and could be used as the core of a regional-development strategy, along with agriculture.

To facilitate the rapid growth of mechanical wood-processing industries, the government should adopt an overall export-promotion strategy like the Republic of Korea's as the general development strategy and, more specifically, undertake necessary steps to:

- Minimize the use of price ceilings and other interventions in the domestic market, which affect negatively the spontaneous growth of the wood-processing industries;
- Improve the efficiency of domestic transport (especially shipping) and port facilities; and
- Develop a few wood-product terminals at strategic locations for smooth and efficient shipment of locally processed wood products to world markets.

At the same time, the industry in these countries should take necessary steps to improve the quality control that is critical in the export business. Joint ventures with experienced foreign companies can be an effective approach at this stage of development.⁵

As for Sarawak, there seems to be room for it to collect higher resource rent on log exports than it does now. The forest resources in Sarawak are not as attractive as those in Sabah or in major forest areas of Indonesia, but commercially valuable species are more numerous and more accessible than in Papua New Guinea. Sarawak may be foregoing both resource rent on logs and benefits of local processing. It may well be a case of benefiting a group of private businesses at the expense of the public interest.

⁵Joint ventures with foreign companies do not necessarily guarantee a faster achievement of technological mastery; however, a recent report prepared by Benjamin F. Sanvictores (1980, unpublished) identifies a vast scope for joint ventures.

One of the issues in plywood trade has been the import duties in industrialized countries, especially their escalated nature. Although the European Community offers preferential duty-free access to developing countries under the Lome Convention and the Generalized Systems of Preferences, other major industrialized countries (Japan, the United States, Canada, etc.) do not give any preferential access on tropical-hardwood plywood. Furthermore, even the EC's preferential duty-free imports are subject to quota ceilings, although the quotas have been steadily increased over time. Because of tariff escalation, the effective rates of protection have been high on tropical-hardwood plywood and have distorted the pattern of trade in tropical-hardwood products.

One reaction of industrialized countries to the recent changes in the log-export policies of major log-producing countries has been to reduce import barriers on veneers and sawnwood, either on the most-favoured-nation basis or on a preferential basis. This is, of course, a welcome trend. However, as the basic economics seem to indicate

that log-producing, labour-abundant countries have the competitive advantage in exporting plain plywood, industrialized countries should, ideally, reduce or eliminate import barriers on tropical-hardwood plywood. Until they do so, the second-best solution in terms of maximizing world economic efficiency is to offset the distortion: log-exporting countries' subsidizing their domestic plywood industries through "two-tier" pricing of logs.

Plywood manufacturing should be the core of a development strategy for mechanical wood-processing industries. If the plywood industry were promoted, sawmilling and production of other wood-based panels, e.g., particleboard, which are complementary to plywood manufacturing, would be automatically promoted. The key to a successful export-oriented sawmilling industry is superior marketing, whereas the key to a successful wood-based panel industry is availability of a large enough market to justify full operation because it is relatively capital intensive compared with other mechanical wood-processing activities.

Discussion

Alhambra Rachman: Let me first congratulate Takeuchi for his fine efforts preparing this manuscript. It was written with finesse, its content well balanced, reviewing changing conditions in prospects for trade of wood products in Southeast Asia.

In accordance with my assignment, my discussion will focus on probable changes of the location of processing in response to policy decisions of governments in timber resource-owning countries, which would initiate a restructuring process in the trade pattern of those products in that area.

In Takeuchi's Table 1, which summarizes a cost comparison of plywood production, data about Japan are included. If Takeuchi's rationale were to indicate the validity of a policy decision to relocate Japanese plywood industry to timber resource-owning countries, I wonder why he did not also include data for South Korea, as it consumes about 50% of its total production, and its industry will be affected by lesser availability of raw material. This is only one of several examples of statistical bias.

In addition, I can't help getting the impression that the analysis carried out in this paper is limited to the present flow of trade, with the U.S. as principal market. This may be misleading in the long term because relocation of an industry would affect the magnitudes of all existing markets and supply points within the Pacific region. Countries that originally are exporters of plywood can become importers, because of scarcity of raw material.

With respect to Takeuchi's coverage, I feel that the analysis is too simple and that his conclusions would have been more reliable if he had expanded his analysis to cover:

- The impact and implications of a more functional integration in the timber business where a company is involved not only in logging operations but also in subsequent processing and marketing activities (a sizable number of logging operations in timber resource-owning countries are set up in the form of joint ventures between local companies and foreign-based partners, and such integration can distort the operation of market forces);

- Future trends of sea transportation costs, which are an important component of import unit value;
- Capital costs, including comparisons of different degrees of capital-intensive operations limited to overall employment generation;
- The impact of negotiated trade agreements on trade flows of plywood in this region;
- Projections of domestic demand for plywood in timber resource-owning countries; and
- Prospects for new markets and new processing technology related to the plywood industry.

My conclusions do not differ much from those of the author. I feel that in the long run there is a necessity for the countries that do not own resources to relocate their timber-processing industry near the raw-material base, but I suspect the present pattern of trade of plywood will still function for a few more years.

Countries where at present the bulk of the plywood industry is located are in a position to slow the process because they have a solid footing

in the market and heavy involvement with managerial, financial, and ownership aspects of logging operations in timber resource-owning countries. Their position will provide them with extra margin in negotiations. In addition, the possible emergence of a new and feasible technology could contribute to an increase of business risk in restructuring for timber resource-owning countries, as it will make the present technology obsolete and therefore more expensive.

The right solution to the freight-cost problem would certainly aid restructuring of the timber industry. The problems in industrial or building standards will also affect entry of Southeast Asian plywood products into the Japanese market. Standard specifications of plywood products in Indonesia, Malaysia, and the Philippines are "four by eight," whereas the Japanese standard is "three by six." The difference in size also affects the log-conversion rate of plywood, which is 54% for the non-Japanese and 65% for the Japanese standard.

Cooperative Fisheries Arrangements between Pacific Coastal States and Distant-Water Nations

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The widespread implementation of extended fisheries jurisdiction (EFJ) throughout the world has meant that substantial fishery resources, which hitherto had been international common property, have become the property of coastal states. One question that this development raises is what is the future role of cooperative fisheries arrangements between coastal states and distant-water nations in the newly created zones. I address the question of whether such arrangements should be viewed as temporary, with the ultimate elimination of distant-water activity in coastal state zones, or as permanent components of the new framework of world fisheries management emerging as a consequence of EFJ. Although many coastal states at the dawn of EFJ viewed cooperative fishery arrangements largely as temporary expedients, the economics of such arrangements indicate that coastal states in the Pacific and elsewhere would benefit from maintaining many, and perhaps most, such arrangements on a permanent basis. This is true whether the coastal states are developing or developed. However, the opportunities for long-term cooperative arrangements in the Pacific and elsewhere are endangered by uncertainties and ambiguities in coastal states' rights to the fishery resources within their zones. Two major sources of uncertainty are the inadequate management capacity of some coastal states and the transboundary nature of many of the stocks in their waters.

L'extension de la juridiction des pêches (EJP), ratifiée par le monde entier s'est traduite par l'appropriation par les états riverains de ressources autrefois propriété internationale. Quel sera, dans ce nouveau contexte, le rôle des accords de coopération relatifs aux pêches dans les nouvelles zones, qui interviendront entre les états riverains et continentaux. On se demande aujourd'hui si ces conventions doivent être temporaires — et déboucher sur l'élimination de la pêche dans la zone éloignée relevant des états riverains — ou permanentes, — et constituer des éléments d'un nouveau cadre de gestion mondiale des pêches résultant de l'établissement des EJP. Même si plusieurs états riverains considèrent ces accords comme des expédients, leur intérêt au point de vue économique commanderait de maintenir certaines de ces dispositions, sinon toutes. Et cela s'applique aussi bien aux états riverains développés qu'en voie de développement. Cependant, l'établissement d'accords de coopération à long terme dans le Pacifique et ailleurs est compromis dans plusieurs régions par l'incertitude et l'ambiguïté des droits de propriété des états riverains sur les ressources halieutiques de leurs zones. L'incertitude se rapporte principalement aux capacités de gestion de certains états riverains et à la nature migratoire des populations de poissons.

As other papers in this conference have stressed, fisheries in the Pacific, as well as in other parts of the world, have been dramatically influenced by the Third Law of the Sea Conference. Extended fisheries jurisdiction (EFJ) has become fact, and important fishery resources, which had been international common property, became the property of coastal states. So extensive has this transformation been that the fishery resources remaining as international common property account for no

more than 1% of the world's fishery harvests (Gulland 1980).

One important issue that the implementation of EFJ raises is the role to be played by distant-water nations — and, thus, cooperative fishery arrangements — in the exploitation of fishery resources within the newly created coastal-state fishery zones. A cooperative fishery arrangement is one in which a distant-water nation participates in the harvesting of a fishery resource in a

coastal state zone, the processing of the harvested fish, or the marketing of the products. This definition covers all joint ventures and so-called fee fishing in which the distant-water nation undertakes all harvesting, processing, and marketing activities and compensates the coastal state in cash or kind.¹

I would argue that the common view among coastal states as they contemplated the advent of EFJ in the mid-1970s was that cooperative fishery arrangements were temporary, and rather unfortunate, expedients to be endured until local harvesting and processing capacity had been built up to utilize fully the newly acquired resources. Thus, the authors of a 1975 study on joint ventures in fisheries argued: "... the joint venture should perhaps be regarded as temporary, since coastal nations, developed and developing alike, nowadays tend to demand greater participation in the fisheries off their shores" (Crutchfield et al. 1975:2).

The question arises, therefore, whether there is a long-term future for cooperative fisheries arrangements between coastal states and distant-water nations in the Pacific or whether the distant-water fishing activity will gradually disappear. The economics of cooperative fisheries arrangements suggest that, in many instances, these arrangements will prove advantageous for the coastal state indefinitely.

However, opportunities for long-term cooperative arrangements will, in some parts of the Pacific, be undermined by uncertainty or ambiguity in coastal-state rights over fisheries in the newly formed coastal-state zones. Although the customary international law has granted coastal states property rights, it cannot ensure that such rights will become established in fact.

Basic Economics

The economics of cooperative fisheries arrangements are a blend of the standard economics of fisheries management and the economics of international trade. Thus, in evaluations of cooperative arrangements, one must begin with an analysis of fishery management in which cooperative arrangements are not an option and move to an analysis in which they are. It is assumed the fishery resource is wholly within the waters of a coastal state.

¹ Instead of thinking of separate categories of cooperative arrangements, it is more sensible to think in terms of a continuum of arrangements, running from the polar extreme of no foreign participation to that of pure fee fishing in which all harvesting, processing, and marketing activities are undertaken by foreigners.

Because the resource is renewable, it is capable of producing a sustainable harvest and, hence, a stream of net benefits to society through time. The object of management is to maximize, over time, the stream of social benefits, however they are measured. This involves ensuring that the harvest flow at any one time yields the maximum benefit to society and ensuring that the optimal stock, or biomass level, is achieved through appropriate investment (or disinvestment) in the resource. Investment (or disinvestment) in the resource is seen to occur whenever the actual harvest falls below (or exceeds) the sustainable harvest or yield, simply by virtue of the fact that, if the harvest is less (or greater) than the sustainable harvest, the resource stock or biomass will increase (or decrease).

The size of the resource stock or biomass influences not only the level of harvests but also, often, the harvesting and processing costs — for example, the greater the numbers of fish, the easier the capture and the lower the cost of harvesting. Likewise, stock density can affect processing — the size of groundfish, for instance, varies with stock density and may have an influence on consumer acceptance as well as processing.

For the sake of simplicity, I have assumed that the price of the fish products accurately reflects the marginal social benefit society enjoys from the harvested fish, that the demand for fish products is perfectly elastic, that the costs of labour and capital constituting fishing effort accurately reflect social costs, and that the supply of the inputs is perfectly elastic. Given these assumptions, the flow of net benefits to society from the harvest can be represented as:

$$\pi_s(x, h, t) = [\alpha(x)p_2(x, t) - c_2(x, t) - c_1(x, t) - m(x)]h(t)$$

where $h(t)$ denotes the harvest rate; x , the biomass; $p_2(x, t)$, the price of the fish product; $\alpha(x)$ the proportion of raw fish usable as finished product; $c_1(x, t)$ and $c_2(x, t)$, unit harvesting and processing costs respectively; and $m(x)$ unit management costs (which relate to fleet size). The object of management can be seen as maximizing the present value of this stream of net benefits, i.e.,

$$\max P.V. = \int_0^{\infty} e^{-\delta t} (\pi_s[x, h, t]) dt$$

where δ denotes the "social rate of discount."

The central problem of fisheries management has traditionally been that fishery resources are, with few exceptions, common property. If no controls are imposed upon the exploitation of a commercially valuable common-property

resource, the efforts to exploit it will expand until the sustainable net economic returns from the resource have been fully dissipated (Gordon 1954).² Moreover, the resource stock will be reduced to a level well below that which is socially optimal.

In fact, the depletion of the resource that occurs in an unregulated, common-property fishery would be socially optimal only if $\delta = \infty$ (Clark and Munro 1975). The reason is simple. The individual fisherman (or company) has no incentive to conserve the resource, to look forward to future harvests: refraining from harvesting likely does no more than increase the harvests of competitors.

It has also been learned, often painfully, that managing fishery resources through the use of global harvest restrictions alone is inadequate from an economic point of view. Thus, if the authorities establish a global harvest quota in a given fishery to maintain the size of the biomass at some desired level but make no attempt to restrict the number of fishing vessels, sustainable net economic benefits are certain to be dissipated. Although fishermen cannot increase the total harvest if the quotas are effective, they can compete with one another for shares of the available harvests. This competition invariably leads to economic waste through the emergence of excessive labour and capital in both the harvesting and processing sectors (Crutchfield 1956).

What is required is some form of control over individuals and vessels. In Canada and elsewhere, attempts have been made to impose direct restrictions on the fleet size and on the number of fishermen in the fishery. The programs have, at best, been partially successful because the incentive for fishermen to expand their fishing effort has not been removed. Economists have advocated the use of landings taxes or individual harvest quotas as alternatives, but these have yet to be used to any significant degree and must be regarded as still being experimental.

Now let it be supposed that the coastal state authorities do have the option of entering into cooperative fisheries arrangements with distant-water nations. Optimal fisheries management now demands that the coastal-state authorities consider the use of foreign harvesters and processing capabilities as alternatives to domestic harvesters and processors.

The basic argument for cooperative fisheries arrangements is no more than a variant of the argument for free trade. Certain distant-water nations may possess a comparative advantage in the provision of particular harvesting or processing (or marketing) services. Hence, it can be mutually advantageous to coastal state and distant-water nation for the coastal state to hire, i.e., import, the relevant distant-water services. The obvious advantage for the coastal state would be reduced unit costs of harvesting or processing at any one time.

Thus, consider a fishery for which coastal-state authorities have only one cooperative arrangement option — the use of a distant-water fleet as exclusive harvester of the resource — the unit cost of harvested fish to the coastal state under the cooperative arrangement would be the ex-vessel price paid to the foreign vessels, $p_1(x,t)$. The price would be determined by bargaining but would presumably reflect the harvesting costs incurred by the foreign vessels. If $p_1(x,t) < c_1(x,t)$, for all x , then the coastal state would minimize its costs for obtaining raw fish by entering a cooperative arrangement.

A less obvious advantage is reduced risk of overinvestment in the resource whenever $p_1(x,t) < c_1(x,t)$ for all x and t . If the coastal authorities do not enter a cooperative arrangement for the lower-cost foreign services, they must offset their extra costs in harvesting by reducing the effort per unit harvest. One way to do this is to increase stock density — overinvestment. When a resource has been excessively depleted, the consequences of overinvestment are an increased investment or stock rebuilding during which harvests are below the sustainable level.³ Overinvestment may also result in smaller long-run sustainable harvests.

The advantages of such arrangements to distant-water nations are much less obvious. The argument that cooperative fisheries arrangements promise them assured supplies of fish is unconvincing, given the existence of a well-developed world market for fish. A somewhat more satisfying argument is, simply, that these arrangements offer profitable exports-of-services opportunities.

Many of the factors giving rise to the cost advantages of distant-water nations are familiar from the standard literature in international economics, whereas others are peculiar to the nature of the fishery.

²If the demand for fish products or supply of fishing effort exhibited finite elasticity, not all net economic benefits from the fishery would be dissipated (Copes 1972a).

³If the stock is not to be rebuilt but rather depleted, e.g., a virgin stock, then overinvestment implies a short-term period of harvesting in excess of sustainable yield.

Factors familiar from the international trade literature include relative capital and labour costs. Thus, in the northeast Pacific relative labour costs have probably been a factor explaining the development of cooperative fisheries arrangements between East-bloc countries, South Korea and Taiwan, on the one hand, and the United States and Canada, on the other. Similarly, Japan would probably be an attractive distant-water partner among developing countries in the Pacific because of its rich physical and human capital (skilled crews).

Factors peculiar to the fishery include seasonality of fisheries combined with nonmalleability of capital, the control of fishing effort, and management costs. Many fisheries are seasonal, lasting a few weeks or a few months. Also, some of them require the use of special equipment that is nonmalleable — it has limited uses during the off-season (Baker 1980; Clark et al. 1979). The combination of seasonal fishing and nonmalleability of capital can easily give rise to attractive cooperative arrangements.

For example, a hake fishery in British Columbia waters normally runs from early July to late October, although the commencement and length of the season are often uncertain. Hake, a low-valued groundfish, has the characteristic of having soft flesh that deteriorates rapidly after capture. The fish is caught far enough from shore that it must be either processed offshore or frozen immediately. Before EFJ, Canadian companies displayed little interest in the fish for several reasons, one of which was that vessels with freezing or processing capacity had inadequate opportunities for use in the off-season. Elsewhere, I (1980) have detailed the consequences of inadequate utilization.

Distant-water nations shift their vessels to different parts of the world over the course of the year; the capital embodied in their vessels is, thus, more malleable than that embodied in vessels confined to a particular region as exemplified by the British Columbia groundfish fleet. As a consequence, when Canada acquired the resource under EFJ, Canadians found it most profitable to exploit the resource through cooperative arrangements (Munro 1981).

Indeed, the hake fisheries in both British Columbia and the American Pacific northwest (northern California, Oregon, and Washington), along with the pollack fishery in the Gulf of Alaska illustrate the complex arrangements with distant-water nations that nonmalleability can produce. In all of these fisheries, joint ventures are for the domestic (i.e., U.S. or Canadian)

trawlers to harvest the groundfish species and deliver the harvest to foreign vessels with processing capacity. The domestic trawlers that engage in these activities invariably regard them as ancillary to their other harvesting activities. For example, many of the U.S. fishermen harvesting pollack in the Gulf of Alaska regard crab fishing as their primary activity. They harvest pollack in the crab off-season when their vessels would otherwise be underutilized. Thus, the perceived marginal cost of harvesting pollack is low. At the same time, it has not proved attractive financially to construct vessels whose primary function would be that of harvesting pollack. Similarly, it has not proved attractive financially to construct vessels whose primary function would be that of harvesting hake farther south.

The result is that the domestic fleets are incapable of harvesting the total allowable catches (TACs) for these resources. This in turn has meant that the joint ventures coincide with substantial fee fishing of the resources by distant-water nations. In 1979, for example, joint ventures accounted for only 9% of the total hake harvested in the Pacific.

Earlier, I argued that one of the unresolved problems of managing wholly domestic fisheries is that of preventing the emergence of redundant fishing effort. One of the advantages to the coastal state of cooperative arrangements involving foreign harvesting is that the burden of eliminating redundant fishing effort is passed to the distant-water nation. This fact could induce authorities to employ the services of distant-water nations even though immediate cost considerations suggest that the harvesting should be done by domestic fleets.

The relevance of resource management costs to cooperative fisheries arrangements arises from the need to control policing costs. If a coastal state refuses to enter into cooperative fisheries arrangements, the surveillance and enforcement costs in preventing poaching by resentful distant-water fleets could prove prohibitive, even if the coastal state were a wealthy developed state. Thus, just prior to EFJ, J. Alan Beesley, the leader of the Canadian delegation to the Law of the Sea Conference, argued that an important reason that Canada was seeking to ensure the cooperation of distant-water nations was to keep surveillance and enforcement costs to a manageable level (Munro 1977b).

Admittedly, the management-cost argument for cooperative fisheries arrangements strains the definition of comparative advantage and perhaps would be more appropriate in discussions of

bribery. Another noncomparative advantage argument for cooperative fisheries arrangements that deserves recognition concerns prices, rather than costs. Up to this point, the assumption has been that the prices of fish products are unaffected by cooperative arrangements or the lack thereof. This assumption is not always valid. There may be cases in which the cooperative arrangements will result in reduced trade barriers and thus a higher return on the fish products. Thus, for example, a distant-water nation enters into a cooperative arrangement with a coastal state and imports the resultant product: the tariff authorities within the distant-water nation, regarding the fish as being in part their own national product, may impose a lower duty on the product than they would had the products involved coastal-state harvesting and processing exclusively. Hence, even though a comparison of costs might favour exclusive domestic harvesting and processing, maximization of the coastal state's net economic benefits from the resource could well call for the establishment of cooperative fisheries arrangements.

The actual form that a cooperative fisheries arrangement takes depends upon cost factors along with what might be termed special bargaining considerations. It has been argued that fee fishing provides the coastal state with less control, and presumably less bargaining power, than do joint ventures where the coastal state plays a direct role in the harvesting or processing of the resource (Tomlinson and Brown 1979). If this is in fact the case, then the coastal state has an incentive to establish joint ventures, even though comparative advantage considerations alone point to fee fishing as optimal.

Given that the basic argument for cooperative arrangements is no more than a variant of the standard free trade argument, then, as to be expected, the arguments advanced within coastal states against such arrangements are no more than the standard arguments for protection. Indeed, if one were to turn to any major elementary textbook in economics and list the arguments, both legitimate and fallacious, for protection contained therein, one would be hard pressed to find any that have not at some time been used in opposition to cooperative fisheries arrangements.

For example, attempts in Alaska to establish cooperative arrangements in which American vessels harvest groundfish for delivery to foreign processing vessels have been vigorously opposed by domestic processors who complain about the unfair competition from foreign offshore proces-

sors that have access to cheap labour. As well, the supporters of the domestic processors warn of the adverse consequences for the U.S. balance of payments of allowing foreigners to process Alaskan fish (Munro 1981). A much more respectable argument is for the development of infant industries.

Before EFJ, many coastal-state fishing industries, without distant-water nation pretensions, viewed fisheries under international jurisdiction to be unduly risky. The attitude was particularly true for fisheries requiring special equipment. Distant-water nations were much less concerned by the uncertain future of the resources. Indeed, in many instances, distant-water fleets engaged in "pulse fishing" (Tanaka 1980:2) in which the resources were heavily exploited on a temporary basis and then abandoned until they were restored.

With the coming of EFJ, resource uncertainty was reduced and coastal-state fishing industries took a greater interest in their exploitation. However, the coastal-state fishing industries were at a disadvantage vis à vis distant-water counterparts because they lacked necessary fleet and plant capacity or necessary skills and techniques. Thus, at least some of the relevant fisheries advanced the argument that they would prove to be the more efficient exploiters of the resources if only given the necessary time to develop the requisite harvesting and processing capacity or the time to acquire the appropriate skills. The infant-fishery argument could be used to support either the proposition that cooperative fishery arrangements should be banned or the proposition that such arrangements be allowed, but on a temporary basis only.

Unquestionably in some instances, the argument will prove to be valid. Like all versions of the infant-industry argument, however, it can be easily abused by those who demand protection for infants who have negligible prospects for reaching maturity.

The Future of Cooperative Fisheries Arrangements

At the dawn of EFJ, a view prevailing in many coastal states was that voiced in 1974 by the then Canadian federal minister responsible for fisheries (Tomlinson and Vertinsky 1975:2570):

The long term is for Canadians. Canada is not only going to reach out and encompass all of the living resources of her continental slope and shelf, we are going to make sure that they are harvested by Canadians in Canadian owned vessels and processed in Canada as well.

This argument — that current cooperative fisheries arrangements are no more than temporary expedients — is simply an argument to the effect that, where cost (or price) relationships currently favour a cooperative arrangement, these relationships will be reversed over time. To illustrate, one can return to the original example of a cooperative arrangement in which foreign harvesting is combined with domestic processing (and marketing) and in which $p_1(x,t) < c_1(x,t)$ for $0 \leq t < T$ and $p_1(x,t) > c_1(x,t)$ for $T \leq t \leq \infty$. It will be recalled that $p_1(x,t)$ denotes the exvessel price to foreign vessels and $c_1(x,t)$ denotes domestic unit harvesting costs.

The cooperative arrangement can be viewed as temporary if there exists a switching time $t = T$, $0 < T < \infty$, such that $p_1(x,t) < c_1(x,t)$ for $0 \leq t < T$ and $p_1(x,t) > c_1(x,t)$ for $T \leq t \leq \infty$. On the other hand, if $T \leq \infty$, then the conditions exist for a permanent arrangement. A switch or reversal is possible if the coastal state's fishing industry actually proves to have a comparative advantage when it has acquired the necessary skills or built up its capacity.

In part, industry factors may well produce cost reversals in selected cases. However, this admission is quite different from the argument that they will be sufficiently powerful and pervasive to bring about cost (price) reversals in all cases. Whereas it is difficult to prove that cooperative fisheries arrangements will have a long-term future in the Pacific and elsewhere, the reverse argument — that *all* cooperative arrangements will eventually be undermined and eliminated — is unreasonable if not untenable. In North America at least, the view has lost ground. In Canada, despite protectionism, the policy of marine autarchy advocated by the former fisheries minister in 1974 is no longer taken seriously, and the likelihood that the cooperative arrangements for harvesting hake, for example, will give way to exclusive domestic harvesting and processing in the foreseeable future is regarded as negligible (Munro 1981).

In the United States, the shift in attitude has been even more striking and is illustrated by the decisions taken about groundfish in Alaska. As a consequence of EFJ, the United States gained control over immense groundfish resources in waters off Alaska, the bulk of which consisted of low-valued pollack. In the late 1970s, the annual harvests of Alaskan groundfish of some 1.4 Mt accounted for an estimated 9% of the world supply of groundfish and exceeded the entire U.S. consumption of groundfish (Stokes 1980b). Of these harvests, less than 1% was accounted for by American fishermen, the remainder being

accounted for by several distant-water nations of which Japan was the most prominent (Munro 1980).

Nonetheless, the American authorities expected a large expansion of the U.S. fishing industry based upon these resources. The resources were mentioned specifically in the legislation establishing the American EFJ [U.S. Congress, Fishery Conservation and Management Act of 1976, Section 2(b) (6)] and figured prominently in the National Marine Fisheries Service plan for the development of American fishing activities (U.S. Department of Commerce 1976).

The United States, in allowing distant-water nation participation, made no attempt to maximize its return from the fishery. Quotas were assigned on the basis of historical fishing rights, and the fees paid by distant-water fleets were set at low levels. Although this behaviour reflected an ambiguity in the U.S. view of its property rights over the resources, it also reflected in large measure a belief, on the part of the American authorities, that foreign exploitation of the resource would be all but eliminated by an expanded American fishing industry (Munro 1981; Stokes forthcoming).

By 1980, it was becoming evident that the expected expansion in the U.S. industry was not going to come about unless the economics of the fishery underwent a radical change (Stokes forthcoming). The infant appeared to be stillborn.

The American authorities were thus faced with the option of either tolerating the presence of distant-water fleets in their Alaskan waters on an indefinite basis or reducing their presence by legislative means. Ultimately, the authorities accepted the former option, passing the American Fisheries Promotion Act (AFPA) in December 1980 (U.S. Congress 1980a). With this legislation, the American authorities adopted a new policy of attempting to extract a positive return from foreigners harvesting within the American zone. In so doing, the American authorities tacitly conceded that the foreign presence in the Alaskan groundfish fishery would be indefinite.

Under the new policy, popularly referred to as the "fish-and-chips" policy, the Americans are now prepared to abandon their historical fishing rights approach and to use harvest allocations as bargaining counters or "chips." The legislation clearly allows the Americans freedom to use fees imposed upon foreigners as a means of extracting resource rent [AFPA Section (b) (10)].

Although I cannot speak with equal authority on shifts in attitudes in other Pacific coastal

states, it would be surprising if the experience of Canada and the United States proved to be unique.

Although the prospects for long-term cooperative fisheries arrangements are good, in several parts of the Pacific an important barrier exists to their development. The barrier takes the form of uncertainty or ambiguity in the nature of coastal-state property rights to the fishery resources acquired under EFJ.

Three observable reasons are: inadequate management capabilities in the coastal states, existence of shared stocks, and ideological or philosophical constraints. If a coastal state lacks the capacity to provide effective stock assessment and effective surveillance and enforcement, then the property rights lack substance. As a consequence, the resources revert, on a de facto if not de jure basis, to their former common-property status. Distant-water nations that enter into arrangements with the coastal state are given every incentive to discount the future of the resources heavily and every disincentive to honour their obligations. Hence, the prospects for long-term arrangements are highly unpromising.

The fact that fish are mobile has meant that many stocks encompassed by coastal-state fishery zones either are shared with other coastal states or are shared with distant-water nations because they cross the zone boundaries into the high seas. Thus, the resources constitute joint property. If the joint owners of a resource can cooperate effectively, they can introduce an optimal management program, even though their goals and interests differ (Munro 1979). However, without such cooperation, the common-property conditions emerge (Levhari and Mirman 1980) and the prospects for long-term cooperative arrangements would be seriously undermined. The greater the numbers of joint owners, the poorer are the chances for effective cooperation.

Uncertainty attributable to inadequate management capabilities and the transboundary nature of stocks is illustrated by the tuna fisheries in the southwest Pacific, the Pacific islands region. Because tuna are highly migratory, the major species in the region (yellowfin and skipjack) are widely shared among the island states and territories. Although there is not the problem of tuna crossing zone boundaries into the high seas in large numbers (Gulland 1980), tuna do cross the boundaries of 23 diverse states and territories — a fact that makes difficult the coordination of a management policy. In addition, many

of the states and territories have small populations, are underdeveloped, and, hence, are seriously lacking in surveillance and enforcement capabilities (Miles 1981).

There does exist a regional coordinating body in the form of the so-called South Pacific Forum Fisheries Agency, which includes the island states plus Australia and New Zealand. The agency has proved unwieldy, however, and, thus, of questionable value as a coordinating body. An attempt is now being made to establish a more cohesive coordinating body consisting of Papua New Guinea, the Federated States of Micronesia, the Gilberts, the Marshalls, the Solomons, Nauru, and Paulu. This group's zones account for 70% of the yellowfin and 90% of the skipjack harvests (Miles 1981). Whether it will prove to be effective is uncertain.

Many of the states and territories in the region will probably not have the capacity to harvest the tuna resource for many years. Hence, the scope for cooperative arrangements is substantial, a considerable number of arrangements having already been established. Japan, by far the most important of the distant-water nations operating in the region, has established arrangements with 16 of the 23 states and territories in the region.

At present, however, distant-water nations have an incentive to underreport their harvests and a complementary incentive to fish heavily now in fear of uncontrolled and uncontrollable entry of new distant-water nations in the future (E. Miles, personal communication). How coastal-state surveillance and enforcement capacity and coastal cooperation can be improved sufficiently to prevent the common-property syndrome from developing unchecked is not at all clear.

Another source of ambiguity of coastal-state property rights arises from ideological or philosophical constraints. In this case, a coastal state may have ample power to manage the relevant resources and may have to share them with no one but is reluctant to lay explicit claim to property rights over the newly acquired resources.

Although I would be hard pressed to point to a case in the Pacific where such reluctance has damaged the prospects for long-term arrangements, I can point to an important near miss involving the American groundfish resources off Alaska. The American position on fisheries during the preparations within the UN leading to the Third Law of the Sea Conference was that coastal states should have exclusive management, but not property, rights to fishery resources within their zones; that, as manager, or steward, of the

resources, they should be allowed preferential harvesting rights within their zone; that they should allocate any surpluses within the total allowable catch (TAC) to distant-water nations; that they should not expect a return on such surpluses; and that the fees imposed on the distant-water fleets should be for the sole purpose of defraying management costs (Munro 1981).

The Law of the Sea Conference rejected the American approach in favour of an approach in which the coastal states were to be given explicit property rights to the fishery resources in their zones. Nonetheless, the spirit of the American position became embodied in the Fishery Conservation Management Act of 1976 (Munro 1981).

Economists had long objected to the American approach on the grounds that, although apparently altruistic in nature, it could easily lead to economic mismanagement of coastal-state resources (Anderson 1974; Christy 1973; Munro 1977a). The coastal state would be faced with an irresistible temptation to acquire property rights over the resources in its zone indirectly by minimizing surplus portions of the TACs.

The implications for cooperative fisheries arrangements were twofold. First, although joint ventures would not be precluded, their future would be dubious because any foreign involvement in the fisheries would weaken the coastal state's indirect property claims to the fishery resources (Munro 1981). Second, fee-fishing arrangements would, almost by definition, be eliminated over time.

The largest fishery resources acquired by the United States under EFJ consisted of the groundfish resources in the Bering Sea and Gulf of Alaska. An overwhelmingly large percentage of the harvest of these resources has, since EFJ, been taken, not by domestic vessels for onshore

processing nor under joint-venture operations, but by foreign vessels on a fee-fishing basis (in 1979, 96% of the harvest) (Munro 1981).

In keeping with the philosophy that coastal states should not profit from foreign harvests in their fishery zones, the American authorities levied only very modest fees on foreign vessels exploiting Alaskan groundfish. Indeed, the fees were probably not adequate to compensate the United States for the management costs implied by the presence of the foreign vessels (Munro 1981). When it became clear that domestic harvesting was not going to expand and exploit the resources, the Americans were faced with the option of tolerating the presence of distant-water fleets in their zone indefinitely or of removing it by legislative force. Although they eventually adopted the former option, there was, in Congress, a serious attempt to adopt the second option.

Conclusions

Two policy questions still require serious investigation. The first concerns the requirements for long-term cooperative arrangements that will be mutually beneficial to the partners. To date, the majority of cooperative arrangements have been short term and ad hoc in nature. The second, and more difficult, question is how to upgrade coastal-state management capacity and to ensure acceptable management of transboundary stocks. In the regions where this question remains unresolved, it will threaten not only the future of cooperative fisheries arrangements, but the EFJ itself.

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Discussion

K. Hemmi: One should look at Gordon Munro's provocative paper carefully. It deals with prospects for cooperative arrangements over the long run. As Catherine Wallace pointed out, joint-venture arrangements have a multiple function. However, the prevailing view in many coastal states is that joint ventures are temporary expedients. Gordon Munro does not think so. In his opinion, excluding foreign fishing fleets from

some fisheries will result in economic losses because the fishery resource is renewable. Moreover, he comments that, if a coastal state refuses to enter cooperative arrangements, the surveillance and enforcement costs in preventing poaching by resentful distant-water fleets may prove prohibitive.

He is pessimistic about the possibility of developing infant industries in the coastal states,

although cooperative arrangements, especially joint ventures, are seen by some as a shortcut to the development of the fishing industry (providing skills, technology, capital and equipment, processing and marketing advantages). Past records of efforts by coastal states to develop their fishing industries, generally speaking, support the author's pessimism. However, I hope that the efforts of Japan, both public and private, to support development of the fishing industries in the South Pacific, for example, will be successful. I do believe that fishing industries in developing countries could play an important role in overall economic development.

As a consequence of EFJ in American and Soviet waters alone, 1000 Japanese vessels became underutilized. This is an important statistic in view of Munro's discussion of the seasonality of some fisheries combined with the nonmarketability of capital investments. I agree with his concern for stressing such facts. I would add that marketing of catch also is extremely important, especially when the species of fish are not consumed in the coastal state.

The free-trade position taken by Munro assumes that both parties have or will acquire perfect knowledge about the optimum amount to be harvested, about harvesting and processing

techniques, and about markets for the products in cooperative fisheries arrangements. The experience of the Japanese in negotiations with coastal states for licenced fishing quotas is that there is a lack of such knowledge. I think that securing perfect knowledge about the fishing industry is an important bargaining point in most cooperative arrangements. Arrangements that actually provide the necessary knowledge to coastal state personnel are, by their nature, temporary and will not ever be a permanent component of the new scheme of world fisheries management.

Finally, as pointed out repeatedly during this conference, unemployment problems in the fishing industry are very serious, and coastal states facing such problems may have a legitimate reason for supporting development of this domestic industry.

In summary, I believe that Munro's paper is a landmark in fishery economics but that he should not be so pessimistic about the prospects for developing infant fishing industries, especially in developing states with extended fisheries jurisdiction. I also believe that unemployment or underemployment may be regarded as more important than his economic arguments and may be a legitimate basis for efforts to develop domestic capacities in newly acquired jurisdictions.

Fiscal Policies and Resource Rents in the Extraterritorial Oceans

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A new law of the sea was essential if the potential economic value of the old extraterritorial seas were to be put to the service of humanity. The informal *Draft Convention* from the Third Law of the Sea Conference went a long way toward developing a system that avoids the dissipation of economic rents for the natural resources in the oceans. It does this mainly through the creation of the 200-mile exclusive economic zones (EEZs) for coastal states. For the ocean resources that remain outside the extended sovereignty of nation states, principally a minor part of world fisheries and the deep-sea polymetallic nodules, new international regulatory systems have been required. The new law of the sea provides for a flexible system of fisheries management based on regional organizations. More detailed arrangements were laid down for deep-sea mining. If deep-sea mining turns out to be highly profitable, the proposed arrangements will restrict its expansion but leave a considerable part of economic rent with investors. This might eventually be seen as a weakness of the system, which could be reduced through the introduction of general income tax obligations and competitive bidding for leases. If deep-sea mining turns out to be a marginally profitable activity in favourable conditions, the proposed fiscal arrangements will not be an important deterrent to development.

L'établissement d'un nouveau droit de la mer constituait une mesure essentielle pour mettre au service de l'humanité la valeur économique de l'exploitation des eaux extra-territoriales. L'avant-projet informel de la III^e Conférence sur le droit de la mer va très loin dans la mise en oeuvre d'un système de droit de propriété des ressources maritimes visant à éviter le gaspillage de la rente économique. Ce système repose principalement sur la détermination d'une "zone économique exclusive" de 200 milles réservée aux états riverains. Quant à l'exploitation en-deçà de cette zone, qui concerne une faible partie des pêches mondiales et les nodules métalliques qui tapissent les grands fond océaniques, il a été nécessaire d'instaurer de nouvelles législations internationales. Le nouveau droit de la mer permet à des organismes régionaux d'exercer une gestion des pêches très souple. Cette formule paraît rationnelle et la politique fiscale établie offre une gamme de choix aux futures organisations. La politique internationale de la conférence a élaboré des clauses plus détaillées en prévision de l'exploitation minière des océans. Si ces opérations s'avèrent très rentables, la convention proposée limitera les activités des investisseurs mais elle leur garantira une grande part de rente économique. Ce peut être là la faiblesse du système qui pourrait cependant être corrigée par l'imposition de taxes sur le revenu et la mise en enchères des permis d'exploitation. Mais si l'exploitation minière des fonds marins ne devenait qu'une activité marginale, les mesures fiscales proposées ne devraient pas constituer un frein au développement.

For nearly 8 years, the Third Conference on the Law of the Sea has been meeting under United Nations auspices in an attempt to establish a system of law for the nonterritorial oceans and to delimit individual nations' sovereignty in the oceans. Early in 1981, Ambassador Koh of Singapore, who chairs the conference, expressed hope that a session in August would reach agreement on the long negotiations, based on an informal draft of August 1980. However, the new

United States administration is reviewing the United States' position on the draft and has warned that this timetable is unrealistic.

Nevertheless, the progress that has been made so far in negotiations provides substantial insight into the system of law that is likely to be established and therefore allows one to say something about systems of fiscal policy that would be appropriate under the new law. The 1980 draft discusses in considerable detail fiscal arrange-

ments in deep-sea mining but is less specific for fisheries. Although the Reagan administration has taken strong exception to some elements of the draft arrangements on deep-sea mining, the fiscal arrangements do not seem to be a main contention at this stage, presumably because they favour the interests of private investors from the advanced industrial countries (Jagota 1981). However, if the United States sends other issues in the draft back to the negotiating table, other countries may take the opportunity to reopen discussion on the fiscal arrangements.

The issues revolving around the fiscal arrangements have been introduced in earlier Pacific Trade and Development conferences (Alexander and Christy 1977; Gorham 1978). Although the issues concern the whole of the international community, they have a special relevance for the Pacific: the Pacific is the most important habitat of the highly migratory species of fish, especially tuna, whose management will be greatly affected by the new arrangements; and the Pacific at this stage seems to provide the most favourable sites for the mining of polymetallic nodules from the ocean floor. The prospective new law of the sea has already precipitated the formation of one new subregional resource management agency, the Forum Fisheries Agency, in the southwest Pacific region.

Natural Resource Rents

A characteristic of natural resources is that in favourable circumstances they can generate economic rent, that is, their exploitation can yield income in excess of the sum of the supply prices of all the economic inputs that are necessary for the activity.

The favourable circumstances include the presence of a system of law that restricts entry into resource exploitation through the establishment of property rights. In the absence of controls on access to a resource, more and more other resources will be applied to its exploitation, beyond the point where the marginal cost of inputs exceeds the value of the incremental resource-based production, until total costs of inputs equals total value of output (Gordon 1954). At this point, by definition, the common-property resource yields no rent.

The theory of economic rent applies to both renewable and nonrenewable resources, although there are characteristic differences between the two types of natural resources that become important to the analysis of economic rent in some circumstances. The classical theory of resource rent was originally developed for a

renewable resource: agricultural land, which, with good management, could be cropped continually without loss of productive power. Part of the classical interest in resource rent was that it was potentially a source of nondistorting taxation.

In the classical theory, renewable-resource rent arose from the fact that the quality of the resource determined its ability to generate output. Economic rent was a measure of the differential and depended on the amount by which the unit cost of production on a specific piece of the resource (land) was below that on a marginal piece.

Clunies Ross and I (forthcoming) have recently demonstrated that the classical concept of economic rent is directly applicable to nonrenewable (mineral) resources in terms of total output over long periods but not in terms of annual output. In place of a rising marginal cost of production in a single time period from renewable resources, one must think of a rising marginal cost of production over the whole of the economically relevant future. Prices and unit costs from different times must be made relevant to the present by the application of appropriate discount rates. For mineral resources, this means that the marginal resource is the highest-cost mineral deposit being exploited not only at a particular time — as is the case with renewable resources — but also indefinitely.

Although the conceptual bases for rents from renewable and nonrenewable natural resources find common ground on the simple classical assumptions, the characteristic difference is that nonrenewable resources are not sustainable at any economically realistic level of production. A renewable resource takes on this property of a nonrenewable resource when either the environmental or biologic components necessary for renewal are destroyed by too-high levels of production. The destruction may be to the physical environment. Environmental destruction is exemplified by soil erosion; biologic, by overfishing. To avoid biologic destruction, scientists have introduced the concept of maximum sustainable yield, unique to renewable resources. The classical theory of rent can be applied only to levels of production at or below the maximum sustainable yield of a renewable resource.

Common-Property Resources

Uncontrolled access to natural resources dissipates economic rents in two ways that are common to renewable and nonrenewable resources and a third that occurs only with renewable resources. In the first, resources continue to be

attracted into the expansion of production from the common-property resource until average cost of production equals price, when, by definition, the resource yields no rent. In the second, additional resources are attracted into exploitation of a natural resource even when they are unnecessary to the full utilization of the resource — that is, there is wasteful duplication of investment. The investment is attracted by the opportunity to share in the economic rents even when the additional investment adds nothing to total output. The extreme case is pure duplication of investment, which occurs when production units race each other to deplete a nonrenewable resource or the periodic yield of a renewable resource. Examples include oil producers drilling the same field, thousands of diggers bearing the overhead costs of migration in a gold rush when hundreds could have fully exploited the field over a longer period, or a large number of boats producing in a short time a catch that could have been managed in a proportionately longer time by a small number utilizing their capacity more fully. In the third, when the price of the resource-based product is higher than is necessary to induce production at the maximum sustainable yield, total output actually contracts, and potential economic value is dissipated to an even greater extent than with either the first or the second way.

When application of ancillary resources yields positive but diminishing increments in resource-based produce, none of the additional inputs duplicates existing productive capacity. This level of production is exemplified by the exploitation of a fishery below the intensity required to generate maximum sustainable yield or the exploitation of a mineral deposit. (I have assumed that the resource is sufficiently small for its output not to affect world prices of the resource-based product.)

In Fig. 1, unit prices and cost of production are shown on the vertical and quantities of production on the horizontal axis. MC represents the marginal cost and AC the average cost of producing the natural resource-based product. With uncontrolled access to the resource, output expands until average cost equals the given price, OP at OQ_2 . However, the addition of productive inputs to expand output beyond OQ_1 is associated with unit costs in excess of the price of the product. The total excess cost of producing beyond OQ_1 is represented by the horizontally shaded area BCD.

The economic rent generated by exploitation of the resource is maximized when production is confined to OQ_1 , where at Q_1 the marginal cost of

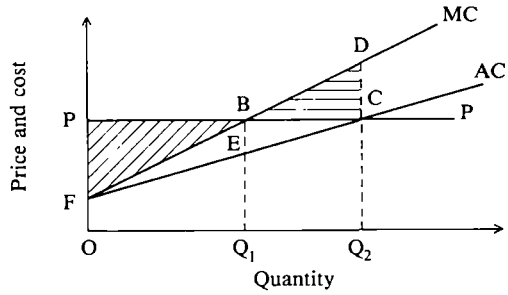


Fig. 1. Dissipation of economic rents in the common-property resource: no decline in total output and no pure duplication.

production equals the product price. The total economic rent is the total surplus of revenue over production costs, at point Q_1 (described by the obliquely shaded area FBP). The area FBP equals the area BCD.

I should distinguish the dissipation of rent described in Fig. 1 from the more extreme case where there is pure duplication of productive effort so that at least part of the additional resources applied to exploitation yields no output, quite independently of considerations associated with overexploitation of a renewable resource.

In practice, uncontrolled access to a natural resource is likely to lead to the dissipation of economic value simultaneously through the first and second ways. When the resource is renewable, the first and second processes of dissipation will be, if product price is sufficiently high, accompanied as well by the third.

Fig. 2 describes how, in the application of increased productive capacity to the exploitation of a renewable resource beyond a maximum (corresponding to output OQ^*), production falls. Average costs continue to rise. The marginal cost curve is discontinuous at point OQ^* : marginal cost is infinite. So long as the product price

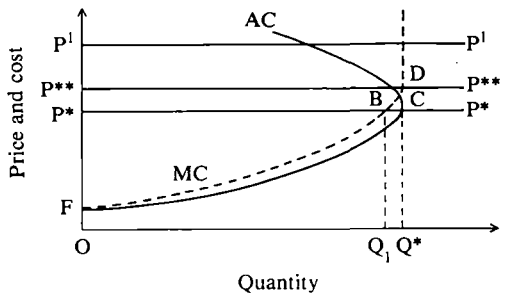


Fig. 2. Dissipation of economic rents in the renewable common-property resource: possible decline in total output and no pure duplication.

remains below OP^* , the analysis is similar to that for Fig. 1: productive effort is expanded until average cost equals price and, beyond the point B at which marginal cost equals price, causes dissipation of renewable-resource rent. The maximum sustainable yield of a common-property resource is always an inefficient level of production at the price that encourages it; at this price, economic rent would be maximized if production were restricted to OQ_1 , corresponding to the point at which marginal cost equals the price OP^* .

Renewable resource rents could be maximized at the maximum sustainable yield only at a price equal to or greater than OP^{**} , greater than OP^* , at which price equals the marginal cost of production at the maximum sustainable yield.

Resource rents are maximized when access to the resources is restricted so that price is equated with marginal costs of production or when production is restricted to the maximum sustainable yield when price exceeds the marginal cost of producing the last marginal contribution to maximum sustainable yield. In most modern societies, mechanisms have been established for restricting access to land-based natural resources in the interests of economic efficiency through the assertion of state ownership, with exclusion rights being granted to private investors by agreement with the state (for example, minerals in all Pacific countries except the United States) or with the establishment of a system of private property rights (for example, agricultural land). The conferences on the law of the sea have been working toward the establishment of a system of property rights that will allow the exploitation of extraterritorial ocean resources by private investors by agreement with various international authorities. The new system requires mechanisms for limiting access to ocean resources to generate economic rent and to secure appropriate distribution of that rent. A closely related matter is the relationship between resource rents and the rents from monopoly in commodity markets.

Resource Rents and Monopoly Rents

The consumer is an often-forgotten participant in the exploitation of resources; in fact, conflict may arise between producers and consumers. Although demand is infinitely elastic over the relevant range of production, consumers are indifferent to the level of production; however, when price is responsive to the level of production, consumers benefit from higher levels of production even if resource rent is dissipated. Much of the fisheries-management literature overlooks this distinction and proceeds as if rent

maximization through the equation of marginal cost and marginal revenue defined an economically efficient level of production (Young 1977:115–117 and the references cited therein). This is the opposite error common among modern libertarian neoclassical economists who tend to see all resource rents as monopoly rents (note the popular statements of Milton Friedman on OPEC).

I propose that:

- Producers and consumers taken together are better off (abstracting from the possibility of the marginal utility of money being greater for consumers than for producers) by restricting production to the level at which marginal cost of production equals price, than with the normal outcome in the common-property resource where output expands to equate average cost and price. Consumers alone are better off with the common-property resource, so long as productive effort in relation to the exploitation of a common-property resource is not greater than is necessary to produce the maximum sustainable yield.

- Producers and consumers taken together are better off when marginal cost is equated with price than when producers use monopoly power in the product market to equate price with marginal revenue, although producers alone may be better off, in a similar position, or worse off through restricting production to equate marginal cost with marginal revenue.

- The interests of consumers coincide with the interests of producers in restricting maximum productive effort to the level that is necessary to produce at the maximum sustainable yield.

Fig. 3 compares welfare effects to equating marginal cost and price with the common-property resource equation of average cost with price,¹ in a world that is defined as in Fig. 1 in all respects other than the downward sloping demand curve.

DD^1 is the demand curve, CMC the marginal cost curve, and CAC the average cost curve. In the common-property resource, output is OQ_1 and price OP_1 . Marginal cost of production, P_3 , is in excess of the level that consumers are prepared to pay for the product at output OQ_1 . Marginal cost equals price at point E, corres-

¹Some of the argument in Fig. 3 and 4 will be made by Clunies Ross and me in a forthcoming publication. The use of analysis along these lines in welfare economics was surveyed by Currie et al. (1971). The argument is valid so long as income effects are relatively small — a condition that would seem to be met for analysis of extraterritorial ocean resource production at present.

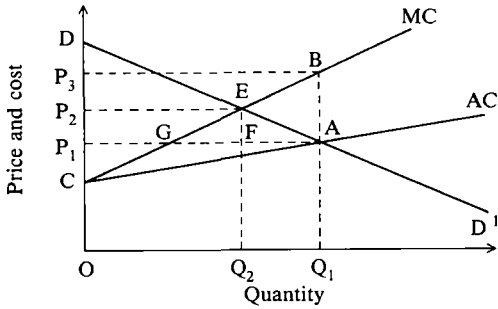


Fig. 3. Welfare effects of natural resources with exclusive property rights and common-property resources.

ponding to the lower output OQ_2 and higher price P_2 . Consumer surplus is greater at the higher than at the lower output, the reduction in consumer surplus being measured by the quadrilateral P_2P_1AE . Resource rent is greater at the lower than at the higher level of output, the increase being the triangle P_2CE .

The sum of resource rent and consumer surplus in the common-property resource is the area covered by the triangle DP_1A . (There is no resource rent.) The sum of resource rent and consumer surplus when marginal cost equals price is given by the triangle DCE . The quadrilateral DP_1GE is common to both areas so that the sum of consumer surplus and natural resource rent in the common-property resource is less than the equivalent sum when marginal revenue equals price if the residual area EGA is less than the residual area P_1CG . The theory of the common-property resource indicates that the area P_1CG equals the area GAB . Since EGA is contained by GAB , the sum of the surpluses is lower in the common-property resource.

Fig. 4 compares welfare effects of equating marginal cost and price with the situation that would exist if monopoly power were used in the product market so that marginal cost was equated with marginal revenue.

The marginal cost curve CMC and the demand curve D^1 are as in Fig. 3. With competition in

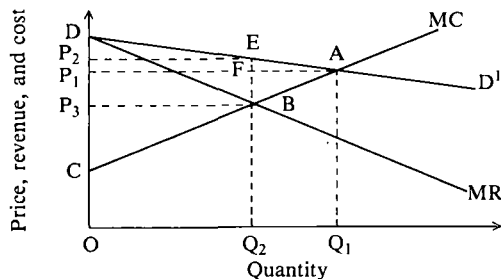


Fig. 4. Natural-resource rents and consumer surplus with monopoly and competitive product markets.

product markets, marginal cost and price are equated at A , corresponding to output OQ_1 and price P_1 . If monopoly power in the product market is fully exploited, production is restricted to OQ_2 , at which product price is P_2 and marginal cost of production the lower level P_3 .

The sum of resource rent and consumer surplus is described by the area DCA with competition in product markets. With the exercise of monopoly power, resource rents are reduced to P_3CB and consumer surplus to DP_2E . However, monopoly rents totaling P_2P_3BE accrue to the producer in the latter situation. The total of resource rents, consumer surplus, and monopoly rents is described by the quadrilateral $DCBE$ when monopoly power is exercised. $DCBE$ falls within the area DCA , demonstrating that the total of consumer and producer surplus is greater with competitive markets.

The exercise of monopoly power increases total producers' rents if the monopoly rents P_2P_3BE exceed the loss of resource rents P_1P_3BA . The quadrilateral P_1P_3BF is common to both areas. The residual gain in monopoly rents P_2P_1FE may be less than equal to or greater than the residual loss of resource rents FBA , depending on supply and demand elasticities. Total producers' rents are more likely to be raised through the exercise of monopoly power the greater the rate of increase in production costs for expansions of output beyond OQ_2 and the more inelastic the demand function.

The analysis of Fig. 1 and 2 becomes indeterminate when applied to a renewable resource with the possibility of producing beyond the maximum sustainable yield. There is no longer any certainty that the demand and average cost curves will cross. If they do not, price increases, productive effort increases, and production declines successively until the resource is totally depleted. Even the interests of the consumer would be served better by controlled access than by the maintenance of the common-property resource, even if control were maintained by a monopolist restricting output, below maximum sustainable yield, to equate price with marginal revenue.

Husbanding and Taxation of Resource Rents

Economic efficiency from an international viewpoint will be promoted by the restriction of access to natural resources in such a way that:

- Producers have an interest in avoiding wasteful duplication of investment and in equating marginal cost with price;

- No single producer can exercise monopoly over product markets; and,
- Above all, the productive effort does not exceed the maximum sustainable yield of the resource.

Private investors or state-owned corporations, which are directed to maximize profits, should be given exclusive rights of access to natural resources so that the *desiderata* for natural resources of a fixed location are secured. Mobile natural resources, most notably fish, are more difficult to manage, because the conferring of exclusive rights of access to particular geographic areas will not generally remove their common-property characteristics. To secure *desiderata*, some regulatory agency must enforce its view on the optimal level of output from a fishery as a whole, establish exclusive rights of access to certain levels of output rather than to the resource itself, and also enforce its view on the optimal level of fishing effort to avoid wasteful duplication of investment.

There are difficult practical problems and high transaction costs in selecting and enforcing optimal levels of productive effort and production. Apart from problems of securing international cooperation in the regulation of fisheries extending beyond the exclusive jurisdiction of a single state, the technical difficulties are considerable in ascertaining the maximum sustainable yield of a fishery, and, where the optimal economic level of production is clearly below maximum sustainable yield, in estimating the economic parameters that determine the level of output at which marginal cost equals price. The best that can be attained in any important fishery is a rough approximation to the optimal.

The regulatory agency enforces its views on optimal levels of fishing effort and output by various means. Perhaps the most common means currently applied are prescribing technology and limiting the fishing season. Other means are direct controls on total output and specific as well as ad valorem taxes on production that reduce net revenue to investors to levels at which they voluntarily produce at the desired level. Cooper (1976) in an interesting survey of these issues in the context of early discussions of the new law of the sea correctly condemns the prescribing of some technology or the limiting of the fisheries season as introducing new sources of dissipation of rent. However, he goes too far in criticizing the use of quantitative controls on output on the same grounds and in preferring deliberately distorting taxation for its presumed superiority in these respects. Direct controls on total output do not inhibit the application of lowest-cost tech-

nology. Moreover, when market prices are in excess of those required for economically efficient production at the maximum sustainable yield, the regulatory agency requires less information to apply quantitative controls than to apply optimal taxes. To enforce optimal quantitative controls in these circumstances, only biologic data are required. However, the application of optimal distorting taxation requires data on price and production costs, in addition to the biologic data.

When the regulatory agency controls such large amounts of a resource that prices are responsive to its own behaviour, it will be in a position to appropriate monopoly rents. To avoid the use of monopoly power, it must ensure that no single investor is granted access to such a large part of a resource that the investor's production decisions can affect price. In the case of quantitative controls on output from a large fishery, rights must be allocated among a sufficiently large number of producers to exclude this possibility.

The establishment of a suitable system of property rights can avoid the dissipation of resource rent but raises the issue of how the rent should be distributed. The regulatory agency can in principle claim the rents as a condition for granting private investors access to resources, but it is not an easy matter to collect all the rent without dissipating part of it through the distortion of investment and production decisions. There is now a large literature on this matter (Garnaut and Clunies Ross, forthcoming), but a summary of the main propositions is warranted.

Optimal Taxation

The regulatory authorities can obtain revenue by requiring that investors pay a fee before being given access to a resource (prior fixed payments) or by charging the investor royalties, or taxes, the total payments of which are conditional upon the amount of production, or of profit, or of net cash flow (conditional payments) (Garnaut and Emerson 1981). The optimal combination of prior fixed and conditional payments depends heavily on what is assumed about the risks occasioned by the commercial and political environment within which an investment decision is made and on what is assumed about the manner in which investors and governments take risk into account in investment decisions.

A great variety of forms of prior fixed cash payments and conditional payments are applied in practice by governments regulating access to natural resources within their control. Neither competitive cash bidding nor taxes on net present

value can be relied upon in all circumstances to collect the whole of the resource rent without distortion.

The most nearly ideal system of setting prior fixed payments in practice is competitive sealed tenders, as used, for example, by the U.S. federal government in the allocation of petroleum licences in known geological structures of producing oil or gas fields. This system appears to work well in allocating rights over resources with calculable risk and modest rent value (Mead 1977). However, there are problems of collecting the full economic value of rights over highly valuable natural resources by this method, especially when risk is high. Apart from considerations arising from investors' aversion to commercial risk, the collection of resource rent through competitive cash bidding is highly vulnerable to investors' fears that the fiscal rules will change after investment has been committed: bids will be discounted for fears that successful outcomes will eventually be taxed. Also when the bid required to win a lease is large, competition between possible investors may be eliminated by collusion or some other factor (Norgaard 1977). Many mineral deposits, for example, promise such large amounts of cash flow that only a few corporations can finance the bids.

Although the problem of financing prior payments could be overcome if the investor were allowed to pay from later cash flow during mining operations, this change would transform the payment from a prior fixed payment to a conditional payment. Allowing the bid to be honoured at some later time would produce a conditional payment if the bid were large in relation to the assets of the successful tenderer. If the exploration or mining activity were unsuccessful, the corporation would be driven into bankruptcy. As a profit-maximizing strategy, owners of corporations may make large bids for licence areas of high but uncertain value, in the knowledge that they must achieve outcomes in the upper end of the probability distribution of outcomes or face bankruptcy.

The most efficient systems of conditional payments are taxes on positive net present value (to prevent distortion of investment), collected as a levy on "surplus" cash flow (to prevent distortion of production from established resource-exploiting facilities). The most nearly ideal system of conditional payments currently is the resource rent tax (RRT), as defined by Garnaut and Clunies Ross (1975) and as used in recent mining and petroleum agreements and taxation legislation in Papua New Guinea and several other developing countries (Palmer 1980). The

RRT does not distort production decisions for established investments: in this it is superior to conventional ad valorem and specific royalties, conventional corporate income tax, and annually progressive profits taxes. It is not collected until investment in a project has been recouped with interest at a specific rate, so that in form it is a tax on realized net present value. It can be neutral with respect to investment decisions so long as tax parameters are set correctly in relation to discount rates applied by investors to future cash flows in the evaluation of investment possibilities. However, the RRT can distort investment decisions if taxation parameters are not set perfectly, and it cannot be used to collect the whole of the resource rent without disincentives to economizing behaviour (Garnaut and Clunies Ross 1979).

Under ideal conditions (under which both competitive cash bidding and conditional payments are able to collect the whole of the resource rent without distortion), the relative reliance on prior fixed payments and conditional payments that maximize the value of revenue collected would depend on the attitudes toward risk of the investor and the regulatory agency. If the investor and the regulatory agency respond to risk consistently with von Neumann-Morgenstern utility theory and are equally averse to risk, half of the expected payments would take the form of prior fixed payments and half, conditional payments (Leland 1978). If the investor were more averse to risk than the regulatory agency, more of the expected revenue would take the form of conditional payments, but some revenue would be collected as prior fixed payments. The opposite conclusion would follow if the investor were less averse to risk.

If the investor and the regulatory agency respond to risk by applying a risk premium to the discount rates that they use to evaluate investment possibilities and if they apply the same discount rates, it is of no consequence whether expected payments take the form of prior fixed payments, conditional payments, or any combination of the two (Garnaut and Emerson 1981). If the investor applies higher discount rates than the regulatory agency, the value of revenue collected would be maximized by conditional payments and vice versa if the regulatory agency discounted future cash flows at a higher rate. The use of other common responses to risk, such as the requirement that the investment be recouped in a specified period or that there is zero or low probability of a totally unfavourable outcome, generally favours relatively heavy reliance on conditional payments (Garnaut and Emerson 1981).

The imperfections of prior fixed payments and conditional payments suggest that a mixed fiscal strategy is optimal because, applied together, the two types of payment support each other. Heavy reliance on competitive cash bidding is likely to be least satisfactory when the size of the bid required to collect the economic rent is large; the application of RRT with prefixed parameters lowers the scale of the bid that is necessary to reflect the economic value of the resource. At the same time, the higher the rates at which RRT is applied, the higher the risk of removing necessary incentives to economizing behaviour; the use of competitive cash bidding to collect the residual economic value of a resource after tax payments have been taken into account reduces pressure to raise RRT rates to levels that might distort expenditure decisions.

There are characteristic differences between renewable and nonrenewable resources that suggest heavier emphasis on competitive cash bidding for nonrenewable resources than for renewable. There are two reasons for this, one depending on degrees of uncertainty about investment outcomes and the other on characteristic scales of investment.

First, the exploitation of a renewable resource has the nature of a repeatable experiment. This is especially true for fisheries, where a large part of the capital committed to investment can be moved for use in alternative locations with little cost. Expectations about the outcomes of future investment are informed by the experience of the past. Although investment outcomes remain uncertain, in general they are less uncertain for renewable than for nonrenewable resource exploitation. Because investors are normally averse to risk, and more averse to risk than the regulatory agency in relation to the outcome of a single investment, reliance on competitive cash bidding is less satisfactory the more uncertain the outcomes and, therefore, more satisfactory in relation to renewable than to nonrenewable resources.

Second, the economically efficient scale of investment, and the scale of resource rent likely to be generated by a single investment, is typically larger for the exploitation of nonrenewable than for renewable resources, mainly for accidental technological reasons. Because competitive cash bidding as a means of collecting resource rent is less efficient than conditional payments for large bids, it is more appropriate for renewable than for nonrenewable resources.

Third, applying distorting charges on revenue (specific and ad valorem duties) results in only

small penalties in terms of reduced value of revenue collections for a mobile renewable resource such as a fishery, so long as the charges do not exceed certain maximum levels (the difference between price and the marginal cost of production at optimal output). The reason is that economic efficiency requires some degree of distortion of production from levels that would rule in the absence of regulation. In this respect, mobile resources such as fisheries are different from stationary resources. In the latter, regulating agencies avoid dissipation of resource rent by establishing exclusive property rights over defined geographic areas and then secure allocative efficiency by allowing production up to the point at which marginal cost equals price. The difference between price and the marginal cost of production at the optimal level of output is difficult to determine in practice. However, so long as substantial amounts of revenue are collected as prior lump-sum payments, collecting the whole rent may not be necessary if it means setting taxes so high as to risk unproductive distortion. The use of specific and ad valorem duties may, however, even in ideal conditions, lead to a less satisfactory allocation of risk between the regulatory agency and the investor and, therefore, some reduction in the value of revenue to the regulatory agency, in comparison with RRT applied in ideal conditions.

Rents and the Law of the Sea

The *Draft Convention* from the Third Law of the Sea Conference establishes property rights to the natural resources of the old high seas. So far as economically valuable resources are concerned, it does this mainly through the extension of the exclusive control of individual states over the natural resources of the sea within 200 miles of their shores, carefully defined archipelagic waters, and for mineral and sedentary living resources, the extremities of the continental shelves. This division leaves less than 10% of the world's fish catch from the oceans and deep-sea polymetallic nodules as the main economically valuable natural resources of the extraterritorial oceans. The proposed system of regulation of extraterritorial fisheries is loose and capable of development in various ways, whereas the system of regulation of deep-sea mining is extraordinarily tight and elaborate.

The extension of national control over such a large part of the natural resources of the oceans, including virtually all of the prospectively highly valuable petroleum resources, is probably as good a system as any from the point of view of

economic efficiency (that is, avoiding the dissipation of natural resource rents), especially when the transaction costs of international regulatory agencies are taken into account. However, the large benefits that it conveys are distributed arbitrarily among states, amounting to, as Cooper (1976:115) hoped it would not, "... one of the major missed opportunities for ... [humankind] ... to build towards a world community."

The new national resources in the oceans will require management in the same way as territorial land and sea resources in the past. Whether the new system will realize its potential for improving the efficiency with which natural resources are used depends on the management capacities of nation states. Most of the developing countries, especially the small islands, will face difficulties in providing domestically the new skills that are required to regulate efficiently access to ocean resources and in stretching the existing stock of old skills to cover more tasks of the old kind. The success of the new system would seem to require the development of mechanisms through which technical assistance in a wide range of scientific, economic, and administrative areas can be supplied internationally.

Extraterritorial Fisheries

The *Draft Convention* lays down some rules for claims on fisheries confined to extraterritorial waters and on those that lie partly within the exclusive economic zone of one state and partly in extraterritorial oceans or in the exclusive economic zones of other states. In both cases, the proposed regulatory system depends heavily on cooperation between states that are affected either as fish producers or as proprietors of exclusive economic zones.

The minimum geographic area over which a single regulatory agency must operate is the full extent of the fishery if the common-property characteristics are to be removed. This minimum necessary size is probably also the maximum efficient size, as the costs of establishing and maintaining an international agency grow rapidly as the number of states participating in it increases. These *desiderata* are reflected in the *Draft Convention*, which places on "... states whose nationals exploit identical resources, or different resources in the same area ..." an obligation to "... enter into negotiations with a view to adopting the means necessary for the conservation of the living resources concerned." The *Draft Convention* directs such states to "... cooperate to establish subregional or regional fisheries organizations to this end" (United Nations 1980:43, Article 118).

The end point of this cooperation is "... to maintain or restore populations of harvested species at levels which can produce the maximum sustainable yield, as qualified by relevant environmental and economic factors..." (United Nations 1980:43, Article 119). The group enjoined to cooperate reflects the interests of producers rather than natural resource proprietors and, therefore, would maximize production rather than resource rents. These rules are inconsistent with the emergence of rents of fisheries in extraterritorial waters until product prices are sufficiently high to prompt productive effort in excess of that required to produce at the maximum sustainable yield. Most professional opinion is that this point is at least several years away for the main extraterritorial fisheries of the Pacific.

However, rising world incomes and limited opportunities to increase world fish supplies suggest that limiting production to maximum sustainable yield will generate substantial resource rents in the extraterritorial Pacific soon enough to warrant some thought now about what should be done with the rents. Leaving the resource rents to traditional fishing states or fortunate fishing personnel is hardly reasonable and would not be acceptable in the international community. One way out is to establish a regulatory agency that comprises representatives from all Pacific states rather than just the fishing states. Such an agency would need fiscal policies for the collection of resource rents — policies similar to those needed by regional groupings that include one or more states whose exclusive economic zones cover part of a fishery.

Rather different regulatory arrangements are envisaged for fisheries that extend from the exclusive economic zone of one state into the economic zones of other states or into extraterritorial oceans. The resource-owning states are to cooperate with each other in the regulation of the fishery unless the fishery extends into extraterritorial waters, in which case both resource-owning and fishing states are to be members (United Nations 1980:25, Article 63). The emphasis on resource-owning states rather than fishing states means that the objective of the agencies will probably be the generation of economic rents rather than maximum production, and this likelihood is reinforced by the absence of any explicit concern for production at the maximum sustainable yield. A special article lays down this same approach for a number of highly migratory species (mainly tuna) but places a stronger requirement of cooperation on the interested resource-

owning and fishing states: "In regions where no appropriate international organization exists, the coastal state and other states whose nationals harvest these species in the region shall cooperate to establish such an organization and participate in its work" (United Nations 1980:25, Article 64).

The different objectives of resource-owning, fishing, and fish-consuming states will often be in conflict. The first will be concerned with the maximization of economic rents, and possibly of monopoly rents as well. The fishing states, in this capacity, will be concerned with maximizing production, except where restrictions on production allow them to enjoy monopoly rents. The different interests coincide only when price equals or exceeds the marginal cost of production at the maximum sustainable yield. Some agreement may be possible if it is based on the objective of maximizing resource rent and distribution of the revenues collected by the regulatory agency.

In any case, resource rents for these fisheries will emerge earlier than for those in the extraterritorial oceans, even if restrictions on productive effort and production are set through crude political processes. How would these rents best be collected for the revenue?

An ideal system might involve the division of the desired level of fish catch into a number of parts and auctioning them for lump-sum cash payments, with limits on the total level of catch allowed a single investor. The cash bidding could usefully be accompanied by a profits tax — most ideally in RRT form or — if market price exceeds, by a wide margin, the marginal cost of production at the desired level — by an ad valorem or specific tax within the margin.

But regulatory agencies should expect to take some time in getting to this ideal position. Some of the fisheries covered by these arrangements would probably not generate genuine competition in an auction. The effectiveness of a bidding system needs to be tested case by case, with the authorities reserving, and where necessary exercising, the right not to allocate fishing quotas when the highest bid does not reflect the true value of the resource. The bidding system should be complemented by a conditional payment that would reduce the loss of potential revenue from failure of competition in bidding. In clearly non-competitive situations, competitive bidding on prior cash payments should be replaced by negotiated lump sums.

Administering conditional payments and cash flow-based taxes such as the RRT has its own set of problems. The costs of policing the returns

upon which taxation is assessed would be justified only for fisheries with high-rent value. Until fisheries have this value, reliance should be on specific and ad valorem duties, at rates clearly within the margin between market prices for fisheries products and marginal cost of production at the level of productive effort that is expected to maximize resource rents. It may not cost the regulatory agency much in terms of the value of revenue to rely heavily on the simply administered specific and ad valorem duties, especially when they are accompanied by substantial lump-sum payments determined by auction or negotiation.

Rents in Polymetallic Nodules

The *Draft Convention* spells out arrangements for deep-sea mining of polymetallic nodules in great detail. This task was obviously necessary to secure agreement among states with widely different objectives, of which the generation of revenue for international purposes was only one and, because it was a central concern of no state, relatively minor. The result is that the arrangements are likely to yield relatively little revenue from the economic rent value of ocean resources, and an important part of whatever is generated will be consumed in the financing of the elaborate international administrative infrastructure.

Unlike the arrangements for fisheries, the *Draft Convention* makes the resources of the sea the "common heritage" of humanity, the prerogatives of which are to be exercised by an agency drawing its membership from all states that are members of the United Nations and participants in the law of the sea conferences.

The main interests reflected in the elaborate draft are those of land-based producers of nickel and the minor metals in the nodules (most importantly Canada but also a number of developing country exporters of metals), those of the major industrial countries who have sought favourable investment opportunities for their private corporations, and those of the "Group of 77" of developing countries. The last group have professed a special concern for the common heritage of humanity and have sought mechanisms through which natural resources of the ocean can be made to yield a role for a major new mining corporation, the Enterprise, to be owned by the international community, and also revenue for international development purposes.

The first set of interests is represented in the control on the expansion of production of metals from the sea (United Nations 1980:56–58, Article 151). The controls limit production to the growth in world demand for metals in the period up to

the commencement of commercial production, and then 60% of either the trend of the actual increase in demand or 3% annually, whichever is greater. The controls are only restrictive if seabed mining is successful, in which case they will introduce an element of monopoly rent into the returns of those investors who are fortunate enough to be allowed entry into deep-sea production, as well as land-based metal producers.

The second and third interests were in direct conflict, and the treatment of the Enterprise and the fiscal arrangements for private investors must be seen as a package and evaluated together. Although the fiscal arrangements viewed in isolation seem highly favourable to private investors, they were accompanied by, and were no doubt a *quid pro quo* for, requirements that private investors provide special assistance to the Enterprise. One half of the value of successful exploration by private investors must be made available to the Enterprise. This is equivalent to a 100% tax on exploration expenditure. On land, this amount would be seen as burdensome on an activity that should be encouraged but might escape this judgment in relation to mining investments that were expected to be highly profitable and lightly taxed. Private investors are also required to make technology available to the Enterprise on conditions that are not specified in detail but that can be expected to reduce the return to investors of investments in research and development.

The fiscal framework is highly complex. One feature is the absence of normal corporate and personal income taxes, or any version of the common sales and import duties, on the activities of extraterritorial miners and their employees. In the absence of international taxation, which had the potential for being a major source of revenue for international purposes (Cooper 1976), there is some prospect of competition for taxation jurisdiction, for example between home governments of investors and their employees and the governments that are hosts to processing facilities. However these matters are resolved, deep-sea mining will probably be treated more favourably for general taxation purposes than is land-based mining in most countries. Although this favourable treatment may not cause uneconomic over-expansion of deep-sea mining because of the production controls, it may occasion higher profits for investors than would otherwise rule. The absence of normal taxation on extraterritorial mining would seem to be undesirable on both distribution and allocation grounds. Perhaps it is not too late to effect some change in these arrangements.

A second feature is the elaborate rules for allocating production licences among private investors. They establish an orderly queuing system in which the first in is served first but only once until all have been served — a setup that would seem to preclude competitive bidding for licences. Minor prior cash payments are provided for in the *Draft Convention*, but most revenue can be expected to derive from conditional payments.

The *Draft Convention* defines a complex hybrid of ad valorem charges on sales revenue, annually progressive profits tax, and resource rent tax. The component on the annually progressive profits tax shows clear signs of having been received via Papua New Guinea's 1974 Bougainville Copper Agreement, whereas the resource rent tax component takes the form of Papua New Guinea's Ok Tedi Agreement.

The *Draft Convention* defines two parallel systems of conditional payments, between which the investor may choose (United Nations 1980:139–145, Article 13). The first is a straightforward system of ad valorem charges on revenue, of the type that is familiar from, and at rates that are fairly common in, traditional mining agreements and legislation. The second is a combination of ad valorem charges at low rates and an annually progressive profits tax, both becoming larger after the investor has recovered cash outlays with interest as in the resource rent tax. The investor declares once and for all which of the two systems it will follow within 1 year of the commencement of commercial production.

The ad valorem charges alone will be applied at the rate of 5% in the first 10 years of commercial production and 12% thereafter. The lower rates in the earlier years are designed to reduce risk and so assist financing and can also be justified in terms of revenue maximization on the reasonable assumption that private investors would apply higher discount rates to future tax flows than would the regulatory agency. The rates are sufficiently high, especially after the 10th year, to distort production decisions through their incentives to "high grading" — even on the highly profitable seabed mining operations to which the ad valorem taxation option is most likely to be applied.

The alternative fiscal arrangement is divided into a less severe early period and a more severe later period, based on the good reasons underlying the ad valorem system. The two periods are separated by the time at which cash outlays are recouped in real terms with interest at 10%/year on the basis of the formula of the resource rent tax. The use of an economic rather than temporal

basis for dividing the period of lower from that of higher taxation allows the objectives of maintaining taxation in early years to be met with lower cost, all other things being equal.

In the early period of the alternative tax arrangement, investors will be required to pay an ad valorem production charge of 2%, plus 35% of profits that represent a return on investment (indexed to current values) between 0% and 10%, 42.5% of profits that represent a return on investment between 10% and 20%, and 50% of profits that represent a return on investment in excess of 20%. In the late period, the rate of ad valorem payments rises to 4%, and the profit shares to 40% on profits representing up to 10% return on (indexed) investment, 50% on profits representing a return between 10% and 20%, and 70% on profits representing a return in excess of 20%.

The definition of investment is taken from Papua New Guinea's Bougainville Copper Agreement, but there is an automatic indexing of past outlays. Like the Bougainville Copper Agreement, the *Draft Convention* defines capital investment generously by adding in to the capital base all capital expenditure and deducting depreciation and amortization only on capital items being replaced.

The fiscal arrangements had to come to grips with the allocation of outlays and revenue to the mining component (covering mining, transport, and shipping). In this respect, the *Draft Convention* was generous to the investor by allocating profits in proportion to capital outlays in the various activities. This stipulation provides a clearcut solution to a practical problem but is hardly consistent with the theory of resource rent because the high profits deriving from resource rent are properly attributable to the mining phase that is to be the subject of the proposed fiscal arrangements.

The alternative fiscal framework should induce only minor "high-grading" effects and have less effect in inhibiting marginal investments than the ad valorem system. The balance of incentives would seem to favour the investor's election for the ad valorem system in projects that are expected to be highly profitable and the mixed system in projects that are expected to be moderately profitable. Paradoxically, the introduction of the choice of two fiscal systems probably makes the system as a whole both more distorting and less onerous in terms of expected revenue yield than a profit-based system alone.

Discussion

T.K. Shoyama: In my view, Ross Garnaut has contributed an outstanding paper to the proceedings of the conference. It blends basic economic theory about resource rent with an exposition of the principles of fiscal analysis and fiscal structure applicable to the collection of such rents. It considers the possibilities afforded by the new law of the sea not only for the collection of rents on fisheries resources but also for the collection of rents that may inhere in the seabed mineral resources, producing helpful parallels and useful distinctions between renewable and nonrenewable resources.

The paper notes that resource owners — and particularly the state — can seek to capture rents in a variety of ways as long as the rents are not dissipated by the uncontrolled entry of harvesters with excess capacity. The problem is overcapitalization, and it has been especially familiar in common-property resources such as fisheries where the state is often called upon to provide subsidies rather than being in a position to capture rents. In seabed mineral resources, or other

natural resources where rights of access can be definitely assigned, the essential approach is to provide exclusive property rights on the basis of either the prior fixed payment (e.g., disposal on the basis of competitive bid) or a series of conditional payments extending over a period of production. This latter can be in the form of specific royalties or taxes.

In practice, there is much to be said for a fiscal strategy combining both approaches, taking into account all the inherent production and market risks that the commercial producer and the fiscal authority, both, are anxious to minimize. Garnaut strongly favours the concept of a resources rent tax (RRT). Here, the most important feature is that little or no tax is payable until the initial investment has been recouped by the enterprise, together, of course, with interest. When the basic payout has been achieved, a variety of tax structures of increasing severity can be applied.

This basic approach has been applied, according to Garnaut, in the exploitation of mineral resources in Papua New Guinea, and it would be

interesting to observe the actual workings of the system — particularly the structure and level of rents ultimately recovered. A similar approach is followed in the fiscal terms for oil and gas development in frontier Canada. The difference is that a modest ad valorem royalty is applied as a bottom-tier tax, and, more importantly in the case of potentially attractive petroleum resources extending over large areas, a significant part of the property right itself and significant rent are also captured. This approach has evolved in Canada, where policymakers started with the notion of “checkerboarding” petroleum lands and went on to carefully manicured schemes for lease selection of production areas.

One of the comforting and helpful notes from Garnaut is the suggestion that, although the analysis elaborated early in the paper leads to certain conclusions about ideal tax systems on efficiency grounds, in practice the difficulty in judging risk, discount rates, and other variables, makes it sensible for policymakers to adopt mixed systems.

As a general principle, moreover, no matter how much one might espouse economic neutrality in the tax system, adjustment for the nature of the particular resource in question is inevitable. There is a world of difference between the large, multinational mining enterprise and the individual inshore fisherman. Garnaut’s discussion of the problem of monopoly enterprise makes this clear, but it applies not only to monopoly profits but also to a monopoly-based wage structure.

Collecting rent from fisheries resources has been made possible by the introduction of extended jurisdiction. It has not been made easy, however. A coastal state must have the ability to devise, administer, impose, and enforce its system of rent collection, whether or not it decides to grant rights of access to distant-water fleets. Neither domestic nor foreign fleets have had to pay for the rights before; in fact in many, if not most, fisheries, the rents have long since been dissipated by a buildup in excess personnel and capital. Reference has been made in several papers to the welfare-employment role of fisheries both in developed and in developing countries. Far from seeking to capture rents, the state as resource owner is more likely to be committed to providing subsidies to maintain employment, sustain incomes, and preserve or enhance the resource at public expense. However desirable or equitable a tax or royalty scheme may be on efficiency grounds, the imposition of a tax burden in any form involves a major reversal of traditional policy.

There is a further, closely related social phenomenon — the romanticism and emotional attachment to fishing as a way of life, rather than just a means of livelihood. Despite obvious physical hazards, hard work, economic risk, and low returns, fishing appeals to many as an occupational way of life. One suspects that many fishermen want to be fishermen even more than many farmers just want to be farmers. I am not sure that any politically feasible system of transferable catch quotas, as suggested in the interesting Moloney paper or in the parallel Garnaut model of an auction in small bits, would lead to a significant outflow from the industry. However elegant and persuasive the theoretical analysis is, it doesn’t seem to offer politically practical solutions.

Be that as it may, the Garnaut paper shows how the *Draft Convention* has set out a general framework under which it is possible to envisage the introduction of fiscal systems designed to ensure the capture of rents by coastal states from their extended fishing zones. The main obstacles are political nationalism and an inability to devise and enforce effective regulatory systems.

Like fisheries, forests are a renewable resource, but they are not plagued by the common-property problems that have surrounded fisheries. Presumably, however, the ideal tax model for rent collection would apply to the softwood resources of the Pacific northwest or the hardwood resources of Southeast Asia, wherever they have not already been alienated to private ownership. At present, rent collection for forests is far from ideal. In British Columbia, for example, a major share of the economic rent has probably been appropriated by strongly organized labour unions, and the resulting high-wage structure poses a major obstacle to the emergence of a more diversified manufacturing, processing, and service economy. This example may provide an object lesson for developing countries on the importance of timely tax policies to appropriate forest rents.

Finally, Garnaut’s account of the provisions of the *Draft Convention* covering seabed mining impresses upon one the complexity of conflicting interests and the elaborate structures and fiscal schemes to deal with this inherent conflict. But one can only regret Garnaut’s broad conclusion that the arrangements are likely to yield relatively little of the economic rent value of ocean resources as revenue for international purposes. My impression is that, whatever theory and analysis might suggest for the broadest public (international) benefit, the narrower, vested objectives of countries with their own interests to pursue tend to prevail.

There is something of a parallel here with the situation in countries possessing a federal structure — the U.S., Canada, Australia, Malaysia, etc. — where subnational states or provinces are constitutional owners of resources and compete with each other and with the federal government for tax revenues or for accelerated exploration and development. The subnational governments often take one of two views: that development and employment under private ownership are more important objectives than is the capture of rents or that maximum rents should be captured even to the point of squeezing normal profits and employment income, thus deterring investment. In Canada, both views are espoused, and the broadest national interest defended by the central government may give way to the particular objectives of the regional governments. One can only hope that the international Enterprise will succeed in due course in the capture of rents through its acquisition and profitable exploitation of the exploration rights assigned to it under the *Draft Convention*.

Hugh Patrick: I was glad to read, and admire, the analytical papers of both Munro and Garnaut on the issues of rents. Munro's analysis is sensible and reasonable. I think one of its most important virtues is that it takes on a number of the myths, shibboliths, and incorrect assumptions that have been bedeviling fisheries policies in recent years. I am delighted by the clear arguments for reliance on comparative advantage in fishing services and for efficient ways of collecting rents as well as prevention of their dissipation to various interest groups through assorted protectionist devices. It seems to me that the United States and Canada, or any of the other high-income countries, cannot justifiably make infant-industry arguments or arguments about low-opportunity costs for capital and labour for their fishing industries. Protec-

tionism, in fishes or forest products, appears to have little economic, or even social, justification for these countries. Although the infant-industry argument may be appropriate for numerous South Pacific countries, they may decide that collecting rents (if they can actually do so) is better than working on shipping vessels — the latter lifestyle not being all that superb, according to Copes and others.

It is not clear who will be the real beneficiaries of the extended fisheries jurisdiction in the South Pacific. My guess is that the beneficiaries will be Australia, New Zealand, and other major aid donors who simply will reduce aid grants as rents increase. The development dilemma for the tiny nations will not be resolved even though they have claimed control over their fishing zones.

Can an infant-industry argument be successfully made for the coastal fisheries or the forest products of larger developing Asian-Pacific nations? Or should fisheries, and perhaps forestry, be viewed mainly as a highly elastic supplier of very low-productivity, low-skilled jobs, to be phased down as better job opportunities are created? I would like to know where fishing and forestry fit into the overall developmental strategies of the developing Asian nations.

One of the most important points this conference has clarified for me is how large a role protectionism plays in domestic industries in the Pacific. Effective protection rates, although not spelled out in the papers in this conference, must surely be substantial. And these protectionist measures force developing countries into second-best policies such as prohibitions on log exports, as were discussed by Takeuchi. As the United States and Japan have been taking the lead in developing and maintaining a relatively open and free multilateral trading system, they should liberalize trade in these areas, as should all the countries in the Pacific and elsewhere.



Conference Summary

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At first blush, it might seem that fish, forest, and fuel problems have little in common. However, they are intricately related in the world's ecological system; a microcosm of their interaction exists in the mangrove swamps, which provide a habitat for aquatic organisms, such as shrimp, and are a source of wood often used for fuel purposes. The mangrove highlights how easily the system can be disturbed: when too much wood is taken from it, the result is the degradation of the marine-life breeding grounds, erosion, or sedimentation. It also demonstrates that indiscriminate exploitation of a resource by one sector incurs immediate external costs to another.

The choice of appropriate mechanisms to reduce such costs, to enforce socially beneficial harvesting practices, and to capture the rents from the available resources were the recurring themes of this conference.

The world is passing through a phase of resource nationalism. Those countries generously endowed with resources wish to undertake domestically a high proportion of their harvesting and a great share of their processing. At the same time, concern that open-access resources have been overexploited in the past has led to formulation of management plans for fisheries and forests. The ocean commons have been enclosed by 200-mile limits and logging ventures and log exports constrained.

These policies have already affected patterns of trade and investment in the fisheries and forestry business of the Pacific basin and will continue to do so throughout the 1980s. They raise questions about the economics of harvesting and processing, especially about the comparative advantage of locating canneries, process plants, sawmills, plywood operations, and pulp-and-paper plants

in the harvesting rather than consuming countries. Are resources in primary and processing activities being optimally allocated at present? Would markets in the consuming countries remain if the activities that they had previously undertaken — catching, cutting, refining — were done by others? Can bilateral monopoly deadlocks on international pricing and market access be resolved between Pacific-basin partners?

Even in the energy sector, there are prospects for new trade patterns in the Pacific region. The switch from reliance on liquid hydrocarbon fuels to coal is already under way. Moreover, as relative prices adjust more and more unconventional fossil fuels will be tapped. Many countries are seeking to replace foreign fuels in part with indigenous energy and thereby to reduce their vulnerability. Often such developments are high cost and may be a misallocation of resources in the short term. Widespread use of nonexhaustible energy would substantially reduce energy trade in the Pacific region, but this is in reality a scenario for the 21st century. More immediate are the requirements for shared technology and international industrial cooperation to ensure the medium-term energy future of the Pacific-basin countries.

Considerations of this sort led to views at the conference that cooperation among Pacific neighbours must be enhanced. On issues such as management of transboundary migratory fish stocks; joint ventures between distant-water fishing fleets and coastal nations; foreign investment in forest harvesting and wood processing; access for products of developing countries to developed-country markets; and technology transfer and cooperation at the research frontiers of conservation and utilization in fish, forests, and

fuels, Pacific nations must work together to preserve the riches of the resource endowment while providing a continuing flow of benefits to the peoples of the region and the rest of the world.

Forest Economics

For 2 centuries, there appears to have been a deficiency in supply of forest products worldwide that has caused the relative price of wood to continue to rise. This suggests that, although the forest is generally looked upon as a renewable resource, it has not always been replaced when cut. Forest continues to exist if the opportunity cost of the land upon which it grows is maximized for forest use and not for other purposes such as agriculture, industry, or urban development. The alternative land uses have, in many instances, proved more valuable than reforestation. As wood prices have risen, forest products have been sought in more inaccessible areas through a Ricardian-type process.

Scott, in his forest-economics overview, distinguished between extensive and intensive forest harvesting. Under extensive exploitation, cutting and clearing has followed a path of development from Europe to North America and eventually to the Pacific, along Ricardian lines. Intensive harvesting has involved:

- Polycyclic methods — selective harvesting of species within a continuing forest, and
- Monocyclic methods — the growing of plantations, often of only one species.

But Scott believes that not much is really known about the economics of such intensive methods.

Forest economists still must cope with many unresolved problems. What does optimizing the stream of benefits to society from the forest mean in changing circumstances at the extensive margin where alternative land uses and their associated rates of return can impact rapidly? Furthermore, there are many ways in which the forest interacts with the agricultural economy in rural areas. Indeed, Bene noted that only 20% of wood appears in world trade and that 80% is used locally in developing countries, where wood-cover supplies not only building materials and firewood but acts as an environment for wildlife, attracts rainfall, retains moisture, and adds to the overall ecological balance of the region. These externalities are social benefits that have not been accurately evaluated and, therefore, have been ignored in private forest harvesting and renewing decisions.

The economics of forestry production are an aspect of capital theory in which the role of “waiting” is crucial. In tropical hardwood forests,

where the waiting may be several generations but the social rate of discount (as implied by rural lending rates of 100%+) is very high, it is not surprising that forests are rapidly cut, often illegally, and rarely replaced. Even reforested areas can be slashed and burned by shifting cultivators. In these circumstances, it may not be possible, as Drysdale advised, to have the resource developed by the most-efficient operators, which would lead to the maximum flow of national resource rents. Akrasanee noted that, in Southeast Asia, deforestation is proceeding apace (particularly in Thailand), where the forest stock is shrinking, possibly never to recover. Once more, enforcement is a problem, as there is widespread illegal logging, which is often ignored in classical forest-economics analysis. The usual tax-subsidy devices have high administrative costs, and even monitoring of log exports can be overcome by illegal levies.

Fast-growing plantations of the intensive, monocyclic type may reach maturity in 10–15 years, in which case the associated “waiting” may be economically acceptable. Sedjo presented simulation results from investments in two types of tree plantations — one producing pulpwood and the other, both sawlogs and pulpwood. The highest regional payoffs for these plantations were found to be in Chile, Borneo, and New Zealand. However, Hemmi was concerned that the estimated rates of return (all more than 10%) could be misleading, as plantation development costs were ignored. Scott suggested that the Fisherian rate of return over all opportunity costs, particularly of alternative land use, is a more appropriate measure. Sedjo replied that most plantation land is marginal for agriculture and that prices of imports were at world-market rates when entered in the simulation, although external benefits and costs may not have been wholly incorporated. As the relative price of wood may not continue to rise, these rates of return are open to revision. Nevertheless, Sedjo quoted data from Lanly and Clement that suggest that industrial plantations in developing Asia and the Far East will increase from 2.9 Mha in 1975 to 8.25 Mha by the year 2000. If developments of this scale occur, they will go some way toward relieving the forecast tightness in many wood fibre markets.

Darr described the wood supply–demand situation in the Pacific northwest forests of Alaska, Washington, Oregon, and British Columbia, while noting that the period of exploiting underdeveloped timberlands in the Pacific northwest of North America has ended

and that intensive management must now take over.

Aird and Calow pointed to four reasons that forest production in the Pacific northwest, particularly in Canada, may decline: timberland withdrawals for other uses and rationalization through forest management, reduced yields from second-growth forests, lower regeneration rates because of past logging practices, and low levels of reforestation. Because most of the resources in Washington and Oregon are privately owned, supply responses differ from those in Canada where most of the resources are public property. In general, tenure arrangements are long term in British Columbia, whereas this rarely is the case on public lands in the states. Darr found the outlook for the forest industry, especially in the U.S., clouded by uncertainties. Competing supplies from Canada, USA, New Zealand, and the USSR make predictions of price and trade volume, especially with Japan, difficult.

Solecki outlined, in detail, the potential for the Soviet role in Pacific-region, forest-products trade. On the import side, Darr noted that Japanese demand is stable or declining for solid wood but is growing for pulp, newsprint, and paperboard — a fact that should trigger increased trade in chips from many suppliers around the Pacific rim.

Japan continues to search for new timber sources of unprocessed wood products in the Pacific region and, as Aird and Calow noted, is buying more logs from Papua New Guinea. Moreover, log restrictions elsewhere in the region are causing Japan to look for further processed products from the forest-resource nations.

Restrictions on log exports from the USA, Canada, and, more recently, the nations of the Southeast Asian Log Producers' Association have distorted the comparative advantage principle for the location of plywood processing, according to Hong. In many instances, these restrictions result in price discrimination that favours domestic processors. As Japan now recognizes a loss of comparative advantage in plywood processing, and South Korea and Taiwan are losing it very rapidly, there are reasons to inquire about the comparative advantage of lumber processing in the North American Pacific northwest. Smith noted that, as long as tariff and nontariff barriers restrict access to East Asian markets for plywood products, it is not obvious where comparative advantage lies, but Sedjo pointed out that many Japanese tariffs are set at rates similar to those in North America and the European Economic Community.

The issue of efficient locations for wood-processing activities around the Pacific rim and especially in Southeast Asia was addressed by Takeuchi and was also brought up in the Indonesian context by Birowo. The latter paper revealed a slump in Indonesia in log exports in 1980. Byron suggested that doubling the log export to processing ratio together with production bottlenecks caused the decline. Rachman added that domestic prices set at about 60% of log-export prices had also stimulated processing and diverted logs to the home market. Takeuchi asked in his paper whether this was a rational economic policy.

Takeuchi reviewed factor-input costs and determined that there are sound economic reasons for the development of mechanical wood-processing industries in certain Southeast Asian nations. However, these activities would have to be established in remote regions of Malaysia (Sabah and Sarawak), and Indonesia (Kalimantan), and possibly the Philippines. Although log export bans distort trade, Takeuchi suggested that the infant-industry argument is less appropriate if one waits for the "right" time — when comparative advantage in wood processing has clearly shifted to the forest regions — because in the meantime the best log resources will have been exhausted.

Not only is the development of timberland and local processing an important issue in Southeast Asian development, but the use of land for plantation tree crops is also of significance. Such crops can have a growth cycle of 3–5 years so that the "waiting" problem is minimized. Indeed, in a plantation setup, illegal access to the resource is lessened, and negative externalities are diminished. Chan discussed the role of palm oil and rubber plantations in the growth and diversification of the economy of Peninsular Malaysia between 1960 and 1978 and the importance of cocoa-coconut plantations in the development of Sabah and Sarawak. A decline in the early 1970s of the competitiveness of natural rubber with synthetics appears to have led Malaysian policymakers to diversify output by encouraging extensive development of palm-oil plantations on new and former rubber-growing lands. Moreover, there was a desire to shift away from overdependence on rubber and exposure to external shocks arising from this monoculture. This diversification again raises questions about the opportunity costs of land in alternative uses, especially in other timber production, rubber, palm oil, or other agricultural husbandry, and also points to a trade off between risk and return in land use.

Ariff argued that rubber prices have been more stable than those of palm oil (for which Malaysia has India as a "single" buyer) and that there were greater forward-backward links in output employment for rubber than for palm oil, as well as greater flexibility of production and less-demanding requirements for soil nutrients. Even if the private internal rate of return from palm oil exceeds that of rubber, there has been little economic analysis of the relative net social benefits from these Malaysian tree crops and there are several external factors that could favour rubber over palm oil. Krause noted that introduction of Stabex-type schemes for rubber, palm oil, coffee, or cocoa would reduce uncertainty and, therefore, probably increase output, but with long-term downward pressures on prices and rates of return. The potential viability of Stabex programs for some commodities and not others makes choice of an alternative land use more difficult.

Economics of Fisheries

The enclosure since the mid-1970s by national jurisdictions of the world's common-property fisheries resources has had important implications for the biological management and efficient exploitation of the fish as well as the distribution of the wealth.

In the Pacific region, a disproportionate share of productive fishing grounds was gained by the developed countries, particularly the USA, Australia, New Zealand, Canada, and the USSR. Among the developing countries, only Indonesia ranked high in the list of beneficiaries. The potential for additional fisheries development in the region now lies mainly in the Indian Ocean and western-central Pacific.

The distant-water fishing fleets historically took most of their catch off the coasts of the developed countries. Thus, enclosure of the marine commons has redistributed the potential for capturing the largest share of fisheries rents from one developed nation to another — for example, from Japan to the USA — and from developing nations to developed nations — South Korea to the USA.

Closing open-access to fisheries can lead to improved fisheries management, reduction of overexploitation resulting from overcapitalization, and better long-run returns for the controlling nation's fisheries industry. The price for these gains is the administrative and enforcement costs of reducing (or eliminating) the external diseconomies of the fishery, whether or not these are caused by fleets from other countries.

Global fisheries production amounted to approximately 65 Mt in 1978, but, according to sources quoted by Copes, the maximum sustainable yield on a species basis could be 120 Mt annually. Even the larger figure is not enough. A 1980 FAO study by Michael Robinson predicts that rising protein requirements, especially in the developing world, will cause a demand for 125 Mt in 2000, with likely production of only 92.5 Mt. The forecast "deficit" suggests that there will be adjustments through shifts in the relative prices of fish to other protein.

What is needed to maximize over time the stream of net benefits to society from the fisheries resource? In the short run, introduction of the 200-mile fisheries jurisdiction for coastal nations has probably reduced efficiency in some measure by displacing globally efficient distant-water fishing fleets by less productive local ones. Many developed countries have higher input costs per unit of fishing effort than do the fleets that have been dislodged from their waters. This is a supply-side reason for recent increases in world relative prices of fish. As Copes noted, in many cases, global irrationality has been replaced by national irrationalities, and, as Munro pointed out, most of the industrial adjustment costs have fallen on the distant-water fleets.

In a number of jurisdictions, enforcement costs are high and, at the margin, outweigh benefits from controlling the fishery. According to Panayotou, this may be the case in several Southeast Asian countries. Boundary problems still exist for transboundary stocks, both between adjacent jurisdictions and between each jurisdiction and the high seas. There are still "free riders" on the high seas, although Munro and Copes suggest that at maximum their catch is only 1% of total catch.

To capture rents from their fisheries resources, coastal nations may:

- Develop an indigenous capability, subsidizing an infant industry initially but ensuring that subsidies are not maintained or assumed in such a way as to become essentially protectionist;
- Enter joint ventures with foreign operators to gain skills, capital, and market access; and
- Allocate access to the resources by licencing foreign vessels.

Optimal mechanisms for capturing rents were discussed by Garnaut.

The shift from ocean commons to national jurisdictions will affect the directions and product mix of fisheries trade as a result of the exclusion of distant-water fleets from traditional fishing grounds. It will also affect patterns of

investment in vessels and processing. At present, the global fisheries industry is still in transition and further autonomous shifts in indigenous fisheries supply curves are probable.

In his paper, Copes reviewed important aspects of international fisheries economics in the context of the changed jurisdictional arrangements since 1977. He expressed some optimism that the 200-mile jurisdictions had already improved fisheries management, reduced fishing effort, and allowed stock rebuilding in many regions. However, management is not yet completely rational within many zones because of local political and social constraints. Moreover, there exist many boundary problems to be resolved by bilateral and multilateral agreements. If the remaining external diseconomies in the fishery were corrected, then, according to Copes, yield might increase by a factor greater than two.

Christy was less optimistic that the impediments to efficient increases in production from world fisheries could be overcome, citing examples of weak enforcement leading to continuing overcapitalization of the resource, especially in the developing world. As Bautista remarked concerning both fisheries and forestry exploitation, such problems inevitably boil down to differences between private and social costs and benefits.

Christy agreed with Copes that, on many fisheries questions, criteria for efficient allocation of the resources become enmeshed with objectives for income distribution. The tangle is particularly thorny for countries in which a large population of artisanal fishing personnel have been at work — as in many developing nations — harvesting protein for local consumption. In such circumstances, the opportunity cost of labour is close to zero. Wilimovsky remarked that the key to success in fisheries development still lies with these artisans who could provide for the growing demand for fish more efficiently than the relatively new and overcapitalized commercial fishing operations of many Southeast Asian nations. Panayotou pointed out that, because control of the national fisheries common-property resource involves high-enforcement costs in Southeast Asia, control measures would work only in an environment of broad-gauge rural development that aims at relieving the survival and unemployment pressures. These pressures have resulted in widespread depredation of public property, both fish and forests. This point underscored Christy's concerns that enforcement of economically rational rates of exploitation of

the fishery is not necessarily closely related to the severity of penalties for rule infringement, most of which is done out of sight of land. Indeed, high penalties may simply mean higher bribes to enforcement officers with awkward distributional effects. Thus, in the developing world, pressing food requirements, low opportunity costs of labour, and expensive enforcement may mean that many fisheries remain, *de facto*, open-access resources.

These discussions suggested that, for the developed nations of the Pacific rim who have expanded jurisdiction over fisheries resources, there are good prospects for improved stock management because the enforcement and administrative costs are outweighed by the potential benefits from the managed resource. The question for these nations is how resource rents can be captured and maximized.

For Pacific-rim countries with distant-water fleets, the problem is eliminating redundant fishing effort, either by seeking access to the new jurisdictions or retiring fleet and processing capacity. Matsuda noted that Japan had had only modest success with joint ventures in skipjack-tuna operations. The scope for increased international trade in fisheries products will depend on the extent to which distant-water fleets are replaced by new national fleets, the catch probably still being sold to markets in, for example, Japan or South Korea.

For many developing countries on the Pacific rim, expanded jurisdiction confers nominal rather than substantive property rights to their fisheries because of the adverse cost-benefit ratio of stock assessment and surveillance. These fisheries will continue for some time to reflect all the economic and environmental drawbacks of open-access exploitation.

The econometric work by Lin et al. on fisheries trade among Pacific-area countries is novel; hence, several model-formulation and data-management problems still have to be overcome. As the data straddle a period of changing property rights in the Pacific, Rhee commented that there are several distorting factors that may have affected the trends and development of trade. Moreover, it may be pertinent for Lin et al. to look at fisheries factor costs as determinants of supply capabilities rather than relying on landings. There was also some concern over the separation of exchange-rate effects from relative price effects in the models by Lin et al., although there may be separate responses by consumers to these variables. More market-structure analysis will be undertaken in future by Lin et al., and the role of

barriers to market entry in the USA and Japan would be incorporated.

Six case studies on various aspects of national fisheries developments were presented to the conference. Stokes reviewed the Alaska groundfish case; Moloney spoke of the Canadian experience in the northeast Pacific fisheries; Doulman discussed the western Pacific tuna fishery; Wallace analyzed the economics of the New Zealand squid fishery; Kamphol and Thanwa estimated costs and benefits of shrimp culture in Thailand; and Sakiyama looked at long-term trends of fisheries development in the South China seas.

The Stokes and Moloney presentations were concerned with the optimal utilization of fisheries resources brought under U.S. and Canadian control by extended jurisdiction. Stokes pointed out that the world market for groundfish (demersals) has been depressed since 1979, with real prices falling. Also, fuel costs, capital equipment costs, and interest rates have all increased, impairing, further, the profit outlook for indigenous fleet development to take Alaska groundfish stocks. Although the building and operating of a subsidized U.S. fleet is remotely possible, a more probable and certainly more efficient use of the Alaskan resource would be continued exploitation by foreign fleets, with allocations being based on a fee structure rather than on historical catch.

The problem for the U.S. is to devise a revenue-earning system that maximizes benefits from access gained for the American fishing industry, earnings from joint ventures, and fees charged for foreign vessels. Matsuda objected that the Japanese should not have to pay to enter a fishery that they had originally developed.

Moloney, in discussing the Canadian west-coast fishery, noted that even after enclosure there continues to be overcapitalization and over-exploitation of stocks, to the extent that rents have been reduced. Attempts to restrict entry to the fishery through licencing vessels have not reduced the total effort because of the potential for capital stuffing. One approach to the entry problem is to introduce taxes that effectively remove all rents from the fishery; another device is to allocate transferable quotas that make fishermen communal owners of the resource. Copes noted that this latter approach is likely to be difficult to enforce and is sometimes incompatible with biological escapement controls aimed at protecting stocks.

Nontransferable licences might be a better effort-controlling device, even though, as Scott observed, they can perform like a "tontine." He

suggested that a system of internationally transferable fishing rights would resolve many of the rent-maximization problems on a global scale. As both the U.S. and the Canadian Pacific fisheries produce items for export — principally to Japan — there is also a potential problem of balancing countervailing power in the setting of access fees for Japanese vessels. As Smith noted, this problem could be solved by a cooperative framework set up to divide the rents.

Doulman discussed the prospects for local involvement by the small states of the western Pacific in the skipjack fishery. Because tuna is a highly mobile species, there are strong arguments favouring a regional fisheries program to overcome transboundary management problems. However, Papua New Guinea, Fiji, and the Solomons only tacitly support such a program, believing that they will be able to gain greater benefits, such as processing industries, from unilateral management. Christy argued that rents in tuna long-line fisheries in the South Pacific probably exceed those of the skipjack fishery. Stokes doubted that these nations were able to lay any more than a nominal claim to their fisheries because of lack of enforcement capability. Scott wondered whether the theory of alliances could not suggest ways to resolve the problems of cooperation among the South-Pacific nations. The need for cooperation probably extends to tuna-processing activities as well because the minimum capacity for an efficient cannery is 6000 t/year.

Wallace analyzed the returned-value and value-added gains from two methods of developing the New Zealand squid fishery. Because neither New Zealand consumers nor fishermen had shown any interest in squid before 1979, the issue of maximizing the flow of net social benefits from this fishery had not been dominated by protectionist arguments for the buildup of indigenous fishing. Both licencing and joint-venture arrangements had recently been made with Japanese, South Korean, and Taiwanese squid jiggers. Wallace's analysis showed a wide range of performance under each type of arrangement but with similar average earnings across the two fleets. The New Zealand government's use of export incentives, in the presence of an overvalued currency, thoroughly distorted the results and led to revenue losses and resource misallocations. Wallace's research offers a unique opportunity to examine the quantitative implications of two access schemes.

Sakiyama focused on factors bearing upon the long-run outlook for South China seas fisheries,

with particular emphasis on Thailand. He noted the role of the mangrove swamp as a habitat for shrimp and a source of fuelwood, and the important ecological function of the mangrove was emphasized in comments by Librero. Both Sakiyama and Librero were concerned that the delicate balance in use of the mangrove swamps would not be maintained; the value of mangrove to the shrimp industry is greater than its immediate return as firewood.

Shrimp production in all parts of the world results in large catches of fish that are discarded. This by-catch often contains the young of commercially valuable fish. Sakiyama was concerned that, in instances where the fish are landed, they are used by fish-meal industries and that this use has precluded the development of a wider market for human consumption. Several participants argued that relative prices could quickly shift the allocation of fish from meal processing to human consumption. However, the speed and extent of such adjustments remain an empirical issue.

Both Librero and Panayotou went to some length to familiarize the conference with the range of problems confronting the artisanal fishing sector in Southeast Asia. High discount rates and low opportunity costs of labour have driven Southeast Asians to catch everything and to use any method, regardless of potential penalties. Librero argued that attempting to raise productivity — even where access to the resource can be controlled — is difficult because fishermen prefer a low-gain, low-risk technology, which guarantees survival, to a high-gain, high-risk technology, which may not. Wilimovsky contended that the underlying issue in global fisheries management remains that of population growth, causing demand to press against scarce resources.

Renewable Energy Resources

As a prelude to the main theme of the 1983 Pacific Trade and Development Conference, a few papers on energy-resource issues were presented and discussed. Smith and Saddler examined the substitution of nonexhaustible resources for fossil-fuel energy and industrial raw materials. Their analysis drew on the Hotelling rule that exploitation of exhaustible resources should be such that their prices rise over time at a pace equal to the rate of interest. The existence of nonexhaustible substitutes affects the time path of use of exhaustible resources, but the precise patterns depend crucially on the abundance of exhaustible resources and their substitutability with each other and alternative inexhaustible resources. The substitution includes, for exam-

ple, the use of natural fibres to replace synthetics in the manufacturing industry. The range of possibilities for substitution makes it difficult to relate substitution incentives to the price of energy from exhaustible sources.

The most important sources of nonexhaustible energy cited are solar energy (including direct sunlight, wind power, marine current, hydroelectric power, chemical energy, and biomass), heat contained in the earth's core (geothermal), and gravitational power (tidal). There are also a wide range of nonexhaustible or renewable inputs that could replace products that are based on exhaustible resources. In many instances the move toward use of renewable resources is merely a reversal of the trend over the last 40 years to replace natural inputs. Reversing the trend would, if relative prices were right, lengthen the period over which fossil fuels could be used in key production processes.

Smith and Saddler noted that exhaustible fuels such as oil and coal are easily transportable and therefore suitable for international trade but most nonexhaustible fuel sources are (in principle) not tradable, e.g., solar, geothermal, and gravitational. Of this type, only agricultural sources of energy are internationally tradable and could eventually substitute for fossil fuels in many instances. Comparative advantage in such renewable resources coincides generally with labour scarcity and large land endowments.

In the short run, fuel trade will exhibit a shift from oil to coal, which will continue until economic exhaustion is reached. Bautista pointed out that exhaustion is only a matter of relative prices. At some juncture, fuels from agricultural products will become economically viable and therefore more evident in foreign trade. Australia and Canada will retain and increase stature as suppliers of fuels from exhaustible and, later, nonexhaustible resources, to markets in the densely populated, resource-poor economies of the Pacific basin.

Wionczek argued that exhaustible fuel resources are much larger than generally thought. When nonconventional hydrocarbons are lumped with conventional fuels, there are sufficient supplies to defer tapping of nonexhaustible sources until well into the 21st century. Relative abundance and prices will determine the speed at which consumers shift from conventional to nonconventional exhaustible fuels and later to nonexhaustible fuels. Helliwell stressed the uncertainty of future fuel-supply prices and availabilities. He argued that the cost of building

greater technical flexibility and adaptability into generating processes may, in the end, outweigh foregone scale economies because predicting energy supplies and trading is highly complex and, therefore, risky. Patrick noted that there was also vulnerability for areas that become too dependent on a single overseas source or specific fuel for industrial use.

South Korea's program for lessening dependence on exhaustible fuels and increasing use of indigenous renewable resources is discussed in Lee and Kim's paper. They examine the South Korean potential for energy production from solar, wind, biomass, tidal power, and small hydro, while noting capital, research and development, skill, and infrastructure constraints. They call for increased international cooperation in technology development so that South Korea and other developing countries can realize a portion of their nonexhaustible-fuel potential, particularly in the rural sector. Bautista was concerned that alternative-energy strategies can involve high opportunity costs, especially when infant, nonexhaustible energy industries are highly subsidized. What value should be placed on indigenous fuel development at a time when

countries still have options for a wide mix of fuel imports and a broad range of suppliers? Similar issues arose from the discussion of energy constraints in China in the paper by Li Guong-on and Luo Yuanzheng. In parallel with a switch in development emphasis from heavy to light industry and agriculture, China will favour more labour-intensive investments in rural noncommercial energy, including increased stress on biomass, solar, wind, and small hydroelectric power projects. Chinese planners intend to further open their economy to foreign commercial relations and technology transfer and to make increased use of market mechanisms. Less reliance is to be placed upon expanding China's coal and petroleum exports and more emphasis on light-industry exports, supported by renewable fuel sources. However, several participants were skeptical of China's hopes of successfully instituting such a program, particularly because the plans are optimistic and the likelihood of resource misallocations remains high.

This set of energy concerns — related to China, the developing nations, and the industrialized economies of the Pacific basin — will be discussed in detail at the 1983 Conference.

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