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Pacific Basin National Econometric Models: A Survey and an Evaluation of Linkage Feasibility

I. INTRODUCTION

The purpose of this paper is twofold: first, to provide a bibliography and a selective survey of known national econometric models of Pacific Basin countries; and second, to evaluate the feasibility of linking a selected set of these models, one for each country, into a regional Pacific Basin model.

Pacific Basin as used in this paper is defined as consisting of all countries that border the Pacific Ocean. Thus it includes not only North America and East and Southeast Asia, but also Oceania and those countries of Latin America that are located on the Pacific Ocean.

The importance of the Pacific Basin needs little emphasis. The international trade of the Pacific Basin countries is growing much faster than the world average. Pacific Basin countries are also gaining rapidly as recipients of foreign direct investments. They are also major producers and exporters of important commodities such as oil, rubber, sugar, and tin.

The countries of the Pacific Basin may be divided into two principal groups: the developed countries—Australia, Canada, Japan, New Zealand, and the United States; and the developing countries—all the others.¹ Among the developing countries, one may further distinguish between the countries that are principally primary producers, such as Indonesia, and

those that are principally light manufacturers, such as the Republic of Korea. The former are usually rich in natural resources. The latter are usually poor in resources, but have relatively skilled labor forces who are able to produce exportable light manufactures with imported raw materials and sometimes imported capital.

Our survey is in some respects critical of some of the existing models of developing Pacific Basin countries. The criticisms are meant to be constructive, however, and we do fully recognize the pioneering nature of many of those efforts. Moreover, the models were built for various purposes and without linkage in mind; so none is to be faulted for failing to do what was never intended. If linkage of these or similar models were to be undertaken, it would have to be on a cooperative basis with objectives clearly defined. In the concluding section we offer some suggestions for desirable improvements from the viewpoint of linkage into a regional model of the Pacific Basin.

II. A LINKED MODEL OF THE PACIFIC BASIN?

The Pacific Basin (PB) countries are part of the world economy, but can they reasonably be described as comprising a regional economy as well? In the absence of an explicit institutional apparatus for joint political and economic decision making, such as the European Economic Community, the answer hinges largely on the degree to which the PB nations are integrated by trading relationships. If most of their trade is with other PB nations, they are more closely tied to one another than to outside countries.

The trade data in tables 1 and 2 show that (1) the countries of the Pacific Basin do trade more with each other than with outsiders, but that (2) there are also several well-defined internal trading blocs within the Basin. On the first point, it will be seen that each of the twenty PB countries or regions distinguished in Table 1 obtains half or more—usually substantially more—of its imports from PB suppliers, and conversely, that the rest of the world (ROW) receives much less than half of its imports from PB suppliers. Similarly, on the export side, seventeen of the twenty PB countries or regions sell more internally than externally, whereas the reverse is true of the ROW grouping (Table 2).

Three important internal trading blocs are also apparent in the trade distribution data for the Pacific Basin, however: (1) Although Canada and Mexico border on the Pacific, they trade primarily with the United States and Europe, rather than with each other or Central or South America or the Western Pacific. (2) Central and South America trade internally and with

the United States and Europe, but very little across the Pacific. (3) The Western Pacific countries trade heavily with one another and (usually) with the United States, but sparingly with other American countries.

It appears, then, that the United States and the Western Pacific countries comprise a well-defined trading group which could be meaningfully linked in a regional PB model. Adding the other American countries to the model would add little information on trade flows in or across the Pacific Ocean. We therefore concentrate on the Western Pacific countries in our survey of econometric models in the Pacific Basin.

III. SOME LINKAGE PRINCIPLES

National economies are linked structurally through their foreign trade and financial transactions. These activities provide the principal channels through which a disturbance originating in one country may be transmitted to another.² On occasion, of course, several countries may be affected by synchronized external shocks from international political events or other global influences, but such factors are difficult to systematize or model.

National economies may receive shocks from abroad through changes in export demand or capital inflows or through externally determined changes in prices of tradable goods or interest rates. They may transfer disturbances abroad through changes in their import demands or capital outflows or through internally determined changes in prices of tradable goods or interest rates. In addition to the foregoing disturbances operating directly through the current and capital accounts, payment surpluses or deficits will affect a nation's monetary base under a regime of fixed or controlled exchange rates, unless changes in foreign exchange reserves are sterilized by the monetary authorities. Finally, external disturbances may induce equilibrating domestic responses through the income multiplier and through endogenous changes in the money stock, interest rates, and the terms of trade, and all of these channels may be affected by discretionary policies as well.

Thus, full-blown linkage would require that each national model provide an endogenous explanation of national income, prices, and interest rates to serve as arguments in the trade and capital flow equations and should have a monetary sector to relate the money stock to changes in foreign exchange reserves on the supply side and to income, prices, and interest rates on the demand side. It would also require that the relevant policy instruments—exchange rates, tariffs, taxes, monetary controls, and so forth—appear explicitly in the models if the system is to be used to study the domestic and international effects of discretionary policies.

TABLE 1 Distribution of Merchandise Imports of the Pacific Basin by Geographic Origin, 1969

Origin of Imports	Pacific Basin						Rest of World		
	U.S.	Canada	Mexico	Cent. and S. America	Western Pacific	Total	Western Europe	Other	Total
Pacific Basin:									
North America									
U.S.	0.0	27.9	2.3	11.4	23.5	65.1	29.3	5.6	34.9
Canada	72.5	0.0	0.1	4.5	6.5	83.5	14.0	2.5	16.5
Mexico	63.6	3.1	0.0	3.0	4.9	74.6	24.4	0.9	25.3
Central and South America									
LAFTA ^a	34.3	3.4	1.1	13.9	6.8	59.5	35.9	4.6	40.5
Central American	35.4	1.5	2.1	31.6	8.7	79.3	20.5	0.2	20.7
Common Market	26.5	3.7	0.5	28.9	7.8	67.4	29.5	3.1	32.6
Rest of developing America									
Western Pacific									
Japan	27.4	4.5	0.8	5.1	24.2	62.0	10.6	27.4	38.0
Australia	23.3	4.2	0.1	0.3	23.6	51.5	38.7	9.8	48.5
New Zealand	11.5	4.0	0.0	0.2	35.5	51.2	44.2	4.6	48.8
Taiwan	29.7	0.9	0.2	2.4	55.9	89.1	7.5	3.4	10.9
Hong Kong	14.1	0.7	0.0	1.8	53.4	70.0	21.6	8.4	30.0
Indonesia	24.1	0.3	0.1	0.3	48.2	73.0	23.4	3.7	27.1
Korea	36.2	0.8	0.0	0.2	45.2	82.4	10.5	7.0	17.5
Malaysia	5.6	1.6	0.0	0.7	56.8	64.7	26.5	8.9	35.4

Philippines	27.8	2.2	0.1	0.8	45.7	76.6	18.8	4.5	23.3
Singapore	10.0	0.3	0.0	1.9	62.7	74.9	18.5	6.6	25.1
Thailand	13.6	0.7	0.0	0.3	51.3	65.9	25.9	8.2	34.1
Vietnam	36.3	0.3	0.0	0.6	50.4	87.6	11.7	0.6	12.3
Rest of developing									
Oceania	7.5	0.3	0.0	1.3	59.7	68.8	29.6	1.6	31.2
China	0.0	8.4	0.0	0.0	42.3	50.7	35.1	14.2	49.3
Rest of the world									
Western Europe	10.0	1.7	0.1	4.0	4.6	20.4	63.7	15.9	79.6
South Africa	16.1	2.4	0.0	0.9	11.7	31.1	53.4	15.5	68.9
Middle East	17.9	0.6	0.0	0.8	10.6	29.9	49.8	20.4	70.2
Rest of developing									
Asia	19.2	2.7	0.0	0.4	23.3	45.6	28.8	25.6	54.4
Rest of developing									
Africa	8.0	0.5	0.0	0.8	9.0	18.3	61.0	20.7	81.7
Oil producing Africa	12.6	0.5	0.0	1.0	5.9	20.0	69.8	10.3	80.1
Council of Mutual									
Econ. Asst.	1.2	0.5	0.0	1.6	3.8	7.1	28.1	64.8	92.9
U.S.S.R.	3.1	0.3	0.0	2.2	12.5	18.1	61.1	20.8	81.9

SOURCE: Computed by the authors from data on total merchandise exports valued in U.S. dollars, as given for more than two hundred countries in the International Monetary Fund computer tape on *Directions of Trade*. Imports of a given country are calculated as the sum of exports from all other countries to it. Hence they are valued f.o.b. and will differ from the usual import totals, which are on a c.i.f. basis.

NOTE: Details may not add to totals because of rounding.

* Latin American Free Trade Association.

TABLE 2 Distribution of Merchandise Exports of the Pacific Basin by Geographic Destination, 1969

Destination of Exports	Pacific Basin						Total	Western Europe	Other	Total
	U.S.	Canada	Mexico	Cent. and S. America	Western Pacific	Rest of World				
Pacific Basin:										
North America										
U.S.	0.0	24.1	3.8	10.9	18.8	57.6	32.6	9.8	42.4	
Canada	71.2	0.0	0.5	3.1	7.2	82.1	15.5	2.4	17.9	
Mexico	66.8	1.2	0.0	10.5	8.8	87.3	12.4	0.3	12.7	
Central and South America										
LAFTA ^a										
Central American	25.8	4.0	0.5	20.0	6.5	56.9	39.4	3.8	43.1	
Common Market	35.0	1.8	0.2	26.4	9.4	72.9	25.6	1.6	27.1	
Rest of developing America	47.5	6.4	0.6	11.9	3.1	69.5	28.4	2.1	30.5	
Western Pacific										
Japan	32.3	3.1	0.6	5.1	31.1	72.1	13.4	14.5	27.9	
Australia	13.9	2.0	0.4	1.1	48.8	66.1	26.1	7.8	33.9	
New Zealand	17.0	3.4	0.0	1.5	20.6	42.4	55.4	2.2	57.6	
Taiwan	38.5	3.8	0.1	0.5	41.7	84.6	9.8	5.6	15.4	
Hong Kong	35.2	2.9	0.3	2.0	25.8	66.2	25.8	8.0	33.8	
Indonesia	19.1	0.0	0.0	0.4	54.9	74.4	25.3	0.3	25.6	
Korea	50.2	2.4	0.0	0.8	34.2	87.6	9.0	3.5	12.4	
Malaysia	16.1	1.8	0.0	0.0	51.6	69.6	18.0	12.4	30.4	

Philippines	41.7	0.4	0.0	1.1	46.7	89.8	9.2	1.0	10.2
Singapore	11.2	4.1	0.0	2.8	54.1	72.2	20.5	7.4	27.8
Thailand	15.0	0.1	0.0	0.1	52.7	67.9	20.3	11.8	32.1
Vietnam	1.9	0.0	0.0	0.0	31.3	33.2	65.3	1.4	66.8
Rest of developing									
Oceania	8.9	2.5	0.0	0.2	52.1	63.7	36.3	0.0	36.3
China	0.0	1.5	0.0	0.4	42.4	44.3	23.0	32.6	55.7
Rest of the world									
Western Europe	8.6	1.5	0.5	3.5	5.0	19.1	66.2	14.7	80.9
South Africa	7.4	1.9	0.1	0.6	13.1	23.1	58.7	18.3	76.9
Middle East	4.0	0.8	0.0	1.8	25.5	32.2	51.7	16.2	67.8
Rest of developing									
Asia	12.8	1.5	0.1	0.6	22.5	37.5	24.4	38.0	62.5
Rest of developing									
Africa	8.3	0.6	0.0	0.4	10.1	19.4	65.7	14.8	80.6
Oil producing Africa	6.3	0.7	0.0	2.7	1.0	10.8	83.7	5.5	89.2
Council of Mutual									
Econ. Asst.	3.4	1.6	0.3	2.4	5.6	13.4	69.2	17.4	86.6
U.S.S.R.	0.5	0.1	0.0	0.3	4.4	5.3	18.7	76.0	94.7

SOURCE: See notes to Table 1.

NOTE: Details may not add to totals because of rounding.

* Latin American Free Trade Association.

No existing system completely meets these requirements. The nearest approach is the Project LINK world economic model, which is a system of thirty-one linked national or regional models, including full-scale structural models for thirteen developed market economies: Australia, Austria, Belgium, Canada, France, Finland, West Germany, Italy, Japan, the Netherlands, Sweden, the United Kingdom, and the United States of America.³ Some of these models have complete monetary sectors, but several do not. None of them presently includes equations for capital flows, but complete balance-of-payments models have recently been developed for Canada, Germany, Japan, the United Kingdom, and the United States, and will soon be added to the system. Meanwhile, it is linked exclusively through the current account. The trade relationships are certainly a large part—probably the dominant part—of the story, however; and the LINK system has proved itself as a forecasting and simulation model capable of a variety of important applications in its present state.⁴

This experience with LINK leads us to the conclusion that a linked regional PB trade model would be a substantial and useful achievement in itself, besides providing the foundation for eventual incorporation of capital and reserve flows in an expanded system. We will accordingly concentrate on the production, price, monetary, and foreign trade sectors in our examination of existing PB models for linkage feasibility. Before turning to the models, however, it will be useful to discuss some general principles of specification and linkage as guidelines for the survey.

First, the typical import equations of a national model should include as explanatory variables a measure of domestic activity, such as real income or industrial production, and the relative price of imported and domestically produced goods. Other variables affecting imports, possibly including lagged values of dependent or independent variables, should also appear when appropriate. Unless relative prices are included, nothing can be said about the effects of currency revaluations on the changes in the terms of trade and unless lags are included, the important distinction between short- and longer-run responses is lost.⁵

Second, in models for developing countries it will frequently be found that foreign exchange reserves are a constraint on the ability to import and must be included in the import function along with the demand variables just described. Ideally, the stock of reserves should then be determined endogenously, but a full explanation would require an endogenous model of capital flows. At least one important component of capital inflow—foreign aid—is in any case an externally determined policy variable. Exogenous variations in foreign aid may be an important component of the transmission of expansionary or contractive forces from the developed to the developing nations in the Pacific Basin and elsewhere. Similarly, fluctuations occurring in private foreign direct investment, whether or not

explained endogenously in the models for developed market economies, may markedly affect the developing countries.

Third, although an aggregate import function is a useful beginning, there is a large payoff to additional commodity disaggregation. All the national models in LINK include import demand functions for four commodity classes: food and agricultural products (SITC 0 plus 1), raw materials (SITC 2 plus 4), fuel and lubricants (SITC 3), and manufactured products (SITC 5 through 9). The relevance of this breakdown is evident, given the importance of oil imports to many economies and the structural differences between developed and developing countries in the composition of trade between materials and finished goods.

Fourth, the domestic income and price levels should be appropriately linked to foreign trade. In demand-oriented models for developed economies, changes in export demand will have multiplier consequences for domestic income and production. Additionally, the domestic price level may be affected if prices are an endogenous function of demand pressures through a Phillips curve or monetary mechanism. With regard to developing country models, real income may be supply-determined and hence unresponsive to changes in export demand in any direct way. If imported materials or capital goods provide the production constraint in such models, real income will respond directly to imports rather than to exports, except insofar as exports augment or diminish foreign exchange earnings and the latter are an effective constraint on imports.

Fifth, the domestic price level may be directly affected by changes in trade prices. In open economies, prices of exportable goods may follow the world price level and may determine other domestic prices indirectly by affecting the wage level.⁶ Increases in import prices will directly affect the prices of goods produced with imported materials. Additionally, wage increases may be induced by the rise in prices of imported consumer goods or domestically produced consumer goods with a substantial import content. Finally, profit margins may be raised on domestic substitutes for imported goods and on goods purchased with imported materials.⁷

Sixth, for exports, two choices are realistically open in a linked system of models. One option is to retain the existing export functions in the national models, where a typical export function would include the volume of world trade as one of the explanatory variables. The difficulty here is that the final linked solution for world trade may be inconsistent on the export and import sides. In the "Mini-LINK" solution algorithm,⁸ for example, the sum of predicted imports from all national models is brought into equality with the volume of world trade, which enters the exports functions of the national models. Nothing in the procedure guarantees, however, that the sum of predicted exports will also be equal to the volume of world trade.

A preferable procedure is the "Maxi-LINK" method, which suppresses

the original export functions of the national models and substitutes a consistent set of export predictions generated through an estimated trade matrix. The basic approach may be sketched as follows:

a. Total imports of a given commodity class are determined in each model by the import demand function:

$$(1) \quad m_{ik} = m_{ik}(y_i, p_{ik}, p_{ik}^m, r_i, z_i)$$

where m_{ik} is the real quantity of imports of commodity k by country i , measured in local currency units; y_i is a real activity variable for country i ; p_{ik} is the domestic price index of close substitutes for the k th commodity; p_{ik}^m is the import price of k in U.S. dollars; r_i is the exchange rate of local currency for U.S. dollars; and z_i refers to other determinants of imports.

b. The vector of national imports so determined is then allocated among supplying countries by estimated market shares. Thus, let x_{ijk} be the exports of country i to country j for the k th commodity class. Then the total imports of the commodity by country j are $m_{jk} = \sum_i x_{ijk}$, and the market shares are $\alpha_{ijk} = x_{ijk}/m_{jk}$. Given the α coefficients and the predetermined import quantities, the exports of country i are:

$$(2) \quad x_{ik} = \sum_j x_{ijk} = \sum_j \alpha_{ijk} m_{jk}$$

The share coefficients may vary from year to year, however, and in the LINK model the current-period shares are a function of relative export prices and time. Thus the export demand function for country i and commodity k is (assuming n countries):

$$(3) \quad x_{ik} = x_{ik}(\alpha_{ik}^0 \dots \alpha_{in}^0, p_{ik}^x, p_{ik}^c, t, m_{ik} \dots m_{nk})$$

In this expression the α_{ijk}^0 are base market shares, p_{ik}^x is the export price of commodity k from country i , and p_{ik}^c is a weighted index of the competing export prices faced by country i .⁹

c. The trade system is completed by two sets of price equations for exports and imports. The export prices are endogenously determined in each model. The import price indexes are weighted averages of the export prices, with weights given by the same market share coefficients as used to allocate import quantities in the base period:

$$(4) \quad p_{ik}^m = \sum_i \alpha_{ijk}^0 p_{ik}^x$$

d. Iterative techniques are used to obtain a consistent solution for the entire system of linked models.¹⁰ For a given set of domestic predetermined variables and exchange rates, the system can be solved for all endogenous variables including a consistent set of trade flows and export and import price indexes, and satisfies the world trade constraint that $\sum_i x_{ik} = \sum_i m_{ik}$ for each commodity, as well as all domestic constraints.

IV. SURVEY OF MODELS

A first objective of our survey of Pacific Basin national econometric models is to catalog past and current econometric building efforts in the countries of the Pacific Basin. Models of the developed countries of the Pacific Basin, namely, Australia, Canada, Japan, and the United States, are well known and have been surveyed elsewhere.¹¹ We shall therefore confine our attention to only the developing countries of the Pacific Basin. A second objective of our survey is to evaluate the feasibility of linking the national econometric models of the PB countries into one regional model. Since our preliminary analysis of the pattern of trade flows indicates that Canada, Mexico, and Central and South American countries on the Pacific Basin trade almost exclusively with the United States and with one another but very little with countries across the Pacific, inclusion of those countries in a linked regional model will not contribute materially to our understanding of the workings of the Pacific Basin economy. We shall therefore further limit the geographical scope of our survey to only the United States and the countries of the West and South Pacific. Moreover, since the United States, Japan, and Australia are already participating members of Project LINK, there is obviously no question of the feasibility of linkage.¹² Our discussion will therefore be primarily focused on New Zealand and on the developing countries in the West and South Pacific.

A number of the developing countries in the West and South Pacific have more than one national econometric model. All known models and their related publications are listed in the bibliography on models of developing countries in the Pacific Basin in Appendix A. However, in order to avoid the laborious process of reviewing each and every model available for each country, a process which will be of only limited interest to the reader, we have decided to choose one model for each country that appears to show the most promise for linkage purposes. There are no set and fast criteria for our choice of models, but we were generally guided by the following considerations: first, it should be a relatively recent model; second, it should be a relatively comprehensive model; third, it should contain as much international detail as possible; fourth, it should be a general-purpose econometric model; and finally, it should be an active model, that is, one that is being continually monitored, maintained, and updated. Not all of the models that we have chosen satisfy these criteria, and the relative weights placed on each criterion are clearly subjective. However, in our opinion, these models do show the best promise for linkage.

The countries explicitly included in the survey are the People's Republic of China, Indonesia, the Republic of Korea, New Zealand, The Philippines,

Singapore, Taiwan (Republic of China), Thailand, and the Republic of Vietnam. Hong Kong and Malaysia, although they fall into the category of developing countries in the West Pacific, are not represented because we have not been able to locate national econometric models for them.¹³ A summary description of each model surveyed is presented in tabular form in Appendix B.

For the survey itself, instead of using a country-by-country approach, we shall use the sectoral approach. We shall examine six sectors of the economy that are important for linkage purposes either because they provide the interface between the linked models or because they are most likely to be directly affected by external developments. The six sectors are production and income, investments, imports, exports, prices, and money and finance.

Production and Income

Total real output in an economy should be equal to total real expenditure in the economy. Production and income are therefore two sides of the same coin. In a national econometric model total real product (or income) may be determined by either supply or demand or by a combination of supply and demand factors. The models for China, Indonesia, Korea, New Zealand, the Philippines, and Thailand all have supply constraints, whereas the models for Singapore, Taiwan, and Vietnam are completely demand determined. However, the models for Korea and Thailand may also be regarded as demand determined because expenditure items such as consumption and investment are either separately explained or exogenous. In the New Zealand model, current real output is in fact demand determined, although capacity real output is exogenous.

Imports of raw materials, intermediate inputs, and fuels may be expected a priori to be important and perhaps even critical production inputs in labor-surplus and resource-deficient economies, such as those of Korea and Taiwan, that specialize in labor-intensive light manufacturing. Surprisingly enough, these inputs have not been included in any one of the production functions in any of the national econometric models surveyed. Thus imports have no *direct* supply-side influences in the determination of GNP.

Even for demand-determined models, it is possible for GNP to be constrained by the quantity of imports, through the latter's influence on consumption. The Vietnam model is precisely such a case. Food consumption depends on rice imports as well as rice production and the number of farm animals. Nonfood consumption depends on GNP and on imports.

China The basic assumption that underlies the model is underutilization

of productive capacity. There is no capital constraint on the quantity of real production. Net domestic product in the economy is determined as the sum of net value added by modern sectors except government, net value added by traditional sectors, and net value added by government. Net value added by modern sectors and net value added by traditional sectors depend directly and indirectly on net value added by agriculture, net value added in agriculture lagged one period, and lagged value added by mining, all of which are assumed to be exogenously determined.¹⁴ Thus, total real product of the economy must be considered as basically exogenous. Investment is determined as a residual of real product minus all the other expenditures. There is no explicit capital stock variable, but inasmuch as the total real product is determined completely independently of the capital stock, its absence does not affect the model. In this model, foreign developments cannot possibly affect the quantity of real aggregate output.

Indonesia The production sector is spelled out in substantial detail. Five sectors can be distinguished: the primary sectors, manufacturing and public utilities, construction, transportation, and services and mining. Manufacturing and public utilities together with construction constitute what is called the secondary sector, and transportation plus services and mining constitute what is called the tertiary sector. There are explicit value-added functions for each of the five sectors distinguished, which depend on the quantities of government capital stocks in agriculture and in industry and on the quantities of private capital stock in those same sectors, but lagged one period. Thus, production is truly supply determined, being constrained by the quantities of government and private capital stocks. In addition, there is a rice yield equation, which is basically autoregressive; given the area of cultivated land in rice, it determines total rice production. However, neither the yield nor the total production directly affect value added in the primary sector. The purpose of introducing rice production is to explain rice consumption, which in turn affects imports of consumption goods.

Korea Total value added is the sum of real value added in the primary sector, consisting of agriculture, fishery, and forestry, and the nonprimary, consisting of all industries other than those three. Value added in the primary sector is assumed to be exogenous to the national econometric model. Value added in the nonprimary sector depends on employment, capital stock, current and lagged real money balances, and a time trend. Constant returns are assumed. Thus, these components of the total real product are supply determined. Aggregate expenditure, on the other hand, is demand determined. Because separate consumption and investment functions are estimated, in addition to the production functions, the GNP

identity need not hold in general for an arbitrary choice of the exogenous variables. Thus, the "statistical discrepancy" between real product and total real expenditure may be large.

New Zealand Real capacity output is exogenously determined by a trend over peaks of seasonally adjusted aggregate expenditure. Current aggregate expenditure is then determined by demand factors.

The Philippines Real aggregate output of the economy is a function of current quantities of the capital stock and employment. Thus, this is a supply-determined model. Given real GNP, the production submodel determines value added of seven sectors: agriculture, fishing, and forestry; mining and quarrying; manufacturing; construction; transport, storage, communications and utilities; commerce; and services. Sectoral output is determined in two different ways. Manufacturing output is a function of capital stock in manufacturing and the price of manufactures. The outputs of the remaining sectors except services depend on output lagged one period and current output prices. Service output is a function only of output lagged one period. Either demand functions for each sector's output or sectoral price formation functions are used to close the system. There may be a discrepancy between real GNP and the sum of values added by the seven sectors. It is interpreted as depreciation plus indirect taxes plus net factor income from abroad.

Singapore There is no production function or supply constraint. The model is demand determined.

Taiwan Gross domestic product is completely demand determined. There are no supply-side constraints. There is also no sectoral supply detail. Given total gross domestic product, the values of the variables—wages and salaries, profits of private enterprises, profit of government enterprises, and depreciation—are determined.

Thailand Production is supply determined. Four subsectors are distinguished in the production sector: rice, agriculture other than rice, manufacturing, and service. Rice production is a function of land area cultivated in rice and capital stock in agriculture lagged one period. Nonrice agricultural production is a function of land area cultivated in products other than rice, agricultural capital stock lagged one period, and the percentage of cultivated land area in rice that is damaged in a given year. Manufacturing sector output is a function of capital lagged one period. Service sector output is a function of capital lagged one period and of time. In addition to the four sectoral values added, there is rubber production, which is

determined by rubber exports—which in turn depends on tappable rubber acreage, the price of rubber, and world demand for rubber—and by desired changes in the stock of rubber, which is exogenous. Real GNP is thus the sum of the four values added plus rubber production plus real net factor income from abroad. There are also three land allocation functions that determine how much cultivated land is to be devoted to rice, rubber, and other agricultural production on the basis of current and lagged relative prices and expected yields of each. Land for tappable rubber depends in addition on itself lagged. Land for other agricultural production depends also on the agricultural capital stock lagged one period. Finally, in the Thai model, there is also a "statistical discrepancy," similar to that in the Korean one, between total real output and total real expenditure.

Vietnam On the aggregate level, GNP is demand determined. However, there is a very detailed production subsector for agriculture, which distinguishes in particular the rice, fish, livestock, and rubber sectors. The output of these sectors has supply constraints, mostly in terms of current and lagged cultivated areas.

Investment

In national econometric models in which real aggregate output is supply constrained, current investment plays a very important role in the determination of not only the present but also the future course of the economy. In addition to being a component of current aggregate demand, investment changes the capital stock of the economy and through the capital stock changes, the future levels of real output. The explanation of investment in the Pacific Basin countries can be classified into two types: supply determined, with investment constrained either by the availability of capital goods (whether domestic or imported) or by credit availability or by profits; and demand determined, with investment related to output by a flexible accelerator mechanism, by lagged capital stock, by expected profits, and possibly by the user cost of capital. Among the supply-determined investment functions, one may further distinguish between those that are resource constrained, that is, constrained by either total production or capital goods production or capital imports, and those that are finance constrained, that is, constrained by the availability of credit, profits or, generally, of investable funds. In general, a particular investment function may be a hybrid combination of more than one of the three types of investment function discussed above.

In all of the models surveyed, New Zealand comes the closest to having purely demand-determined investment functions. The investment functions in the rest of the models may all be considered as having both demand and

supply factors. In particular, the quantity of imports enters directly into the investment functions of Indonesia, The Philippines, and Vietnam. A foreign capital flow variable enters directly into the investment functions of Korea. Bank credit and other liquidity variables enter the investment functions of Indonesia, Taiwan, and Thailand. Government investment and exports both lagged one period are the determinants of private investment in the Singapore model.

China Investment is determined by the residual of output minus all other expenditures. Since real aggregate output is basically exogenous, investment is effectively constrained by supply. Yet inasmuch as there is no capital stock variable in the Chinese model, the quantity of investment has no impact on either current or future levels of real aggregate output.

Indonesia A distinction is drawn between government and private capital stock and government and private investment. Total investment in the economy depends on the quantity of capital imports lagged one period and current total bank credit, which is exogenous to the model. Thus total investment is supply determined. Total investment is disaggregated first into government and private investment. Government investment is determined through the capital stock equations of government capital in agriculture, industry, and welfare respectively. All three capital stocks depend on the imports of capital goods and themselves lagged one period. In addition, the last two investment functions depend on per capita gross domestic product and government revenue. Total private investment is the difference between total investment and total government investment. Given total private investment, the investments in four of the five production sectors are determined; the investment in the remaining sector is determined by the residual method. Primary-sector capital stock is determined by primary-sector output and capital stock lagged one period. Investment in construction is determined by total private investment and the change in output of the construction sector. Investment in manufacturing and public utilities and in services and mining depend on total private investment.

Korea The investment functions are of the flexible accelerator type. Five kinds of investment are distinguished: residential construction, investment in machinery and equipment, nonresidential and other construction, inventory investment, and government investment. Government investment is determined exogenously. Residential construction is assumed to depend on income and housing stock, both lagged. Investment in machinery and equipment and nonresidential construction are both assumed to depend on changes in the total value added of the nonprimary sector and on the inflow of long-term foreign loans, which is exogenously given. Foreign

capital inflow turns out to be an important determinant of these two types of investment. Inventory investment depends on changes in the outputs of the primary and nonprimary sectors.

Total fixed investment in the economy is the sum of residential construction, investment in machinery and equipment, nonresidential construction, and government investment. Fixed investment in the nonprimary sector is defined to be 0.925 of total fixed investment. Fixed investment in the nonprimary sector results in increases in capital stock in the nonprimary sector, which in turn results in increases in future outputs of the nonprimary sector.

New Zealand Here, as in Korea, four types of private investment are distinguished: private residential construction, private nonresidential construction, investment in plant and machinery, and inventory investment. Private residential construction is assumed to depend on current and lagged building permits issued, lagged real balances, and the rate of change in the price of residential construction. The volume of building permits issued depends in turn on the stock of private residential construction. The functions for private nonresidential construction and investment in plant and machinery are both of the flexible accelerator type. In addition, the former depends on its stock and the average mortgage interest rate, both lagged one period. The latter depends on its own stock lagged one period, the price of imports relative to the consumer price index, real balances lagged one period, and capacity utilization lagged two periods. Total private fixed investment is the sum of private residential and nonresidential construction and 0.70 of real investment in plant and machinery. However, since there are no production constraints in the model, the capital stocks have no effect on real aggregate output.

The Philippines Total gross domestic investment is a function of current real aggregate output, real imports, the price of output, and the wage rate; so it includes both supply and demand factors. Investment enters into capital stock, which in turn affects real aggregate output through the production function. Although seven production sectors are distinguished, the manufacturing sector is the only one with a capital stock variable. Changes in manufacturing capital stock depend on total gross domestic investment and the price of manufacturing output relative to the general price level. Manufacturing capital stock enters into the manufacturing supply function but does not have any effect on real aggregate output of the economy.

Singapore Investment is classified as either government or private. Government investment is exogenous. Private investment depends on exports and on government investment, each lagged one period. The assumption is

that investment is induced by government infrastructure investment and export opportunities. Thus, investment is basically demand determined. The level of investment has no impact on either current or future real aggregate output.

Taiwan Total investment is classified as either government or private. Within each kind, four types are distinguished: construction, plant and equipment, transportation, and inventory investment. Government investment (except inventory investment) is exogenous. Investment in construction is assumed to depend on expected profits, which is exogenous, and the degree of urbanization. Investment in plant and equipment is assumed to depend on the change in real aggregate output lagged one period and the interest rate, which is exogenous. Investment in transportation is assumed to depend on real aggregate output and on liquid assets of business enterprises lagged one period, which is also exogenous. Inventory investment is assumed to be of the accelerator type and to depend in addition on the rate of interest. Since real aggregate output is demand determined, increases in investment due to changes in exogenous factors will increase real aggregate output. However, investment has no cumulative effects because of the lack of a production function through which accumulated investment can exert an influence.

Thailand Total investment is classified as either government or private. Within each kind, three types are distinguished: agricultural, manufacturing, and service. Government investment is assumed to be exogenous. Private agricultural investment depends on changes in agricultural output, the supply of bank credit relative to the price of capital goods, and the price of agriculture lagged one period relative to the price of capital goods. Private manufacturing and private service investments are both of the accelerator type and also depend on the real supply of bank credit. These investment functions are therefore hybrids of demand and supply types. Total investment (government plus private) in each sector increases that sector's capital stock, which in turn increases the quantity of output of the sector.

Vietnam Total investment depends on GNP and imports. This probably reflects supply considerations much more than those of demand. There is no aggregate output supply constraint in this model.

Imports

As pointed out earlier, import functions are crucial for the purposes of linkage. We have already seen that in some of the models surveyed,

imports play a direct role in the determination of investment. Imports can also enter directly into either the production or the consumption function. Here, we are primarily concerned with the determinants of imports in each model. Imports can be either supply or demand determined or both. On the supply side, imports may be limited by the availability of foreign exchange holdings, which may depend in turn on exports, capital inflows, and other endogenous or exogenous credit items in the balance of payments. On occasion, imports of a specific commodity may depend on its world availability. This has not been the case in all of the Pacific Basin models surveyed, although conceivably supply-side limitations of that kind may be important for such imports as fuels and raw materials, especially when rationing is practiced by the exporting countries. However, to properly accommodate this possibility, production functions which depend explicitly on fuels or raw materials must be established in the models themselves. On the demand side imports may depend on GNP, other domestic sectoral activity variables, and the price of imports relative to the domestic price. Domestic sectoral activity variables may be further distinguished by whether they refer to the production-originating sectors, e.g., agriculture or nonagriculture, or end-use sectors, e.g., consumption or investment.

In terms of the degree of disaggregation, many of the models are remarkably alike: in those for Indonesia, The Philippines, Taiwan, and Thailand imports are broken down by capital goods, raw materials, and consumer goods. The Korean model also has a fourfold breakdown but it is slightly different in coverage. On the other hand, the models for the People's Republic of China, New Zealand, and Vietnam basically explain only total imports.

China Total real imports are a function of net domestic product lagged one period. Imports are not further disaggregated. The quantity of imports does not affect the rest of the economy except as an expenditure item in the national income identity and hence helps to determine investment, which is defined as the residual.

Indonesia Imports are disaggregated into capital goods, raw materials, and consumer goods. Imports of capital goods are assumed to depend on real output of the nonprimary sectors and foreign exchange holdings lagged one period. Imports of raw materials are assumed to depend on the real outputs of the secondary and tertiary sectors and on foreign exchange holdings lagged one period. Imports of consumer goods are assumed to depend on population, domestic rice production, and foreign exchange holdings lagged one period. Thus imports are determined by a combination of demand and supply factors. Besides entering the investment function

directly, the value of imports also affects the balance of payments which in turn affects the level of foreign exchange holdings.

Korea Imports are disaggregated into machinery and equipment, intermediate goods, grain, and services (including factor income). Imports of grain and services are exogenous. Imports of machinery and equipment are assumed to depend on expected output of the nonprimary sector (approximated by a weighted average of lagged nonprimary sector outputs) and the real effective price of imports (approximated by a weighted average of Japanese and U.S. export prices relative to the domestic wholesale price). Imports of intermediate goods are assumed to depend on current nonprimary sector output and also on the real effective price of imports as described above. In this model, changes in imports have no effect on real aggregate output.

New Zealand Imports are disaggregated into an endogenous and an exogenous component. The latter consists of large, random items. The former is assumed to depend on a weighted average of past and current real aggregate expenditure, real money balances lagged one period, domestic capacity utilization, and the price of imports relative to the consumer price index. Imports affect present and future current payments for imports, which in turn affect the current account balance and hence official overseas assets. Endogenous imports also enter into indirect taxes-customs duty function and thus indirectly affect disposable income.

The Philippines Total imports in money terms are assumed to be equal to total exports in money terms. Thus, the quantity of imports is directly constrained by the ability to export and the terms of trade. Four categories of imports are distinguished: capital goods, raw materials, consumer goods, and services. Capital goods imports are assumed to depend on total investment, the domestic price level, and the price of imports. Raw materials imports are assumed to depend on manufacturing sector output, the domestic price level, and the price of imports. Services imports are assumed to depend on total imports. Finally consumer goods imports are determined as a residual. Since only total imports, which are determined by total exports, enter into the aggregate investment function, imports of capital goods have no effect on the quantity of real aggregate investment.

Singapore Imports are classified into two types: entrepôt and retained. Entrepôt imports are assumed to be a function of entrepôt exports, which are exogenous. Retained imports are assumed to depend on private consumption, private investment, government investment, and GNP less government consumption. Thus retained imports are also determined by demand-side factors.

Taiwan Imports are disaggregated into four categories: capital goods, raw materials, consumer goods, and services. Capital goods imports are assumed to depend on real aggregate output and exports lagged one period. Consumer goods imports are assumed to depend on the sum of personal and government consumption and the trade balance lagged one period. Service imports are assumed to depend on total imports of goods. Thus both demand and supply factors are involved. However, neither capital goods nor raw materials imports constrain the economy on the supply side, because there is no production function. Finally, neither domestic nor import prices enter into any of the import functions.

Thailand Imports are disaggregated into four categories: capital goods, raw materials, consumer goods, and services. Real capital goods imports are assumed to depend on real gross domestic investment and imports of capital goods lagged one period. Real raw materials imports are assumed to depend on manufacturing sector output and on the effective price of imports relative to the domestic price level. Real consumer goods imports are assumed to depend on the sum of personal and government consumption and on the effective price of imports relative to the domestic consumer goods price. Imports of services are assumed to depend on the variable itself lagged one period and on the sum of exports and imports of goods. Thus imports in Thailand are mostly demand determined.

Vietnam Total imports are assumed to be a function of GNP and U.S. aid. Imports are found to be inversely related to GNP, showing perhaps that the substitution effect between imports and domestic output dominates the income effect. The reason may also be that in a demand-determined model, an increase in imports means a decline in GNP, other things being equal. In addition to total imports, there are separate functions for rice and fish imports, but those do not feed back into total imports.

Exports

In linking national econometric models which do not have explicit multilateral trade or capital flow details, it is frequently necessary to suppress either the export or the import functions (likewise, either the capital inflow or the capital outflow function) to ensure consistency. The reason is that one country's exports must be another country's imports; if the exports and imports of each country are determined by its own functions, the sum of all exports may turn out to be greater than or less than the sum of all imports, after f.o.b.-c.i.f. adjustments. In Project LINK, it is the export functions in each national econometric model that are suppressed in the Maxi-LINK simulations, as explained in section III above.

One possible drawback to the suppression of export functions is that insufficient account may be taken of the supply constraints in the export

sectors. This is especially serious in the model if the supply price of exports is not an endogenous function depending directly or indirectly on either domestic expenditure or exports. It will also be impossible to take into account unilateral quantity restrictions on exports. The latter circumstance may be of great importance if the restricted commodity is a fuel or raw material crucial to the production process.

In the Pacific Basin national econometric models surveyed, exports are predominantly determined by demand-side considerations, with the exception of the models for the People's Republic of China and The Philippines, in which exports are determined wholly or partly by current or lagged supply conditions. Models in which exports are determined by demand-side considerations may be further divided into those in which exports depend only on exogenous variables, and those in which exports depend wholly or partly on current or lagged export prices or domestic prices, which are endogenously determined in the models. For all practical purposes of linkage, exports that depend only on exogenous variables may be treated in the same way as truly exogenous exports, inasmuch as their values in both cases are determined by factors external to the national econometric models.

Exports are exogenous in the models of Indonesia, New Zealand, Singapore, Taiwan, and Vietnam. In the models of Korea and Thailand, exports depend on external demand variables that are mostly exogenous to the national econometric models. In the Thailand model, there are some residual supply effects through the domestic price variable and for rubber exports through the tappable land area variable.

China Total real exports are assumed to be a function of net domestic product lagged one period.

Indonesia Total exports are disaggregated into four exogenous components: oil, mineral products other than oil, exports of agricultural products, and exports of other products. Exports affect the economy only through their collective effect on the trade balance. The latter affects the balance of payments, which in turn affects foreign exchange holdings, which in turn affect imports, which in turn affect gross domestic investment.

Korea Total exports are disaggregated into exports of goods and exports of services. Total exports of goods are explained by an external demand variable (weighted average rate of change of real Japanese and U.S. GNP) and by an effective relative price variable in the Japanese and U.S. markets. Both the exchange rate and rate of export subsidy play a role in the formation of the effective relative price variable. Exports of services are exogenous. With the exception of the influence of domestic wholesale

price in Korea, exports are determined almost solely by exogenous variables.

New Zealand Total exports are exogenous. Current receipts for exports, which are also exogenous because the price of exports is exogenous, affect the current account balance and official overseas assets both directly and through induced current payments other than for imports.

The Philippines Total exports are subdivided into ten categories: logs and lumber, copra, coconut oil, copper concentrates, desiccated coconut, abaca, plywood, sugar, nonprincipal commodities, and services. Exports of the first seven categories depend on a variety of factors: domestic production, price of output, price of competing commodity, wage rates of agriculture, manufacturing, mining and quarrying, price of manufacturing output, and manufacturing employment. Basically, the export quantities are determined by supply factors. For the model, prices of the first seven categories of imports, sectoral wage rates, and domestic outputs of logs and lumber, plywood, and coconut are all exogenous. The last three categories are exogenously determined. Exports do not depend explicitly on any external demand variable.

Singapore Exports are classified as either *entrepôt* or domestic. Both are exogenous.

Taiwan Total exports are exogenous. An increase in exports will increase real aggregate output by the usual Keynesian multiplier mechanism. An increase in exports also increases profits, holding other domestic expenditures constant. Profits influence taxes, and taxes influence disposable personal income, which in turn influences consumption and hence, ultimately, the gross national product. Through the gross national product exports will influence investment, which will have a feedback effect on current GNP. However, inasmuch as aggregate real output is demand determined, investment will not have any effect on future levels of aggregate real output.

Thailand Exports are disaggregated into six categories: rice, rubber, tin, other agricultural commodities, manufactures, and services. All except services are assumed to depend on external demand conditions. Rice exports are assumed to depend on total Asian rice imports, U.S. rice exports, the export price of rice, and the Burmese price of rice. Rubber exports are assumed to depend on total world rubber imports, the export price of rubber, the domestic price level, and the tappable area—the last two variables representing the supply factors. Tin exports are assumed to

be a function of total world imports and of manufactured exports lagged one period. Service exports are a function of the sum of exports and imports of goods plus service exports lagged one period.

Vietnam Total exports are exogenous, and since real aggregate output is demand determined, a rise in exports will increase GNP through the usual Keynesian multiplier mechanism. In addition, there is a rubber exports function. However, the rubber exports function does not play a role in the determination of real aggregate output or other aggregate variables.

Prices

Here we are concerned with the mechanism of formation of domestic, import, and export prices, and the interrelationship among them. An important channel for the international transmission of changes in economic conditions is through prices. Import prices can affect imports directly; they can also affect the consumer price index as well as the price of manufactured goods. Furthermore, to the extent that prices play an important role in the determination of the equilibrium of the real sector the impact of changes in international prices can be substantial. If export prices are endogenously determined, then changes in domestic prices due to changes either in the domestic economy or originating from abroad will have an impact on export prices, which may in turn affect both the level of exports to, as well as imports (and import prices) from, the trading partner countries.

On the basis of our survey, we conclude that the price sector is a relatively weak channel for the international transmission of economic disturbances within these Pacific Basin national econometric models. The possible reasons are that there is no price sector or that the price sector is insufficiently integrated with the real sector or that the general price level is independent of the price of imports or that there is no mechanism for the determination of the price of exports.

Even in models with disaggregated imports, there is usually only a single import price index for all categories of imports. This may lead to a distorted picture if all or most of the import price increase is in one category, e.g., oil.

It is also interesting to note that in none of the models surveyed is the price or wage determination mechanism of the Phillips-curve type. This is so partly because the labor markets of those countries are probably quite different from those of developed economies, and partly because data on unemployment are either unavailable or unreliable. Similarly, unit labor cost does not play an important role in the models surveyed.

China The whole model is written in real terms. Neither domestic nor international prices appear in any of the structural equations of the model. Consequently, changes in international prices have no impact on the model.

Indonesia The whole model is written in real terms, with the exception of the balance-of-payment accounts, which are written in nominal terms. Domestic prices are not included. However, changes in the import or export prices or both (and in the exchange rate) have an impact on the value of the trade balance (though not in real terms) and hence on the value of foreign exchange holdings, which in turn affect the quantities of imports of the next period.

Korea The rate of change of wholesale prices in Korea is assumed to depend on the rates of change of the money supply, real output of the nonprimary sector, changes in the exchange rate, and prices of rice and of public utilities. The last three are considered policy variables and hence exogenous to the national econometric model. The consumer price index is also exogenous.¹⁵ So are the effective import and export prices. There is only a single import price for all the different import categories.

New Zealand The price sector is quite detailed. Prices for six consumer good categories are distinguished: nondurables, durables, private transport, services, home ownership, and rent. The prices of nondurables and durables are assumed to depend on the price of imports, the ratio of wage and salary income to real aggregate expenditure (a demand pressure variable), and the prices themselves lagged one period. The price of nondurables is assumed to depend in addition on the wholesale farm price, which is exogenous. The prices of private transport and services also depend on the ratio of wage and salary income to real aggregate expenditure, on lagged values of themselves, and on the lagged value of the general consumer price index. The remaining two prices are exogenous. The general consumer price index is a weighted sum of the prices of the six categories of consumer goods, with the weights given exogenously. In addition, the price deflator for the building sector is assumed to depend on the wholesale price of imports used in building and construction, which is exogenous, the utilization rate lagged one period, and average salary and wage income for private-sector employees. These prices enter into the determination of the level and composition of consumption, the level and composition of investment, and imports. Since the New Zealand model is basically demand determined, changes in these prices will have considerable impact on the real aggregate output of the current period.

Import prices and export prices are both exogenous.

The Philippines The implicit GNP deflator is assumed to be a function of real aggregate output and the money supply. The GNP deflator affects employment in the model and through employment, real aggregate output. Given the implicit GNP deflator, the sectoral prices of agriculture, fishing and forestry, mining and quarrying, manufacturing, construction, transport, storage, communications and utilities, commerce and services are determined, sometimes together with the sectoral wage rates. However, these sectoral prices do not feed back into the implicit GNP deflator.

Import prices and export prices are all exogenous. There is only a single import price for all four categories of imports. Import prices do not enter into the formation of the individual domestic sectoral prices; they influence the implicit GNP deflator indirectly, and through it they influence imports, which affect investment and government revenue. Export prices affect only the export sector.

Singapore There are no price variables in the Singapore model, which is completely written in real terms. Thus, there cannot be any direct price or exchange rate effects.

Taiwan The Taiwan model is one in which the real sector and the price sector can be completely separated. All the real variables of the economy may be determined without reference to the price variables. A change in the exchange rate will have no real effect in this model, but will induce a change in prices. Likewise, changes in international prices will have no impact on the real sector of the economy.¹⁶

The GNP deflator is defined implicitly as a ratio between nominal and real GNP. Six expenditure components of GNP are distinguished: consumption, investment, government, inventory, exports, and imports. Six additional prices are also distinguished: wholesale prices; prices of industrial products, agricultural products, industrial raw materials, and urban consumption; and the manufacturing wage rate. The exogenous inputs into the price sector are the rate of change of the service wage rate and the price of government consumption, of fertilizers, and of imports. Despite the disaggregation of imports, there is only a single import price. Given these exogenous prices, the remaining prices are determined recursively. First, the manufacturing wage rate is assumed to depend on the price of urban consumption, and per capita real GNP, both lagged one period. The price of agricultural products is assumed to depend on the price of fertilizers and of agricultural products lagged one period. The price of industrial raw materials is assumed to depend on the price of imports and of raw materials lagged one period. The price of industrial production is determined by the price of industrial raw materials and the manufacturing wage rate. Second, having now determined the prices of both the agricultural

and industrial products, the wholesale price and the price of exports are both determined as functions of the price of agricultural and industrial products. Third, the price of inventory is assumed to depend on the wholesale price. The price of urban consumption is assumed to depend on the wholesale price and the rate of change of the service wage rate. Finally, the price of consumption is determined as a function of the price of urban consumption, and the price of investment is determined as a function of the price of industrial products. This is a fairly complex recursive system. But it is clear that the price of imports plays an important role, and indirectly affects the price of exports.

Thailand The implicit GNP deflator is determined via a modified quantity theory of money. It does not depend on the price of imports. Once the GNP deflator is determined, the sectoral prices for consumption, investment, manufactured goods, services, and other agricultural goods are all determined as functions of the GNP deflator and themselves lagged one period. The rice price index depends on the implicit GNP deflator and the world price index less the export tax. The rubber price index depends on itself lagged one period and on the world price of rubber. These prices in turn enter into the agricultural production, investment, and international trade sectors. The import price is exogenous, and there is only a single import price index, although four categories of imports are distinguished.

Vietnam The implicit deflator for gross domestic expenditure (consumption + investment + government expenditure) is assumed to depend on gross domestic expenditure, money supply, and the price level lagged one period. The price of imports is exogenous and does not have any effect on the real activity variables or on prices. It appears only in the nominal GNP identity and plays a role only in the determination of the GNP deflator. The price of exports is assumed to be a function of the domestic consumer price index and the export price of rubber. Again, it does not feed back into the real activity variables. The implicit deflator for gross domestic expenditure directly or indirectly determines all of the other prices—the prices of food consumption, nonfood consumption, investment, government, and consumer price indexes (including and excluding rent)—either alone or in conjunction with other variables.

Money and Finance

The effect of a change in one country's economic condition can also be transmitted to another country through the monetary and financial sectors. In general, this will involve induced changes in the monetary base, induced capital flows, and induced changes in the rates of interest.

Unfortunately, not all of the Pacific Basin national econometric models have monetary sectors, and with the exception of New Zealand, none has a financial sector. Thus, even if these models are linked, changes in monetary and financial policies will not be found universally to have significant cross-national effects.

China There is neither a monetary nor a financial sector.

Indonesia There is neither a monetary nor a financial sector. There are, however, variables such as foreign exchange holdings and bank credit, which conceivably can be affected by external monetary and financial developments. One exogenous component of foreign exchange holdings is net private capital inflow, which presumably will depend on the real rate of return relative to alternative opportunities of the same risk class.

Korea There are two equations in the monetary sector: the demand for money and the demand for time deposits. Both are functions of current and lagged values of nominal total GNP, the rate of interest, and a weighted average of past rates of change of consumer prices. The latter two variables are both exogenous. Money is particularly important in the Korean model because aggregate real output is assumed to depend positively on real balances.

New Zealand The monetary and financial sector is very detailed, covering currency and trading banks, savings banks, and nonbank financial institutions. Demand deposits of trading banks are assumed to be a function of aggregate current expenditure, government borrowing requirements, overseas private capital balances, and the interest rate. The latter two are determined exogenously, and demand deposits are lagged one period. Demand deposits of savings banks are assumed to be a function of aggregate current expenditure, the personal income tax, the interest rate, and deposits themselves lagged one period. The yields on both long-term and short-term government securities are exogenous. The only endogenous interest rate is the average rate on new mortgages. The United Kingdom bank rate enters into the determination of current payments other than for imports and indirectly affects the current account balance and official overseas assets. However, the latter do not affect the money supply directly.

The Philippines Money supply determines the price level via a quantity theory mechanism. Money supply itself is determined in a monetary submodel that consists of nine equations. The exogenous variables specific to the submodel are government debt, the rediscount rate, the reserve

requirement ratio, Central Bank loans to banks, and a catchall variable including all factors other than the trade balance that affect changes in the international reserve. Money supply is assumed to depend on the monetary base and the reserve requirement ratio. The monetary base is assumed to depend on government debt, Central Bank loans to banks, and the quantity of international reserves, all lagged one period. Since the trade balance is assumed to be zero in the Philippine model, international reserves are primarily affected by exogenous factors, with the result that money supply is in effect exogenously determined. The monetary sector also determines the demand for currency, the supply of private bank credit, and the demand for time deposits. However, the latter variables do not feed back into the main system.

Singapore There is neither a monetary nor a financial sector.

Taiwan There is neither a monetary nor a financial sector. However, liquid assets of households lagged one period affect consumption of other commodities. Business liquid assets lagged one period affect private transportation investment. Liquid assets are defined to be total holdings of deposits in bank and nonbank financial institutions less currency in circulation. To the extent that the level of liquid assets may be dependent on changes in international economic conditions, they are a potential channel through which cross-national impacts may be transmitted.

Thailand The monetary sector consists of four equations: demand for currency, demand for demand deposits, demand for time and savings deposits, and credit from commercial banks. The demand for currency is assumed to be a function of current GNP and the share of the value added by the nonagricultural sector in GNP. The demand for demand deposits is assumed to be a function of current GNP and the number of banking branches. The demand for time and savings deposits is assumed to be a function of disposable income and the share of the nonagricultural sector. Credit from commercial banks is assumed to be a function of total demand deposits, time and savings deposits, the discount rate, the reserve ratio, and government securities held by commercial banks, the last three variables being exogenously determined. Total money demanded is the sum of demand for currency and demand for demand deposits. Given a total money supply that is exogenously determined, the money demand function may be inverted to give the value of current GNP. The price level is then determined by a nonstochastic equation, $P = kY/X$, where X is real GNP and k is a constant that depends on the choice of the base period of the price index. Since price effects are pervasive in the Thai model, and most of the sectoral prices are tied to the GNP deflator, the impact of price

changes can be quite substantial. However, as noted earlier, import prices do not have any direct impact on the general price level. The supply of credit from commercial banks is an important determinant of investment, and given the supply-determined nature of the Thai model, will have an effect not only on current real output, but future real output as well.

Vietnam There is no monetary sector, but money supply, which is exogenous, directly affects the price level.

Summary of Transmission Channels

We conclude this survey by summarizing the channels through which changes in international economic conditions can affect each national econometric model.

China As noted before, changes in international economic conditions have no impact on the Chinese model. However, if the endogenous export function is suppressed, then exports are determined outside of the Chinese model, and changes in exports have a direct impact on investment, which is determined as a residual. Current or future GNP remains unchanged.

Indonesia First, a rise in exports, given the supply-determined GNP, leads directly to a decline in consumption, which is determined by the residual. It also leads to a rise in the export surplus, which increases the foreign exchange holdings. The effect is to increase imports, and in particular imports of capital goods, in the next period. Imports of capital goods in turn increase investment in the following period. Investment increases capital stock, which in turn increases output of the next following period. Imports also depend partly on current domestic real activity levels and thus have a tendency to increase some more so as to further reduce the trade balance. In addition, the rise in imports immediately tends to restore the trade balance and consumption to their original level. An increase in imports results in an increase in government revenues through indirect taxes. An increase in government revenues translates directly into an increase in government investment, which in turn increases government capital stock and aggregate real output in subsequent periods. Thus through this channel it will take three or more periods before all the real effects are felt.

Second, a change in the exchange rate makes itself felt primarily through changes in the U.S. dollar value of foreign exchange holdings; a change in either the export or the import price has a similar effect.

Third, changes in exogenous items such as direct foreign investment and foreign transfers (aid and credit) also affect the economy through their impact on foreign exchange holdings.

Fourth, income from oil companies enters directly into government revenue and affects the economy via the process described above for changes in government revenue.

Korea First, an exogenous rise in exports, other things being equal, results in a decrease in the statistical discrepancy, because of the supply-determined nature of GNP.

Second, a change in the exchange rate changes the price level, which can influence real money balances and hence value added by the non-primary sector. This sets up secondary effects through the induced increase in the demand for money and investment, which may in turn increase output even further. An increase in import prices decreases imports. An increase in export prices decreases exports. All these effects are absorbed by the statistical discrepancy variable. They have no independent effect on production or prices as long as the exchange rate remains constant.

Third, the inflow of foreign long-term capital (direct investment or loan) increases investment and hence capital formation and through the capital stock the future levels of value added by the nonprimary sector.

New Zealand First, an exogenous rise in exports increases current GNP in accordance with the Keynesian multiplier mechanism. In addition, it increases current payments other than for imports and decreases both the current account balance and official overseas assets.

Second, a change in the exchange rate affects the quantities of imports and exports. A change in the endogenous component of imports in turn increases indirect taxes. A change in the import price directly affects real investment in plant and machinery, which in turn affects GNP in accordance with the Keynesian multiplier mechanism. A change in the export price affects directly both company income and nonfarm other persons' income. Finally, a change in the U.K. bank rate also adversely affects current payments other than for imports and leads to a fall in both the current account balance and official overseas assets. The import price enters directly in the determination of certain domestic prices, and changes in it affect the general price level.

Third, a change in the overseas exchange transactions private capital balance affects demand deposits of trading banks and hence the money supply. Influences of the money supply are quite pervasive in the New Zealand model. Real balances lagged one period affect consumption, investment, and imports.

The Philippines First, an exogenous rise in exports, other things being equal, results in an increase in imports of the same quantity, leaving the trade balance unchanged. An increase in imports increases total investment and government revenue. An increase in investment eventually finds its

way into increases in output through capital formation. A change in output leads to changes in money supply and prices. An increase in government revenue increases government consumption but decreases disposable income. Current personal consumption, being a residual of the GNP identity, of necessity declines. A decrease in disposable income affects sectoral real output and investment.

Second, a change in the exchange rate amounts to a change in the terms of trade. Hence for given total exports, imports must adjust, and effects similar to those traced out in the preceding paragraph hold. A change in import or export price also has the same effect as an exchange rate change. In addition, a change in import prices affects the consumption of imports. A change in export prices affects both the level and the composition of exports.

Third, there is a catchall exogenous variable which includes all exogenous factors that cause changes in international reserves. That variable affects the monetary base, and indirectly the money supply and through the money supply aggregate real output, the price level, and the wage rate. If total exports are allowed to differ from total imports, then the trade balance will also exert the same influence as the catchall variable.

Singapore First, an exogenous rise in exports increases GNP in accordance with the Keynesian multiplier mechanism. The effect is substantially higher for an increase in domestic exports than for an increase in entrepôt exports. Second, a change in the exchange rate has no effect on the model. Likewise, changes in import and export prices also have no effect. Third, there are no foreign exchange holdings or foreign investment variables in the model. The only channel for the transmission of international economic disturbances is through exports.

Taiwan First, an exogenous rise in exports increases GNP in accordance with Keynesian multiplier mechanism. Moreover, it increases imports of raw materials as well as consumption in the next period. (But raw materials do not feed back into production.) It also increases profits, which in turn increase taxes and decrease personal disposable income. This will tend to lower consumption. Investment is affected but the effect is not lasting because of the demand-determined nature of the model.

Second, a change in the exchange rate will have no real effect in this model. It affects only prices, including the export price. An increase in the price of imports also affects only prices, since there is no balance-of-payments or foreign exchange constraint to imports.

Third, there is no explicit consideration of foreign direct investment or other capital transfers and flows.

Thailand First, an exogenous rise in exports, other things being equal, results in a decrease in the statistical discrepancy, because of the supply-determined nature of GNP.

Second, a change in the exchange rate affects the quantity and composition of imports and exports. The general price level, however, is independent of import prices. The prices of rice and rubber, on the other hand, depend on the corresponding world prices net of export taxes. Changes in prices change land allocation and in turn the outputs of the agricultural sectors.

Third, there is no variable for foreign direct investment or foreign transfer of capital or aid.

Vietnam First, an exogenous rise in exports increases GNP in accordance with the Keynesian multiplier mechanism. An increase in GNP, however, is accompanied by a decrease in imports. A change in imports affects investment directly.

Second, a change in the exchange rate will have an impact on the quantity of imports. Exports of specific commodities such as rubber will also be affected.

Third, the level of foreign aid (principally from the United States) is an important variable in the determination of imports and hence indirectly of investment.

V. PROSPECTS FOR LINKAGE

Linkage Feasibility

Quantities and prices of imports and exports, international capital flows (including foreign direct investment, foreign aid, and foreign long-term credit), flows of international reserves, and the international structure of interest rates are the principal areas of interface between national econometric models. As presently constituted, the models surveyed in this paper meet the minimum requirement for trade linkage, since they contain endogenous import functions on an aggregated or disaggregated basis. Consequently it would be feasible to link these models (together with models of Australia, Japan, and the United States) into a Pacific Basin regional model along the lines of the Mini-LINK methodology mentioned in section III. Without further improvements in the domestic sectors of some national models, however, such a system would incorporate only foreign trade multiplier effects and would be incapable of dealing with

linkages through capital flows, monetary disturbances, or the terms of trade. And without further improvements and greater uniformity in the international sectors of the models, the linkages even through trade flows would be unsatisfactory and incomplete.

Possible Improvements in the International Sectors

Geographic detail on the distribution of trade is a primary requirement for a linked system that is to be used for tracing the transmission of a disturbance in one country to each of the other countries. Thus an econometric model of multilateral trade flows should form the centerpiece of a Pacific Basin regional model. For reasons discussed by Rhomberg (1973), the most practical approach is through a trade model based on a matrix of market shares.¹⁷ As sketched in section III, the Maxi-LINK method of international linkage utilizes a market shares approach in which the shares are themselves endogenous functions of relative export prices.

The basic relationships in such trade models are a set of import functions for the various countries or regions and an export shares matrix for distribution of the predicted imports by supplying countries. Moreover, if the export shares themselves are functions of relative export prices, for consistency the import price indexes figuring in the import demand functions must be weighted averages of the same export prices, with the weights drawn from the shares matrix.

In principle, each country's export price and import quantity could be predicted exogenously and the shares matrix could then be used to predict the associated export quantities and import prices. This partial equilibrium approach has been used by Taplin (1973) in the expanded world trade model of the International Monetary Fund (IMF) and by Hickman and Lau (1972) in a pilot study of interregional trade flows in the Pacific Basin. It does not require complete national models but only reduced form equations to predict import quantities and export prices.

While useful in some applications, for example, for ex ante projections of trade flows, the partial equilibrium approach cannot be used to investigate interactions between foreign trade and prices and domestic production and prices in the various countries, and hence it cannot be used to study the international transmission of economic disturbances. For that purpose, import demand and export price equations must be embedded in national models with endogenous domestic variables. The national models need not necessarily be large, but they must be complete enough to answer the basic questions to be asked.

The Maxi-LINK or trade shares approach to international linkage imposes a constraint that the simpler Mini-LINK approach does not. For the latter,

the existing import and export functions of the national models could be used. For the former, however, the import equations for all models should be on the same level of disaggregation, and there should be a corresponding set of export price equations in each national model. These alterations would be comparatively simple to accomplish in a cooperative linkage project.

It would also be necessary to build the trade model itself. For that purpose, the partial equilibrium approach outlined above could be used, with import quantities and export prices given exogenously. As noted, the trade model would be directly applicable to some important problems, and it could readily be incorporated in a larger system of linked national models whenever the latter were ready.

The Maxi-LINK or trade share approach may also be applied to the analysis of the geographical distribution of trade in services. The so-called invisibles, such as financial services, insurance, shipping, and tourism may constitute a substantial component of the total trade of some of the Pacific Basin countries, especially the smaller ones. To the extent that quantities and prices of services may be sensitive to domestic or foreign developments, they constitute an additional important channel for the international transmission of economic disturbances not captured by the merchandise trade alone. The principal difficulty in the implementation of a model of multilateral trade in services, however, lies in the need for the compilation of data on the multilateral flows of services, which are much less readily available than those on multilateral flows of merchandise trade.

For capital flows, an approach similar to that for the trade share matrix is possible in principle, but it is not in practice a feasible option because of the scarcity of data on multilateral flows and stocks of capital. However, within the Pacific Basin context, it may be sufficient to focus attention on the capital outflows of the developed countries, since the capital outflows of the developing countries are negligible because of imperfections in the latter's capital markets and because of the existence of foreign exchange controls. The capital inflows (direct investment, aid, long-term credit) of a developing country may depend on the domestic activity variables of the capital-exporting country, as well as on relative rates of return and political, military, and humanitarian conditions. The more prosperous a country is, the more likely it is to make more foreign direct investment and give more aid, other things being equal. Thus, once the models are linked, adding the nominal GNP of capital-exporting countries to the equations of capital inflows in the models of the developing countries may help to explain the availability of foreign resources in the developing countries. This will also constitute an additional channel for the international transmission of economic disturbances. Some of these capital flow functions may indeed be of a bilateral nature. Frequently, these flows may be tied,

that is, they may be used only for the purchase of imports from the capital-exporting country. Features such as these should also be taken into account explicitly.

Further down the list of useful improvements are the explicit modeling of multilateral capital flows subject to overall accounting constraints; studies of exchange rate formation; investigations of the world markets for major commodities such as oil, rice, rubber, sugar, and tin, which constitute a substantial proportion of the exports and imports of many of the Pacific Basin countries; and possibly a study of the role of the "Asian dollar market" in Hong Kong and Singapore.

Possible Improvements of the Domestic Sectors of National Models

Although the national econometric models can be linked as they exist through international trade into a Pacific Basin regional model, the potential benefits of such linkage will be substantially enhanced by research efforts in several directions. First, an attempt should be made to strengthen the supply side of the models. At a minimum the supply side should consist of a production function that depends on the capital stock, and preferably on employment, energy, and raw materials as well. The models of Korea and Thailand, which already have supply sides, and the model of Taiwan all have the potential for a large statistical discrepancy in the national income identity. That potential should be eliminated. Further improvements in the supply side will consist of possible disaggregation of the production sector and a detailed study of production and demand factors in the export sector. Second, prices do not play an important role in many of the models surveyed. In order to capture the full effect of transmitted international economic disturbances, one must have more simultaneous determination of prices and quantities. For example, the price of exports must also depend on the quantity of exports either directly or indirectly. International prices should be systematically introduced as explanatory variables in the formation of domestic prices, and if the trade sector is disaggregated, both the export and import prices should also be disaggregated to the same level. Formation of export prices should also be explained on a disaggregated basis. Third, both the quality and size of these national econometric models are quite uneven. While it is not possible to standardize all the models because of local peculiarities, an attempt should be made to have the models cover the same amount of detail domestically and internationally. Finally, some of the models surveyed here are short-run ones. Others are of a more long-run nature. The purposes of the short-run models are obviously different from those of the

long-run ones. Perhaps it may be useful to consider separate linkage of short-run and long-run models.

Useful Linkage Exercises

What kinds of questions can be asked with a linked Pacific Basin regional model? Besides the usual questions that can be asked about any national econometric model, it is possible to consider the nature of transnational effects of changes in the national policy or environment of one country. With international trade linkage (whether Mini-LINK or Maxi-LINK), it is possible to study the international impact of changes in fiscal policy on real GNP and prices in any one of the Pacific Basin countries, as has been done by Hickman (1974) for Project LINK. With improvements in the domestic and international price formation sectors, it is also possible to study the international transmission of inflation directly through trade prices. If, in addition, the import functions of the Pacific Basin countries may be refined to include significant price effects, meaningful simulations can be made of the linked model under alternative assumptions such as (1) simultaneous exchange rate adjustments; (2) simultaneous multilateral changes in the rates of tariffs; (3) formation of an Asian common market or customs union or a currency area; (4) imposition of general or country-specific export or import quotas (including total embargo as a special case); (5) exogenous increases in the prices of critical commodities, e.g., oil, rice, etc.; (6) rationing of critical commodities. Of course, to properly gauge the effect of assumptions 4 through 6, a model is needed with disaggregated production and possibly consumption sectors, preferably ones that are sensitive to price changes.

Concluding Remarks

On the basis of our survey of the Pacific Basin national econometric models, we conclude first, that a Mini-LINK approach is minimally feasible for international trade linkage of the existing national econometric models in the present form. In addition, if a trade model of the Pacific Basin is developed to explain the geographical distribution of trade, the Maxi-LINK approach may be implemented. However, to obtain maximal benefit from trade linkage, the formation of both domestic and international prices should be endogenized in many of the national econometric models. Given the relatively high degree of trade interdependence among the Pacific Basin countries, linkage of these models should be very useful for forecasting and for simulation purposes. The benefits of linkage will be substantially enhanced if additional work on these models along the lines suggested above is undertaken.

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APPENDIX B: SUMMARY TABLES OF NATIONAL ECONOMETRIC MODELS SURVEYED

People's Republic of China, 1952–1957

SOURCE: T. C. Liu, "Quantitative Trends in the Economy," in A. Eckstein, W. Galenson, and T. C. Liu, eds., *Economic Trends in Communist China* (Chicago: Aldine, 1968), pp. 87–182.

Summary of Principal Characteristics

Type of data: Annual

Method of estimation: Ordinary least squares

Size of model:

Number of stochastic equations	11
Number of identities	5
Number of endogenous variables	16
Number of exogenous or predetermined variables	7

Structure of model:

Sector	Number of Equations
Consumption	2
Production	7
Investment	1
Employment	1
Government	0
International trade	2
Price and wage determination	0
Money and finance	0

Dynamic feature: One-period lags

Special comments: Net value added by agriculture and net value added by the mining sector are exogenous.

Indonesia, 1954-1970

SOURCE: T. Fukuchi, "An Econometric Model for the Indonesian Economy," February 1973" (mimeographed).

Summary of Principal Characteristics

Type of data: Annual

Method of estimation: Two-stage least squares

Size of model:

Number of stochastic equations	32
Number of identities	31
Number of endogenous variables	63
Number of exogenous or predetermined variables	22

Structure of model:

Sector	Number of Equations
Consumption	1
Production	11
Investment	15
Employment	8
Government	13
International trade	10
Price and wage determination	0
Money and finance	0

Dynamic feature: One-period lags

Special comments: Consumption is determined as a residual; there are many dummy variables; social overhead capital is an explicit variable.

Republic of Korea, 1963-1972

SOURCE: H. Song, "An Econometric Forecasting Model of the Korean Economy," Working Paper 7212 (Seoul: Korea Development Institute, 1973).

Summary of Principal Characteristics

Type of data: Quarterly

Method of estimation: Ordinary least squares

Size of model:

Number of stochastic equations	15
Number of identities	12
Number of endogenous variables	27
Number of exogenous or predetermined variables	27

Structure of model:

Sector	Number of Equations
Consumption	1
Production	1

Investment	4
Employment	1
Government	2
International trade	3
Price and wage determination	1
Money and finance	2

Dynamic feature: Multiperiod lags

Special comments: Production relations are nonlinear and include real money balances. Foreign loans enter directly into the investment functions. Value added in agriculture is exogenous; imports do not feed back into production. Exports do not have supply constraints. The national income identity can have large statistical discrepancies.

New Zealand, 1965–1970

SOURCE: R. S. Deane, M. A. Lumsden, and A. B. Strum, "Some Simulation Experiments with a New Zealand Model," in R. S. Deane, ed., *A New Zealand Model: Structure, Policy Uses and Some Simulation Results*, Research Paper 8 (Wellington: Reserve Bank of New Zealand, 1972), pp. 14–64.

Summary of Principal Characteristics

Type of data: Quarterly

Method of estimation: Ordinary least squares

Size of model:

Number of stochastic equations	51
Number of identities	44
Number of endogenous variables	95
Number of exogenous or predetermined variables	92

Structure of model:

Sector	Number of Equations
Consumption	4
Production	5
Investment	7
Employment	1
Government	11
International trade	3
Price and wage determination	5
Money and finance	15

Dynamic feature: Multiperiod lags

Special comments: This is a Keynesian model with excess capacity. There are therefore no supply constraints. Export receipts as well as export and import prices are exogenous.

The Philippines, 1950-1969

SOURCE: J. Encarnacion Jr., R. M. Bautista, M. Mangahas, and G. M. Jurado, "An Econometric Model of the Philippines with Projections through 1976" (mimeographed), Discussion Paper 72-5 (Manila: Institute of Economic Development and Research, School of Economics, University of the Philippines, 1972).

Summary of Principal Characteristics

Type of data: Annual

Method of estimation: Ordinary least squares

Size of model:

Number of stochastic equations	62
Number of identities	21
Number of endogenous variables	83
Number of exogenous or predetermined variables	10

Structure of model:

Sector	Number of Equations
Consumption	0
Production	9
Investment	2
Employment	8
Government	16
International trade	16
Price and wage determination	10
Money and finance	9

Dynamic feature: One-period lags

Special comments: The model consists of many submodels. The production subsector takes GNP as given. Personal consumption is computed as a residual. Money supply and wage rate are basically exogenous.

Singapore, 1960-1969

SOURCE: K. P. Wong, "A Macroeconomic Model of Singapore, 1960-69," *Malayan Economic Review*, April 1974, pp. 35-45.

Summary of Principal Characteristics

Type of data: Annual

Method of estimation: Ordinary least squares

Size of model:

Number of stochastic equations	5
Number of identities	3
Number of endogenous variables	8
Number of exogenous or predetermined variables	6

Structure of model:

<i>Sector</i>	<i>Number of Equations</i>
Consumption	1
Production	0
Investment	1
Employment	0
Government	1
International trade	2
Price and wage determination	0
Money and finance	0

Dynamic feature: One-period lags

Special comments: The model is demand determined. Everything is written in real terms. There are no prices in the model. Exports are exogenous.

Taiwan (Republic of China), 1952-1968

SOURCE: T. Yu, "A Short-Term Macroeconomic Model of Taiwan," *Economic Papers, Selected English Series 8* (Taipei: Institute of Economics, Academia Sinica, 1971).

Summary of Principal Characteristics

Type of data: Annual

Method of estimation: Two-stage least squares

Size of model:

Number of stochastic equations	30
Number of identities	8
Number of endogenous variables	38
Number of exogenous or predetermined variables	29

Structure of model:

<i>Sector</i>	<i>Number of Equations</i>
Consumption	4
Production	0
Investment	4
Employment	0
Government	5
International trade	4
Price and wage determination	10
Money and finance	0

Dynamic feature: One-period lags

Special comments: There are no supply constraints. The real sector and the price sector can be uncoupled from each other. Exports are exogenous.

Thailand, 1953-1969

SOURCE: V. Ramangkura. "A Policy Simulation Model for the Development of the Economy of Thailand" (Ph.D. dissertation, University of Pennsylvania, 1972).

Summary of Principal Characteristics

Type of data: Annual

Method of estimation: Ordinary least squares and two-stage principal components

Size of model:

Number of stochastic equations	38
Number of identities	16
Number of endogenous variables	54
Number of exogenous or predetermined variables	35

Structure of model:

Sector	Number of Equations
Consumption	2
Production	7
Investment	6
Employment	0
Government	2
International trade	10
Price and wage determination	7
Money and finance	4

Dynamic feature: One-period lags

Special comments: Production in agriculture is disaggregated into rice and nonrice production. Manufacturing and mining and service production are also distinguished separately. Capital is the only limitational factor in addition to land. Investment is a mixture of an accelerator model and a supply model. Export and import sector is quite detailed. Price determination is through the quantity theory of money. Sectoral prices are determined by the implicit GNP deflator.

Republic of Vietnam, 1961-1968

SOURCE: R. F. Daly, R. F. Hoffman, F. Nelson, H. Weingarten, N. Hancock, B. Chugg, and A. Rojko, "Agriculture in the Vietnam Economy: A System for Economic Analysis" (mimeographed), FDD Field Report 32 (International Development Center, Economics Research Service, U.S. Department of Agriculture, 1973).

Summary of Principal Characteristics

Type of data: Annual

Method of estimation: Ordinary least squares

Size of model:

Number of stochastic equations

Number of identities	20
Number of endogenous variables	49
Number of exogenous or predetermined variables	68

Structure of model:

Sector	<i>Number of Equations</i>
Consumption	4
Production	11
Investment	1
Employment	0
Government	0
International trade	3
Price and wage determination	12
Money and finance	0

Dynamic feature: Multiperiod lags

Special comments: This model is demand determined. There is a very detailed price sector and an agricultural sector consisting of rice, rubber, livestock, and fish subsectors.

NOTES

1. Although the U.S.S.R. is also located on the Pacific Ocean, we do not consider her in this paper because the bulk of her economic activities are oriented toward Europe.
2. Immigration provides another important structural link when free to respond to market forces, as in the European Economic Community, but that is not the case in the Pacific Basin.
3. The best general reference on Project LINK is Ball (1973). Briefer surveys are in Hickman (1975) and Moriguchi (1973).
4. As examples, see Moriguchi (1973), Johnson and Klein (1974), and Hickman (1974).
5. On the importance of lags, see Junz and Rhomberg (1973) and Hickman and Lau (1973), who have found substantial delays in the response of imports and market shares to relative price changes.
6. This factor is stressed in the "Scandinavian" model of "imported inflation" via export prices. See Edgren et al. (1969) as summarized in Artis (1971). The approach was developed earlier (in 1966) at the Central Bureau of Statistics of Norway under the leadership of Odd Aukrust.
7. Because import prices are entered negatively in the implicit deflator for GNP, the deflator may understate the effects of import prices on the domestic price level, as discussed in Hickman (1974).
8. See Klein and van Peetersen (1973).
9. See Hickman (1973) for the theoretical derivation of the weights for $p_i^* \bar{x}_i$. Alternative formulations of equation 3 are discussed in Klein et al. (1972), Moriguchi (1973), and Hickman and Lau (1973).
10. Details of the solution algorithm may be found in Klein and van Peetersen (1973), Waelbroeck (1973b), and Moriguchi (1973).
11. An early survey of econometric models of the United States can be found in Christ (1956). For a more recent survey see Fromm and Klein (1973). See also the Symposium

- (1974a, 1974b, 1975) in the *International Economic Review*. International surveys include Nerlove (1966), Hickman (1969), Ball, ed. (1973), and Waelbroeck (1973b). These surveys cover all of the developed countries of the Pacific Basin that are of interest.
12. The national econometric models in Project LINK have been surveyed by Ball, ed. (1973). The models themselves will be published in a forthcoming volume edited by J. Waelbroeck for the North-Holland Publishing Company, Amsterdam. Countries included in the Ball surveys are Austria, Belgium, Canada, Finland, the Federal Republic of Germany, Italy, Japan, the Netherlands, Sweden, the United Kingdom, and the United States. Subsequently, models for Australia and France have been added to Project LINK.
 13. A model for Hong Kong is being constructed at the Chinese University of Hong Kong by Tzong-Biau Lin.
 14. It should be remarked that data for the Chinese model are severely limited. Thus, the specification of the functional relationships depends to a large extent on what data are available rather than on what variables are the most suitable.
 15. In the published model, the consumer price index is listed as endogenous. If this were the case, the model would be incomplete. We have therefore assumed that the consumer price index is exogenous.
 16. In linking the Taiwan model to the other models, one can, of course, introduce some price influence on the real sector by making exports dependent on international prices.
 17. See Rhomberg and Taplin (1968), Taplin (1973), Hickman (1973), and Hickman and Lau (1973) for examples of variants of this approach.

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DISCUSSION

Speakers: Bert Hickman and Lawrence Lau

Discussant: Hang-Sheng Cheng, Federal Reserve Bank of San Francisco

Cheng doubted that, for the Pacific Basin countries, the linkage of existing general-purpose national models would be very useful. To be sure, as Hickman and Lau had noted, the minimal conditions for linkage feasibility

are satisfied, since each of the models discussed in their paper contains an import function. However, the models are otherwise underspecified, and hence the linked system would have little analytical power. For example, very few of the models contain relative prices in the trade equations; relative price terms are included in four out of the eight import equations, but in only two of the eight export equations. Yet, none of the six topics outlined in the discussion of "Useful Linkage Exercises" could be studied without relative price terms in the trade equations.

Thus, the need for improvements in the existing national models is self-evident. In their paper, Hickman and Lau had in fact pointed out that the lack of price terms represented a serious drawback. They had also mentioned the desirability of ultimately including international capital flows. Cheng said he was not as pessimistic as the authors about the possibility of modeling these flows, and even suggested that capital flow specification would not be as difficult for developing countries as for developed ones. In particular, Cheng maintained that foreign aid could be treated as exogenous; direct investment would then be a function of the economic growth rates in LDCs, and short-term capital flows would depend on trade flows.

Hickman and Lau had also suggested that the supply side of the existing models be strengthened, for example, by including capital stock, volume of employment, raw materials, and fuels in the production functions. Cheng went further in advocating that consumer goods imports also be included in the production function, and he argued, in fact, that all imports should be considered as inputs for national production. This, then, would represent a significant shift in outlook from Keynesian analysis, in which imports are regarded as leakages. Under Cheng's view, imports constitute essential inputs for production, and thereby augment national output.

Cheng criticized Keynesian aggregate demand analysis on other grounds as well, namely, that it is ill suited for times of shortages and inflation. He said it was high time that aggregate supply analysis stepped to the fore and shared the stage with aggregate demand analysis.

Similarly, Cheng argued that the Maxi-LINK approach of suppressing the national export functions is not appropriate for a seller's market. Given the current shortages, it would be better to stress those factors that determine the exporters' supply capabilities, and therefore, exports should be determined directly, rather than indirectly, by explicitly considering the supply functions.

Given the various deficiencies of the existing national models, Cheng proposed the possibility of constructing special-purpose models for studying specific problems, where the national models would share uniform specifications. The resulting linked system would have the advantage of greater manageability since it would be more narrowly focused. And as

long as new models were to be developed, it would be desirable perhaps to base the international price linkage on the monetarist view rather than utilize the cost-push approach which had been adopted by Hickman and Lau.

Several other conference participants shared Cheng's doubts about linkage feasibility. Robert S. Einzig, for example, felt that even with proper modeling, there would be inadequate interconnections to justify the linkage of Pacific Basin countries. He also disputed Cheng's contention that capital flows are proportional to imports and exports and went on to argue that in many instances investment flows show a stronger linkage with Europe than with the United States. J. Howard Craven doubted if linkage could be established without somehow considering the rest of the world, and Michael Keran wondered if the Harry Johnson-Robert Mundell approach to balance-of-payments adjustments might not be more appropriate.

Hickman and Lau were both sympathetic to the concerns expressed by Cheng and others, and reiterated that the proposed linkage was only a beginning and that the models would have to be augmented to make for improved linkage. Thus, Lau reaffirmed that relative prices would need to be considered. Hickman agreed that financial linkages with Europe are important and suggested that ultimately trade and financial flows with the rest of the world would have to be considered, not to mention the necessity of modeling the capital flows *within* the Pacific Basin region. Furthermore, money supply and demand mechanisms would be desirable, too, and the monetary base could be linked to the change in reserve flows through the money supply equations. Hickman emphasized that the price level had not been assumed to be independent of the money supply—it only appeared so because the monetary sectors of the various models were incomplete.

Hickman wished to clarify the authors' position on cost-push price determination. He contended that exogenous increases in import prices (e.g., oil prices) do in fact affect the domestic price level, and therefore that this type of price channel constitutes an important element of the international transmission process which must be taken into account in the analysis. On the other hand, he also noted that the models allow for a demand-pull price linkage in the sense that an exogenous increase in the demand for exports also influences the domestic price level.

Hickman also took issue with Cheng's comments about the export functions in the Maxi-LINK approach. He remarked that while it is true that the demands for imports are determined and then passed through a trade matrix to generate export demands, this in no way implies that supply constraints are being neglected. In fact, export supply functions do exist in the Maxi-LINK national models, and these functions generate export prices as endogenous variables which then become part of the linkage process.

Hence, there exists an export supply side that operates via the price variables.

Einzig observed that some of the models utilize quarterly data while others are specified on an annual basis, and he wondered if annual data would obscure whatever linkages there might be. Hickman felt that the use of annual data would be more appropriate since the important issues, such as the developmental problems of LDCs, are concerned with the long run.

Richard H. Holton stated that the availability of data might constrain the modeling process and that, therefore, special-purpose models which did not require large amounts of data might be more suitable. Hickman thought the point was well taken, although he noted that special-purpose models do not necessarily imply smallness. In Hickman's view, general-purpose models in fact might be more useful, since they can be utilized to analyze a wider variety of problems. And to the extent that the general-purpose-special-purpose distinction is manifested in differences in model size, largeness will constrain understandability rather than applicability. After all, the computer technology exists to handle complex problems, and it is not even expensive.

Hickman also pointed out that the dichotomy between the general- and special-purpose model was not strictly a matter of starting from scratch, although Cheng had coupled the two in his earlier discussion of the paper. In fact, Hickman questioned the value of adopting uniform specifications for the various national models, remarking that each economy is likely to have a distinct structure. Moreover, since local participation is desirable because the models can then be updated and revised by those with the advantage of an on-the-spot viewpoint, it makes sense to start with existing national models.

In closing, both authors again underscored the fact that the linkage proposed in the paper would be subject to refinement. Yet, they contended that Pacific Basin linkage would be useful since these countries are closely connected through trade.