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INTRODUCTION

In a classic article "What is Conservation," written many years ago by Orris Herfindahl, but still well worth reading, numerous definitions of conservation are reviewed. The well known early conservationist Gifford Pinchot appears to have been the most prolific creator of such definitions. On close examination they all prove to be high-sounding bits of nonsense. The following are a few examples. "Conservation is the use of natural resources for the greatest good of the greatest number for the longest time." Clearly this definition requires the impossible by demanding the achievement of simultaneous conflicting objectives. Another Pinchot thought on the matter is: "Conservation implies both the development and the protection of resources, the one as much as the other." This statement naturally neglects the fact that the two stated objectives are normally in conflict with each other. A final example with a ringingly conclusive sound: "Conservation is simple, obvious, and right." H. L. Mencken is said to have paraphrased this statement into: "For every problem economists have an answer, simple, obvious, and wrong."

While I would not deny that there is considerable truth in the last statement, economic theory does provide a conceptual framework for consideration of conservation policies. In this paper the economic conceptual framework is used to consider a number of questions surrounding the matter of the proper rate of use of energy resources.

But what is conservation? History has shown the bootlessness of trying to formulate a general definition which will be both understandable and satisfying to everyone. Therefore I will not attempt to define it. The issue I will examine, however, concerns the economic justification for slowing down the depletion of a natural resource below the rate which would otherwise occur, by means of deliberate public policies and the instruments for implementation of these policies. In general the pertinent public policy instruments fall into two

*Parts of this paper draw heavily on portions of a report *Natural Resources Policy 1975-1985* prepared by the author for the Joint Economic Committee of the United States Congress.

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categories: (a) altered economic incentives, such as taxes on certain activities or release of controlled prices, and (b) administratively enforced standards, e.g., prohibitions on certain acts such as driving above a prescribed speed.

The present paper concludes that when measured against "ideal" market behavior, the actual functioning of the economic system in the United States contains multiple biases in the direction of excessively rapid use of natural resources, including energy resources. These biases result both from systematic failure of markets to function in an ideal manner and because public policies developed in the past, many of which are still in place, have tended to encourage rapid resource development.

Before proceeding to develop these points, it is appropriate to inquire whether we are in fact addressing an issue of import. Is it in fact technically possible to substantially reduce the rate of growth of energy usage without drastic reduction in the quality or quantity of production and consumption services which would otherwise occur? A number of recent studies on the subject conclude that it is possible. The greatest possibilities appear to exist in three areas, at least in the relatively near future:

(a) More economically efficient energy usage in transportation, especially improved automobile gasoline mileage.
(b) Construction and operation of buildings in a manner which would reduce the energy needed for space conditioning.
(c) Improved energy efficiency in industry, including cogeneration of electric power (e.g., the simultaneous production of electricity and process heat).

In general the energy savings would occur by some substitution of capital for energy and from design changes aimed at achieving greater energy efficiency. It is not my purpose here to evaluate the details of any of the particular studies of possibilities for reduced energy usage, but simply to point out that in general they suggest considerable elasticity in energy demand, especially after a few years.[1] Thus, it seems likely that conservation policies aimed at lower rates of energy usage per unit of economic output could in principle be effective in influencing the rate of energy demand growth without necessarily causing widespread economic disruption.

The question then becomes what, if any, rationale would there be for undertaking such policies and what would be the most suitable

1. This is already reflected in the fact that with the increased level of energy prices which has already occurred most public and private projections of energy usage are below historical trends.

instruments for implementing them. This question will be approached by first providing a review of how economic theory envisages an ideal market in operation.

THE IDEAL MARKET

Economic theorists have found that the results of market exchange may be regarded as desirable or normative if a certain basic value judgment is accepted and if the market exchange economy displays certain consistent structural characteristics. The value judgment is that the personal wants and preferences of the individuals who constitute the present members of a society should guide the use of that society's resources. This is also the premise which is at the root of Anglo-American political theory.

The three structural characteristics in a desirable market exchange are:

(1) All markets are *competitive.* This means that no specific firm or individual can influence any market price significantly by decreasing or increasing the supply of goods and services offered by that specific economic unit. Competition must extend to all markets, including those for money.

(2) All participants in the market are *fully informed* as to the quantitative and qualitative characteristics of goods and services and the terms of exchange among them.

(3) All valuable assets in the economic system can be *individually owned* and managed without violating the first assumption of perfect competition. Individual ownership of all assets, plus competition implies that all costs of production and consumption are borne by the producers and consumers directly involved in economic exchanges. A closely related requirement is that there must be markets for all possible claims. This is particularly pertinent to the consideration of questions of conservation and the role of futures markets.

If all of these conditions are met, it can be concluded that the best social solution to the problem of allocating the society's scarce resources is to limit the role of government to merely deciding questions of equity in income distribution, providing rules of property and exchange, enforcing competition, and allowing the exchange of privately owned assets in markets to proceed freely. The connection between this market exchange model and the real working economy has always been tenuous at best. But the idealized model has served as a standard against which an actual economy could be judged as a resource allocation mechanism for meeting consumer preferences.

Ways in which the real world functioning of markets departs from

the theoretical ideal will now be reviewed, and then some implica tions for rates of resource use will be covered.

I will start with a consideration of the assumption that all valuable assets can be privately owned in view of the reality of commor property resources. The latter idea has largely been used to help explain the economic origins of environmental problems but its addi tional pertinence to conservation questions can be explained by introducing into the picture a simple concept from physics: mass balance, the first law of thermodynamics. While I will discuss the concepts of common property resources and mass balance in the general context of natural resources development and use, they have a special pertinence to energy because, in our economy, the mass o energy resources used is so large and the use of common property resources by that sector so heavy.

MASS BALANCE AND COMMON PROPERTY[2]

When materials such as minerals, fuels, gases, and organic materials are obtained from nature and used by producers and consumers their mass is essentially unaltered. Material residuals generated in production and consumption activities are therefore about equal in mass to that initially extracted from nature. Similarly, all energy converted in human activities is discharged into the environment.

Conservation, in the physical sense of mass-energy, taken together with the peculiar characteristics of environmental resources, has important implications for the allocation of resources in a real mar ket system as contrasted with the ideal market system. While most extractive, harvesting, processing, and distributional activities can be conducted relatively efficiently through the medium of exchange of private ownership rights just as the idealized market model envisages the process of returning into the environment the inevitable residuals generated by production and consumption activities makes heavy use of common property resources.

The term "common property resources" refers to those valuable natural assets which cannot, or can only imperfectly, be held in private ownership and which therefore cannot be exchanged in mar kets as can ordinary commodities. Important examples are the air mantle, watercourses, large ecological systems, landscapes, and the audial and electromagnetic spectrums. When open and unpriced access to such resources is permitted, it is apparent what must hap

2. For a fuller discussion of these concepts and their relationship to economic theory see A. KNEESE, R. AYRES & R. D'ARGE, ECONOMICS AND THE ENVIRONMENT: A MATERIALS BALANCE APPROACH (1970).

pen. From careful study of particular common property or common pool problems like oil pools and ocean fisheries, it is well known that unhindered access to such resources leads to overuse, misuse, and quality degradation. With respect to environmental degradation, this takes the form of large masses of materials and energy being discharged into watercourses and the atmosphere, thus degrading their quality. Furthermore, resource extraction processes themselves can cause visual degradation and other forms of pollution such as clear-cut forests, mine tailings, unreclaimed strip mine land, and acid mine drainage.

Costs associated with the destructive effects of these situations are of no consequence to the enterprises involved, inasmuch as they are imposed on or transmitted through common property resources. The impacts of these effects, referred to as "external costs," are imposed on society as a whole. Pareto optimality is not gained through exchange because private ownership of natural assets must be incomplete. Without ownership, the market by itself can generate no incentive to protect environmental resources.

Conservation of mass-energy dictates that as economic development proceeds and as the mass of material and energy flowing through the economy increases, and if environmental resources remain in their common property status, environmental conditions must display a tendency to get systematically worse as the economy grows. The systematic degradation of air quality in many parts of the country over the past few decades is an illustration of this problem. Efforts at controlling this phenomenon have been made, as will be discussed later. First, however, it will be useful to consider the relationship between common property, mass balance, and the rate of use of natural resources commodities.

COMMON PROPERTY—THE PRICE STRUCTURE AND RESOURCE ALLOCATION

The combination of the two simple but revealing concepts introduced in the previous section—conservation of mass and common property resources—provides considerable insight into the basic nature of environmental problems involving pollution in a market system. But the implications are not limited to environmental matters. When the use of certain environmental resources is not priced, the entire price structure is then distorted. Thus the price of extractive resource commodities, which are exchanged in markets, will deviate substantially from the actual social costs of their use. This comes about in two major ways.

First, the extraction and processing of extractive resource commodities involves particularly heavy use of environmental resources. Strip mining, copper processing, coal conversion, the making of steel, and oil refining are obvious examples. In the ordinary course of market exchange the social costs associated with any damage to these environmental resources are not reflected in the private costs incurred by the producers of resource commodities and by the ultimate users of the products produced from them.

Second, when such commodities are devoted to their end uses they further generate social costs which the market does not reflect. Junkyards, litter in the countryside, and the combustion of fuel in automobile engines are random but obvious examples.

Thus the market generates a *systematic bias,* the result of which is to essentially publicly subsidize the production of extractive resource commodities. The larger the impact on environmental resources in the extraction, processing and use of resource commodities, the larger the subsidy. Furthermore, as environmental resources become increasingly scarce and thus more valuable, and as the production of environmentally destructive resource commodities increases, the societal subsidy of such production correspondingly increases.

The natural tendency of markets to work in this unfortunate manner is bad enough. But policies formed to stimulate the production of resource commodities during the euphoria of extreme abundance, and made in the interest of rapid economic growth, aggravate the situation. For example, special tax treatment of extractive industries, prominently including the energy industries vis-a-vis ordinary industries, abounds.

The ultimate result of market malfunctioning and of the biases of policy is excessive use of materials and energy in general, excessive use of virgin materials in particular, too little recovery and reuse of materials and energy, and excessive environmental deterioration. With this set of ideas in mind I will turn to a consideration of natural resources policies which affect rates of energy use, turning first to environmental policies.

ENVIRONMENTAL POLICY ISSUES BEARING ON REDUCED RATES OF USAGE

I will not linger over the matter of environmental policy in the United States, as it is an area I have discussed extensively elsewhere.[3] The essential point to be made is that the development of environ-

3. *See, e.g.,* A. KNEESE & C. SCHULTZE, POLLUTION, PRICES AND PUBLIC POLICY (1975).

mental policy in the United States has been built around a combination of subsidies and direct regulation and has not recognized the economic sources or the possible remedies for the problem. Many studies, in addition to my own, have concluded that a system of economic incentives in the form of fees for the use of common property resources (effluent and related fees), has a sounder basis in economic theory than the presently used approach and can be defended on the basis of improved efficiency, effectiveness, and equity. In any case environmental concerns provide one basis, albeit an indirect one, for energy conservation as defined in this paper. Changes in economic incentives to take account of costs imposed on common property resources would recognize the distortions in the price structure which otherwise occur. One response among others is that energy use would tend to be restrained because energy users then bear a greater percentage of the social cost.

The direct regulation policy presently pursued to restrict the use of common property resources can also have the effect of raising costs as emissions and other environmental controls are required. But, as mentioned, many questions have been raised by economists and other scholars about the effectiveness, equity, and efficiency of this policy and its implementation.

To summarize thus far: the energy industries have been unusually heavy users of common property resources, as have the final consumers of energy. Historically, the whole energy conversion process has fallen far short of meeting the full social costs of production. This tendency to undershoot social costs has been aided significantly by a number of different types of special tax treatment. In general, it is common knowledge that the extractive sector of the economy is one of the most lightly taxed ones. In part this limited taxation is a result of special provisions for extractive industries, such as depletion allowances and capital gains for timber, coal, and iron, and expensing of exploration and development expenditures. But it is also partly due to the special ability of the extractive industries to take advantage of uniform provisions in the tax code; for example, the foreign tax credit and capital gains treatment. It is now generally agreed upon by students in the area that investment in extractive industries has been at least 50 percent greater (and possibly much greater than that) than it would have been if taxation of these industries had been on the same basis as other industries.[4]

A combination of unpriced use of common property resources and

4. S. Agria, in THE TAXATION OF INCOME FROM CAPITAL (A. Harberger & M. Bailey eds., 1969).

a light tax burden has made energy artificially cheap and has stimulated the development and use of energy-hungry technologies throughout our economy. As already indicated, this has led to excessive rates of natural resource materials use, excessively rapid rates of resource depletion, and as was emphasized in the previous section, environmental pollution on an enormous scale. Approximately 60 percent of the total weight of materials flow in the United States consists of mineral fuel materials.[5]

A DYNAMIC CONSIDERATION IN REGARD TO RATES OF ENERGY USAGE

In considering the environmental dimension of the energy usage question I have emphasized market failures resulting from the presence of common property resources. Other types of market failures such as monopoly elements in the energy industry and national security problems could also be considered in this context.[6] However, in this concluding section I will address only one other aspect of the question—the absence of markets for future claims.

As has been stressed several times, one of the characteristics of the "ideal" market model is that markets for all goods and services in fact exist. So far, we have considered this requirement in a static context and have found that the condition is not met in reality. But in a dynamic context there is the further implication that a full set of futures markets must exist if the market system is to have the desired normative property of optimal allocation of resources use over time, as well as at a given time. This means that it should be possible today to make contracts about deliveries of goods and services in the future. For example, an owner of a nonrenewable resource should be able to sell a claim today on one unit of the resource to be delivered fifteen years from now. This is a requirement of profound importance for ideal markets with respect to extractive resources because they are depleting resources, and such a full set of futures markets does not exist.

The absence of futures markets causes a systematic incentive to produce too much of a nonrenewable resource in the present at the expense of production in the future. This is perhaps the most fundamental rationale for levying severance taxes and undertaking other non-environmentally based conservation measures with respect to extractive industries.

5. This calculation excludes construction materials.
6. *See,* the joint Economic Committee paper.

CONCLUDING COMMENTS

Perhaps the most profound aspect of the conservation question, the one that is intergenerational, has not been addressed in this paper. This is an exceedingly difficult problem and one on which research is just beginning to yield some interesting results. But this paper has argued that there are multiple biases in the system which, in the past, have led to excessively rapid exploitation of natural resources including energy resources, even when only the preferences of the current generation are considered. In the broadest general sense these biases are institutional—partly results of a policy structure conducive to rapid resources use, and partly results of the inability of the market to function effectively with respect to some important values.

To the extent that a policy response to this situation has been made, a piecemeal approach has been taken relying on an increasingly detailed, cumbersome, and inefficient direct regulation approach that has been chosen by Congress. This paper suggests that there is indeed a case to be made for conservation, in the sense used here, but that the proper approach to incorrect economic incentives is to replace them with better ones. Elements of a coherent economic program would be price deregulation, the cessation of special tax treatment for certain industries, and use of the tax system to counter any insufficiency of attention by the market to the future.