Development or Environment: An Economic Approach

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INTRODUCTION

In the years since the environmental movement has gained political power, United States policy with respect to the environment has developed into an all-or-nothing approach. Zero discharge limitations, although not currently in effect, are the final goals of Water Quality and Air Quality legislation. The interim limitations, Best Practical and Best Available Technology, are aimed at forcing producers into approaching the zero discharge requirement. There are two aspects of the zero approach that are troubling: first, there is a total disregard for the costs of achieving that good, just as there has been disregard of the pollution costs by producers; second, there is no recognition of the wide variances in local circumstances. There exists a large and well-developed body of economic theory with which to assess the desirability of these, and other, environmental controls. [See, for example, Seneca and Taussig, 1974; Edel, 1973; Schultze and Kneese, 1975; Enthoven and Freeman, 1973; Dorfman and Dorfman, 1972].

ECONOMIC THEORY OF POLLUTION

Pollution is dealt with in two different ways in the economics literature, but both of the approaches have their base in the newly-developing theories of property rights and resource ownership. Ownership has been defined as consisting of three property "rights": (1) the right to the use of the property; (2) the right to transform the property, including sales; and (3) the right to exclude other users, which is the basis for collecting returns
to the property. When any one of these rights are denied, misallocation of the property is likely to result. Misallocations that result from the inability to exclude others from using a property are generally treated as "common property" problems, of which pollution is just one. A non-exclusive property is often used as a waste-sink, since those who generate waste are free to impose the costs associated with their waste on the owners of the property, namely society at large. These costs are also called externalities, third-party effects, spillover effects, or pollution.

If the waste sinks were privately owned, there would likely develop a market for waste disposal, so that producers would be forced to consider the cost of waste disposal along with all other costs of production. The result would be that effluent would be treated as long as treatment cost was below the disposal price, and that in general production and pollution would be reduced. Such a market results in an economically optimal level of production and pollution, in that all external costs of production are internalized to owners of the production processes.

Figure 1 illustrates this optimum. As production increases, the increment to net benefits, or value, of each additional unit of output is smaller and smaller. There are two reasons for the declining net benefits: First, production processes, particularly in given plants, exhibit diminishing returns. That is, as more inputs are added to a fixed base, say a plant, the increments in production become less and less. Second, as more of a product is produced, it is likely that price will fall due to increased supply, particularly if the industry as a whole is expanding. Thus, as a firm adds inputs and pays the price for those inputs, gross returns for each additional unit of input are smaller, so that net returns are also smaller.

At the same time marginal social cost of production is rising. As more pollution is produced, clean air and clean water become more scarce;
Figure 1. Optimum Production Levels
that is, snorter in supply. The value of the clean air and water will rise. Thus, further production of output carries with it an increasing opportunity cost of foregone clean air and water. It is also possible that as production of a given product increases, the utility of an additional unit of that product and of the income it generates declines, so that as the social value of foregone amenities increases, the social value of the output declines. Thus, the marginal net benefit curve is downward sloping, while the marginal social cost curve is upward sloping.

The social optimum occurs at $X_{opt}$, since if any less of $X$ is produced, the marginal net benefits can be increased more than the marginal social costs; if any more $X$ is produced, the marginal social cost exceeds the marginal net benefits.

There is another way in which to analyze the potential trade-offs between production or "economic development," and environmental amenities. As discussed above, as production increases, clean air and water become increasingly scarce. Further, due to the diminishing returns to production, the more production increases, the greater the reduction in environmental amenities. This relationship gives rise to the production possibility frontier illustrated in Figure 2.

The incremental increase in $X$ becomes more and more "costly" in terms of losses of environmental amenities. Note the converse, however. If pristine environments exist, it will require relatively little in environmental degradation to generate relatively large increases in outputs. Decreasing absorption powers of the environment are responsible for the increasing loss of amenities as production increases. At any point on the frontier, the amount of $X$ that must be given up to achieve an increment in amenities, or vice versa, can be determined. This "marginal rate of transformation"
Figure 2. Production Possibility Frontier between X and Environmental Amenities
increases as X increases. Thus, there exists trade-offs between amenities and production, or development.

Using this approach, what is the social optimum? A function relating social value, or welfare, or utility is superimposed on the production frontier, as in Figure 3. The social value of additional units of amenities gets larger, relative to the value of output X, as more X is available, just as in the net benefit function. \(X_{\text{opt}}\) is the optimal level of production, since for any less X, the value gain to increasing output of X is greater than the loss of value in amenities, and for any production greater than X, the value given up in amenities exceeds the value obtained from X. It can be shown mathematically that the social optimum is the same for both approaches.

The Coase Theorem, among other treatises in economics literature, indicates that the economic optimum will be reached irrespective of the property right ownership, if transactions costs are zero. That is, it makes no difference in the allocation resources whether those who suffer from pollution bribe the polluters to reduce production or the polluters pay those who suffer from pollution for their suffering. In either case, producers must "internalize" the cost of polluting. There are, of course, differing effects on the distribution of income, but the production levels will be identical. It is clear, however, that there will likely be some pollution at the social optimum, as long as the pollution is not extremely costly, such as life-threatening pollutants.

Since property rights to the waste sinks are not, in general, held privately, there are grounds for social action, that is governmental interference in the market. The objective of the governmental action should be to achieve the socially optimum levels of production and amenities. Governmental action can be of two basic forms: prohibitions or monetary payments.
Figure 3. Optimal Production
There may be a mixture of these forms, of course, wherein fines are part of a prohibition, or limits of production are set within which payments are levied. In any event, both approaches have been used. European governments, particularly in the Ruhr and Rhine River areas have levied pollution taxes of several kinds, including a "license to pollute." In these rivers, water quality has improved remarkably, and industrial development and growth is occurring at a relatively high rate. However, neither river is pollution-free.

The United States, on the other hand, has chosen to impose effluent and stream standards, which ultimately will include zero discharge limits. Theoretically, these effluent limitations will lead to a social optimum only in relatively few circumstances. If the production possibility frontier is linear; that is, the transformation of amenities to outputs is at a constant marginal rate, and if the value of amenities exceeds the value of output at the intersection of the maximum value curve, the transformation curve, and the vertical axis, then zero discharge (zero production, as illustrated) is socially optimal, as in Figure 4.

Effluent limitations generally presuppose treatment capabilities. Producers will treat as long as treatment costs are less than revenue net of all other costs including whatever fines or charges are levied on pollution. In the case of the effluent charge, treatment will be used until its cost exceeds the effluent charge, then production will continue until the effluent charge equals the marginal net benefits, as illustrated in Figure 5. Some pollution will probably occur, depending on the effluent charge. Production
Figure 4. Social Optimum at Zero Production
Figure 5. Levels of Output with Effluent Charges and Limitations
is socially optimal if the effluent charge equals the marginal social cost. Assuming this equality, the imposition of zero discharge will result in two little production, since \( X \) will be produced only where the marginal treatment cost is less than marginal net benefits, at \( X_{\text{limit}} \). Note that with an effluent charge equal to the marginal social costs, the producer has the option to use less efficient and less costly treatment procedures and still produce, whereas for the zero discharge case, the producer must use 100 percent efficient removal system, regardless of cost, if he is to produce.

In the U. S. phased interim limitations call for Best Practical Technology (assumably with respect to economic feasibility as well as operational capabilities) and Best Available Technology, both based on required treatment or effluent levels. These rules are effective; the recovery of the Great Lakes is clear evidence. The problem lies, however, in that effectiveness. How much income and production must be foregone in order to achieve fishable, swimmable waters and zero discharge? Achieving 95, 98, and 99 percent reductions in effluent result in an almost geometric increase in treatment cost. A 100 percent reduction may be so costly as to cause cessation of production in many heavy industries. Some of these costs are becoming evident (Utah State University, 1975). Just as the passage of the Clear Water Amendments and the Clean Air Act indicated increasing costs of environmental degradation, so the relaxation of the time frames in which to achieve the various effluent levels may indicate an emerging awareness of the opportunity cost of producing the environmental amenities.

There is another issue with respect to zero discharge rules that is of major concern to Utah. It may well be the case that in regions where industrialization and pollution are heavy, a significant reduction in output might be socially optimal. However, the nation-wide application of zero discharge
entirely ignores areas in which pollution levels are low or unobservable and for which a small trade-off of environmental amenities will generate substantial increases in development or production. In other words, population in rural areas such as abound in Utah may be willing to accept some increase in pollution in order to obtain development and the concomitant higher incomes. The failure to consider the regional trade-offs when pollution is often a very local problem, particularly in rural areas, may lead to a large loss of welfare for local residents and little gain in welfare to anyone else.

The theoretical discussion indicates that in order to maximize social welfare, the trade-offs between development and production and environmental amenities be assessed over a broad range of levels of output. Effluent standards, particularly zero discharges rules, generally are not set with respect to trade-offs. On the other hand, effluent charges will not necessarily lead to a social optimum without a knowledge of the relative values of output and environmental amenities.

Decision making in the face of ignorance about these trade-offs and relative values may be worse than no policy at all.

METHODOLOGIES FOR ANALYZING TRADE-OFFS

There do exist several suggested methodologies for analyzing trade-offs between completing objectives. All of these methodologies are based on some form of systems analysis, either simultaneous modeling or optimization models. Since the relationships between production, input use, effluents, and the environment are often complex, systems analysis is required. Frequently, simulation models and optimization models are used together. Many of these models are constructed to generate the production frontiers. Others are developed to produce the social optimum, using varied techniques for establishing the values for outputs and environmental amenities. Most of these
techniques are opinion surveys of one form or another. In general, the production models have been substantially more theoretically sound and practically useable than models that utilize the value weights.

Several of the approaches have been used in research that examined problems in Utah, including development of the energy corridor along the Colorado River Basin (Utah State University, 1975; Keith, et al forthcoming), potential growth in the Virgin River Basin (Keith, et al, 1977), and Great Salt Lake management schemes (Riley, et al, 1976). There are also others research efforts being undertaken in other states (Hames, et al, 1977, for example). Many of these research efforts have revealed the two problems with the current environmental legislation: (1) that local problems cannot be efficiently handled by a uniform national law, and (2) that there exist trade-offs which must be considered in each situation in order that intelligent decisions about development can be made.

For example, the imposition of a stream quality standard, which would decrease salinity and sediment by a 5 to 10 percent in the Virgin River Basin of Utah could result in a 50 to 60 percent decrease in irrigated agriculture. That same kind of standard applied to a Mid-Western river could be achieved with a relatively small change in agricultural and industrial production. It has also been shown that the Colorado River Basin will probably result in a total containment approach to waste water, and in little or no change in downstream water quality. Further, the zero discharge standards applied to small towns along the Colorado will impose a high cost on residents and have no discernable effects a short distance downstram. While these examples may be somewhat atypical, the implication for the legal restriction approach which ignores the physical and social trade-offs on a local or regional basis is clear: Social Welfare may be diminished, not increased.
LITERATURE CITED


