21 THREE GENERAL POLICIES TO ACHIEVE SUSTAINABILITY

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ABSTRACT

Sustainability is a long-term goal over which there is broad and growing consensus. Establishment of this goal is fundamentally a social decision about the desirability of a survivable ecological economic system. It entails maintenance of (1) a sustainable *scale* of the economy relative to its ecological life-support system; (2) a fair *distribution* of resources and opportunities between present and future generations, as well as between agents in the current generation, and (3) an efficient *allocation* of resources that adequately accounts for natural capital. We can only be certain we have achieved sustainability in retrospect. Sustainable policies and instruments are therefore those that we *predict* will lead to the achievement of the goal. Like all predictions, they are uncertain. In designing sustainable policies and instruments, one would like to maximize the likelihood of success, while acknowledging and minimizing the remaining uncertainty.

This chapter describes three broad, mutually reinforcing policy instruments that have a high likelihood of assuring that economic *development* (as distinct from economic *growth*) will be ecologically sustainable. They utilize incentives to produce the desired results (sustainable scale and efficient allocation). They address only that aspect of the distribution issue having to do with distribution between current and future operations. Other aspects must be handled politically. They are:

1. A *natural capital depletion tax* aimed at reducing or eliminating the destruction of natural capital. Use of non-renewable natural capital would have to be balanced by investment in renewable natural capital in order to avoid the tax. The tax would be passed on to consumers in the price of products and would send the proper signals about the relative sustainability cost of each product, moving consumption toward a more sustainable product mix.

2. The *precautionary polluter pays principle (4P)* would be applied to potentially damaging products to incorporate the cost of the uncertainty about ecological damages as

well as the cost of known damages. This would give producers a strong and immediate incentive to improve their environmental performance in order to reduce the size of the environmental bond and tax they would have to pay.

3. A system of *ecological tariffs* aimed at allowing individual countries or trading blocks to apply 1 and 2 above without forcing producers to move overseas in order to remain competitive. Countervailing duties would be assessed to impose the ecological costs associated with production fairly on both internally produced and imported products. Revenues from the tariffs would be reinvested in the global environment, rather than added to general revenues of the host country.

INTRODUCTION

The integration of ecology and economics has begun to provide new insights about the linkages between ecological and economic systems, and to suggest some broad policies concerning how to achieve sustainability (Daly 1990; Costanza 1991; Young 1992). In this chapter three fairly broad, interdependent proposals are described and discussed. Taken together, they are comprehensive, and may be sufficient to achieve ecological sustainability, a necessary prerequisite to total system sustainability. Ecological sustainability implies maintaining the economy at a scale that does not damage the ecological life-support system (i.e., safe minimum standards) and a fair distribution of resources between present and future generations. The market incentive-based instruments suggested to implement the policies are intended to do the job with relatively high efficiency and effectiveness. They are not the only possible mechanisms to achieve these goals, but there is considerable evidence that they would work rather well. By focusing on specific policies and instruments, we can also address the essential changes that need to be made in the system and begin to build a broad enough consensus to implement these changes.

Various aspects of the proposals have appeared in other forms elsewhere (Pearce and Turner 1989; Daly 1990; Cropper and Oates 1990; Perrings 1991; Costanza 1991; Costanza and Daly 1992; Costanza and Cornwell 1992;Young 1992; and Bishop 1993). This chapter represents an attempt to synthesize and generalize them as the basis for developing an "overlapping consensus." (Rawls 1987). According to Rawls, a consensus that is affirmed by opposing theoretical, religious, philosophical, and moral doctrines is most likely to be fair and just, and is also most likely to be resilient and to survive over time. A key overlapping consensus that has emerged recently is the goal of sustainable development, a form of economic development that maintains the ecological processes and functions that underpin it and reaps the benefits of improving the quality of life now without denying future generations a similar opportunity (WCED 1987; Young 1992; *Agenda 21* 1992).

The proposals are interrelated and interdependent. A natural capital depletion tax assures that resource inputs from the environment to the economy are sustainable in a general and comprehensive way (Costanza and Daly 1992), while giving strong incentives to develop new technologies and processes to minimize impacts. The precautionary polluter pays principle (4P) assures that the full costs of outputs from the economy to the environment are charged to the polluter in a way that adequately deals with the huge uncertainty about the impacts of pollution, and encourages technological innovation (Costanza and Cornwell 1992). A system of ecological tariffs is one way (short of global agreements that are difficult to negotiate and enforce) to allow countries to implement the first two proposals without putting themselves at an undue disadvantage (at least on the import side) relative to countries that have not yet implemented them.

NATURAL CAPITAL AND SUSTAINABILITY

A minimum necessary condition for sustainability is taken to be maintenance of the total natural capital (TNC) stock at or above the current level (Pearce and Turner 1989; Costanza and Daly 1992). This condition is sometimes referred to as *strong sustainability* as opposed to *weak sustainability* which requires only that the total capital stock (including both human-made and natural capital) be maintained (Costanza and Daly 1992). Since natural and human-made capital are, in general, complements rather than substitutes, the strong sustainability condition is more appropriate. While a lower stock of natural capital *may* be sustainable, given our uncertainty and the dire consequences of guessing wrong, it is best to at least provisionally assume that the we are at or below the range of sustainable stock levels and allow no further decline in natural capital. This "constancy of total natural capital" rule can thus be seen as a prudent minimum condition for assuring sustainability, to be abandoned only when solid evidence to the contrary can be offered.

In the past only human-made stocks were considered as capital because natural capital was superabundant. Human activities were at too small a scale relative to natural processes to interfere with the free provision of natural goods and services. Expansion of human-made capital entailed little or no opportunity cost in terms of the sacrifice of services of natural capital. Human-made capital was the limiting factor in economic development, and natural capital was a free good. But we are now entering an era, thanks to the enormous increase of the human scale, in which natural capital is becoming the limiting factor. Human economic activities can significantly reduce the capacity of natural capital to yield the flow of ecosystem goods and services upon which the very productivity of human-made capital depends.

Of course, the classical economists (Smith, Malthus, Ricardo) emphasized the constraints of natural resources on economic growth, and several more recent economists, especially environmental and ecological economists, have explicitly recognized natural resources as an important form of capital with major contributions to human well-being (Scott 1954; Daly 1968, 1973, 1977; Page 1977; Randall 1987; Pearce and Turner 1989). But environmental economics has, until now, been a tiny subfield far from the mainstream of neoclassical economics, and the role of natural resources within the mainstream has been de-emphasized. If we are to achieve sustainability, the economy must be viewed in its proper perspective as a subsystem of the larger ecological system of which it is a part, and ecological economics needs to become a much more pervasive approach to the problem (Costanza 1991).

WHY IS ACCOUNTING FOR NATURAL CAPITAL SO IMPORTANT?

Natural capital produces a significant portion of the real goods and services of the ecological economic system, so failure to adequately account for it leads to major misconceptions about how well the economy is doing. This misconception is important at all levels of analysis, from the appraisal of individual projects to the health of the ecological economic system as a whole. This chapter will concentrate on the level of national income accounting, however, because of the importance of these measures to national planning and sustainability.

There has been much recent interest in improving national income and welfare measures to account for depletion of natural capital and other mismeasures of welfare (Ahmad et al. 1989). Daly and Cobb (1989) have produced an index of sustainable economic welfare (ISEW) that attempts to adjust GNP to account mainly for depletions of natural capital, pollution effects, and income distribution effects. Figure 21.1 shows two versions of their index compared to GNP from 1950 to 1986. What is strikingly clear from Figure 21.1 is that while GNP has been rising over this interval, ISEW has remained relatively unchanged since about 1970. When depletions of natural capital, pollution costs, and income distribution effects are accounted for, the economy is seen to be not improving at all. If we continue to ignore natural capital, we may well push the economy down while we think we are building it up.

NATURAL CAPITAL DEPLETION (NCD) TAX

One way to implement the sustainablility constraint of no net depletion of natural capital is to hold throughput (consumption of TNC) constant at present levels (or lower truly sustainable levels) by taxing TNC consumption, especially energy, very heavily. Society could raise most public revenue from such a natural capital depletion tax, and compensate by reducing the income tax, especially on the lower end of the income distribution, perhaps even financing a negative income tax at the very low end. Technological optimists who believe that efficiency can increase by a factor of ten should welcome this policy, which raises natural resource prices considerably and would powerfully encourage just those technological advances in which they have so much faith. Skeptics who lack that technological faith should nevertheless be happy to see the throughput limited since that is their main imperative to conserve resources for the future. The skeptics would be protected against their worst fears; the optimists would be encouraged to pursue their fondest dreams. If the skeptics are proven wrong and the enormous increase in efficiency actually happens, then they will be even happier. They will get what they wanted, but it will cost less than they expected and were willing to pay.

The optimists, for their part, can hardly object to a policy that not only allows, but offers strong incentives for the very technical progress on which their optimism is based. If they are proven wrong, at least they should be glad that the rate of environmental destruction has been slowed.

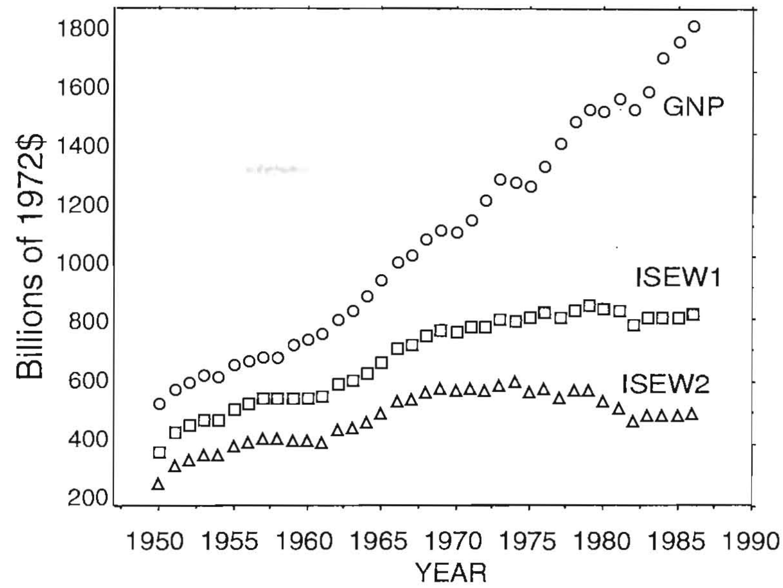

Figure 21.1. U.S. GNP compared to the Index of Sustainable Economic Welfare (ISEW, from Daly and Cobb 1989) for the interval 1950 to 1986. ISEW 2 includes corrections for depletion of non-renewable resources and long-term environmental damage; ISEW 1 does not.

Implementation of this policy does not hinge upon the *precise* measurement of natural capital, but the valuation issue remains relevant in the sense that the policy recommendation is based on the perception that we are at or beyond the optimal scale. The evidence for this perception consists of the greenhouse effect, ozone layer depletion, acid rain, and the general decline in many dimensions of the quality of life. It would be helpful to have better quantitative measures of these perceived costs, just as it would be helpful to carry along an altimeter when we jump out of an airplane. But we would all prefer a parachute to an altimeter if we could take only one thing. The consequences of an unarrested free fall are clear enough without a precise measure of our speed and acceleration. We would need at least a ballpark estimate of the value of natural capital depletion in order to determine the magnitude of the suggested NCD tax. This, we think, is possible, especially if uncertainty about the value of natural capital is incorporated into the tax itself, using, for example, the refundable assurance bonding system discussed below.

The political feasibility of this policy is an important and difficult question. It certainly represents a major shift in the way we view our relationship to natural capital, and would have major social, economic, and political implications. But these implications are just the ones we need to expose and face squarely if we hope to achieve sustainability. Because of its logic, its conceptual simplicity, and its built-in market incentive structure leading to sustainability, the proposed NCD tax may be the most politically feasible of the possible alternatives to achieving sustainability.

We have not tried to work out all the details of how the NCD tax would be administered. In general, it could be administered like any other tax, but it would most likely require international agreements or at least national ecological tariffs (as discussed later) to prevent some countries from flooding markets with untaxed natural capital or products made with untaxed natural capital (as discussed later). By shifting most of the tax burden to the NCD tax and away from income taxes, the NCD tax could actually simplify taxation administration while providing the appropriate economic incentives to achieve sustainability.

DEALING WITH TRUE UNCERTAINTY

One of the primary reasons for the problems with current methods of environmental management is the issue of scientific uncertainty—not just its existence, but the radically different expectations and modes of operation that science and policy have developed to deal with it. If we are to solve this problem, we must understand and expose these differences about the nature of uncertainty and design better methods to incorporate it into the policy-making and management process.

To understand the scope of the problem, it is necessary to differentiate between *risk* (which is an event with a *known* probability, sometimes referred to as "statistical uncertainty") and *true uncertainty* (which is an event with an *unknown* probability, sometimes referred to as "indeterminacy"). Every time you drive your car, you run the *risk* of having an accident because the probability of car accidents is known with very high certainty. We know the risk involved in driving because, unfortunately, there have been many car accidents on which to base the probabilities. These probabilities are known with enough certainty that they are used by insurance companies to set rates that will assure those companies of a certain profit. There is little uncertainty about the risk of car accidents. If you live near the disposal site of a newly synthesized toxic chemical, you may be in danger as well, but no one knows even the *probability* of getting cancer or some other disease from this exposure, so there is true uncertainty. Most important environmental problems suffer from true uncertainty, not merely risk.

One can think of a continuum of uncertainty where zero represents certain information, moving to intermediate levels representing information with statistical uncertainty and known probabilities (risk), and ending with high levels for information with true uncertainty or indeterminacy. Risk assessment has become the central guiding principle at the U.S. EPA (Science Advisory Board 1990) and other environmental management agencies, but true uncertainty has yet to be adequately incorporated into environmental protection strategy.

Science treats uncertainty as a given, a characteristic of all information that must be honestly acknowledged and communicated. Over the years scientists have developed increasingly sophisticated methods to measure and communicate uncertainty arising from various causes. It is important to note that the progress of science has, in general, uncovered *more* uncertainty rather than leading to the absolute precision that the lay public often mistakenly associates with "scientific" results. The scientific method can only set boundaries on the limits of our knowledge. It can define the edges of the envelope of what is known, but often this envelope is very large and the shape of its interior can be a complete mystery. Science can tell us the range of uncertainty about global warming and toxic chemicals, and maybe *something* about the relative probabilities of different outcomes, but in most important cases, it cannot tell us which of the possible outcomes will occur with any degree of accuracy.

Our current approaches to environmental management and policy making, on the other hand, abhor uncertainty and gravitate to the edges of the scientific envelope. The reasons for this are clear. The goal of policy is to make unambiguous, defensible decisions, often codified in the form of laws and regulations. While legislative language is often open to interpretation, regulations are much easier to write and enforce if they are stated in clear, black and white, absolutely certain terms. For most of criminal law this works reasonably well. Either Mr. Cain killed his brother or he didn't; the only question is whether there is enough evidence to demonstrate guilt beyond a reasonable doubt (i.e., with essentially zero uncertainty). Since the burden of proof is on the prosecution, it does little good to conclude that there was an 80% chance that Mr. Cain killed his brother. But many scientific studies come to just these kinds of conclusions because that is the nature of the phenomenon. Science defines the envelope while the policy process gravitates to its edges—generally the edge that best advances the policy maker's political agenda. We need to deal with the whole envelope and all its implications if we are to rationally use science to make policy.

The problem is most severe in environmental policy making. Building on the legal traditions of criminal law, policy makers and environmental regulators desire absolute, certain information when designing environmental regulations. But much of environmental policy is based upon scientific studies of the likely health, safety, and ecological consequences of human actions. Information gained from these studies is therefore only certain within their epistemological and methodological limits (Thompson 1986). Particularly with the recent shift in environmental concerns from visible, known pollution to more subtle threats like radon, regulators are confronted with decision making outside the limits of scientific certainty with increasing frequency (Weinberg 1985).

Problems arise when regulators ask scientists for answers to unanswerable questions. For example, the law may mandate that the regulatory agency come up with safety standards for all known toxins when little or no information is available on the impacts of these chemicals. When trying to enforce the regulations after they are drafted, the problem of true uncertainty about the impacts remains. It is not possible to determine with any certainty whether the local chemical company contributed to the death of some people in the vicinity of the toxic waste dump. One cannot *prove* the smoking/lung cancer connection in any direct, causal way (i.e., in the courtroom sense), only as a statistical relationship. Similarly, global warming may or may not happen after all.

As they are currently set up, most environmental regulations, particularly in the United States, *demand certainty* and when scientists are pressured to supply this nonexistent commodity, there is not only frustration and poor communication, but mixed messages in the media as well. Because of uncertainty, environmental issues can often be manipulated by political and economic interest groups. Uncertainty about global warming is perhaps the most visible current example of this effect.

The "precautionary principle" is one way the environmental regulatory community has begun to deal with the problem of true uncertainty. The principle states that rather than await certainty, regulators should act in anticipation of any potential environmental harm in order to prevent it. The precautionary principle is so frequently invoked in international environmental resolutions that it has come to be seen by some as a basic normative principle of international environmental law (Cameron and Abouchar 1991). But the principle offers no guidance as to what precautionary measures should be taken. It "implies the commitment of resources now to safeguard against the potentially adverse future outcomes of some decision," (Perrings 1991) but does not tell us how many resources or which adverse future outcomes are most important.

This aspect of the "size of the stakes" is a primary determinant of how uncertainty is dealt with in the political arena. The situation can be summarized as shown in Figure 21.2, with uncertainty plotted against decision stakes. It is only the area near the origin with low uncertainty and low stakes that is the domain of "normal applied science." Higher uncertainty or higher stakes result in a much more politicized environment. Moderate values of either correspond to "applied engineering" or "professional consultancy," which allow a good measure of judgment and opinion to deal with risk. On the other hand, current methods are not in place to deal with high values of either stakes or uncertainty, which require a new approach—what might be called "post-normal" or "second order science." (Funtowicz and Ravetz 1991). This "new" science is really just the application of the essence of the scientific method to new territory. The scientific method does not, in its basic form, imply anything about the precision of the results achieved. It *does* imply a forum of open and free inquiry without preconceived answers or agendas aimed at determining the envelope of our knowledge and the magnitude of our ignorance.

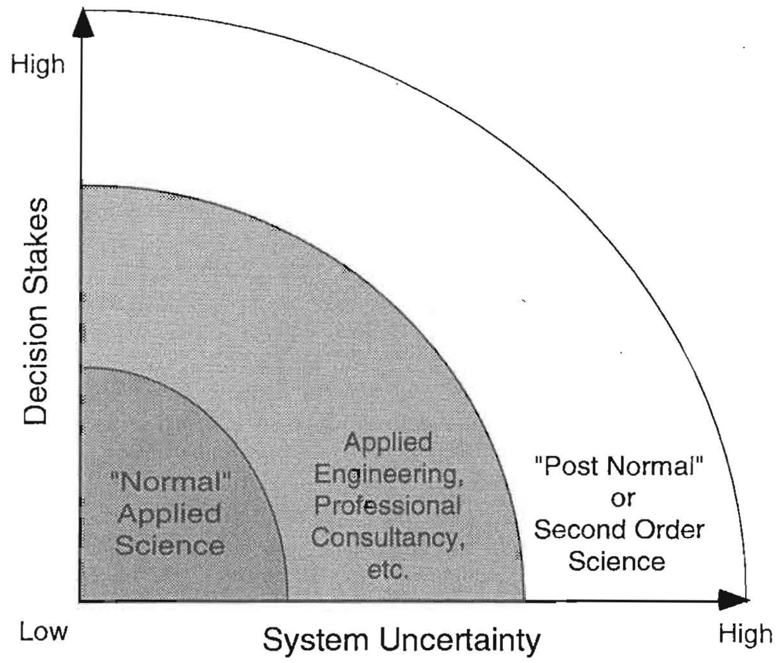

Figure 21.2. Three kinds of science (S. O. Funtowicz and J. R. Ravetz 1991).

THE PRECAUTIONARY POLLUTER PAYS PRINCIPLE (4P)

Implementing this view of science requires a new approach to environmental protection that acknowledges the existence of true uncertainty rather than denying it, and includes mechanisms to safeguard against its potentially harmful effects while at the same time encouraging development of lower impact technologies and the reduction of uncertainty about impacts. The precautionary principle sets the stage for this approach—the real challenge is to develop scientific methods to determine the potential costs of uncertainty, and to adjust incentives so that the appropriate parties *pay* this cost of uncertainty and have appropriate incentives to reduce its detrimental effects. Without this adjustment, the full costs of environmental damage will continue to be left out of the accounting (Peskin 1991), and the hidden subsidies from society to those who profit from environmental degradation will continue to provide strong incentives to degrade the environment beyond sustainable levels.

Over the past two decades there has been extensive discussion about the efficiency that can theoretically be achieved in environmental management through the use of market mechanisms (Brady and Cunningham 1981; Cropper and Oates 1990). These mechanisms are designed to alter the pricing structure of the present market system to incorporate the total, long-term social and ecological costs of an economic agent's activities. Suggested "incentive-based" mechanisms include pollution taxes, tradable pollution discharge permits, financial responsibility requirements and deposit-refund systems. Dealing with the pervasive uncertainty inherent in environmental problems in a precautionary way is possible using some new versions of these incentive-based alternatives.

An innovative incentive-based instrument currently being researched to manage the environment for precaution under uncertainty is a *flexible environmental assurance bonding system* (Costanza and Perrings 1990). This variation of the deposit-refund system is designed to incorporate *both* known and uncertain environmental costs into the incentive system, and to induce positive environmental technological innovation. It works in this way: in addition to charging an economic agent directly for known environmental damages, an assurance bond equal to the current best estimate of the largest potential future environmental damages would be levied and kept in an interest-bearing escrow account for a predetermined length of time. In keeping with the precautionary principle, this system requires the commitment of resources *now* to offset the potentially catastrophic future effects of current activity. Portions of the bond (plus interest) would be returned *if and when* the agent could demonstrate that the suspected worst case damages had not occurred or would be less than originally assessed. If damages did occur, portions of the bond would be used to rehabilitate or repair the environment, and possibly to compensate injured parties. Funds tied up in bonds could continue to be used for other economic activities. The only cost would be the difference (plus or minus) between the interest on the bond and the return that could be earned by the firm had they invested in other activities. On average one would expect this difference to be minimal. In addition, the "forced savings" which the bond would require could actually improve overall economic performance in economies like that of the United States, which chronically undersave.

By requiring the users of environmental resources to post a bond adequate to cover uncertain future environmental damages (with the possibility for refunds), the burden of proof (and the cost of the uncertainty) is shifted from the public to the resource user. At the same time, agents are not charged in any final way for uncertain future damages and can recover portions of their bond (with interest) in proportion to how much better their performance is than the worst case.

Deposit/refund systems, in general, are not a new concept. They have been successfully applied to a range of consumer, conservation, and environmental policy objectives (Bohm 1981). The most well-known examples are the systems for beverage containers and used lubricating oils that have both proven to be quite effective and efficient.

Another precedent for environmental assurance bonds are the producer-paid performance bonds often required for federal, state, or local government construction work. For example, the Miller Act (40 U.S.C. 270), a 1935 federal statute, requires contractors performing construction contracts for the federal government to secure performance bonds. Performance bonds provide a contractual guarantee that the principal (the entity which is doing the work or providing the service) will perform in a designated way. Bonds are frequently required for construction work done in the private sector as well.

Performance bonds are frequently posted in the form of corporate surety bonds that are licensed under various insurance laws and, under their charter, have legal authority to act as financial guarantee for others. The unrecoverable cost of this service is usually 1%–5% of the bond amount. However, under the Miller Act (FAR 28.203-1 and 28.203-2), any contract above a designated amount ($25,000 in the case of construction) can be backed by other types of securities, such as U.S. bonds or notes, in lieu of a bond guaranteed by a surety company. In this case, the contractor provides a duly executed power of attorney and an agreement authorizing collection on the bond or notes if they default on the contract (PRC Environmental Management 1986). If the contractor performs all the obligations specified in the contract, the securities are returned to the contractor, and the usual cost of the surety is avoided.

Environmental assurance bonds would work in a similar manner (by providing a contractual guarantee that the principal would perform in an environmentally benign manner), but would be levied for the current best estimate of the *largest* potential future environmental damages. Funds in the bond would be invested and would produce interest that could be returned to the principal. An "environmentally benign" investment strategy would probably be most appropriate for a bond such as this.

These bonds could be administered by the regulatory authority that currently manages the operation or procedure (for example, in the United States, the Environmental Protection Agency could be the primary authority). But a case can be made that it is better to set up a completely independent agency to administer the bonds. The detailed design of the institutions to administer the bond is worthy of considerable additional thought and analysis, and will depend on the requirements of an individual situation).

The bond would be held until the uncertainty or some part of it was removed. This would provide a strong incentive for the principal to reduce the uncertainty about their environmental impacts as quickly as possible, either by funding independent research or by changing their processes to ones that are less damaging. A quasi-judicial body would be necessary to resolve disputes about when and how much refund on the bonds should be awarded. This body would utilize the latest independent scientific information on the worst-case ecological damages that could result from a firm's activities, but with the burden of proof falling on the economic agent who stands to gain from the activity, not the public. Protocol for worst-case analysis already exists within the U.S. EPA. In 1977 the U.S. Council on Environmental Quality required worst-case analysis for implementing NEPA (National Environmental Policy Act of 1969). This act required the regulatory agency to consider the worst environmental consequences of an action when scientific uncertainty was involved (Fogleman 1987).

One potential argument against the bond is that it would favor relatively large firms that could afford to handle the financial responsibility of activities potentially hazardous to the environment. This is true, but it is exactly the desired effect, since firms that *cannot* handle the financial responsibility should *not* be passing the cost of potential environmental damage on to the public. In the construction industry, small "fly-by-night" firms are prevented (through the use of performance bonds) from cutting corners and endangering the public in order to underbid responsible firms.

This is not to say that small businesses would be eliminated. Far from it. They could either band together to form associations to handle the financial responsibility for environmentally risky activities, or, preferably, they could change to more environmentally benign activities that did not require large assurance bonds. This encouragement of the development of new environmentally benign technologies is one of the main attractions of the bonding system, and small, start-up firms would certainly lead the way.

The individual elements of the 4P system have broad theoretical support, and have been implemented before in various forms. The precautionary principle is gaining wide acceptance in many areas where true uncertainty is important. Incentive-based environmental regulation schemes are also gaining acceptance as more efficient ways to achieve environmental goals. For example, the U.S. Clean Air Act reauthorization contains a tradable permit system for controlling air pollution. Both the precautionary and the polluter pays principles are incorporated in *Agenda 21*, the final resolutions of the 1992 United Nations Conference on Environment and Development (*Agenda 21* 1992). By linking these two important principles, we can begin to effectively deal with uncertainty in an economically efficient and ecologically sustainable way.

In a sense, we are already moving in the direction of the 4P system. As strict liability for environmental damages becomes more the norm, far-sighted firms have already begun to protect themselves against possible future lawsuits and damage claims by putting aside funds for this purpose. The 4P system is, in effect, a *requirement* that all firms be far-sighted. It is an improvement on strict liability because it:

(1) explicitly moves the costs to the present where they will have the maximum impact on decision making,[1]

(2) provides "edge-focused, second order scientific" assessments of the potential impacts from a comprehensive ecological economic perspective in order to ensure that the size of the bond is large enough to cover the worst case damages, and

(3) insures that appropriate use of the funds are made in case of a partial or complete default.

Because of its logic, fairness, efficiency, ability to implement the precautionary and polluter pays principles in a practical way, and use of legal and financial mechanisms with long and successful precedents, the 4P system promises to be both practical and politically feasible. We think it can do much to help head off the current environmental crisis before it is too late.

ECOLOGICAL TARIFFS: MAKING TRADE SUSTAINABLE

If all countries in the world were to adopt and enforce the 4P system and NCD taxes, there would be no problem (at least from an ecological point of view) in allowing "free" trade. Given recent commitments of the global community to the idea of sustainable development (*Agenda 21* 1992), it does not seem totally out of the question that a global agreement along these lines could someday be worked out. But in the meantime, there are alternative instruments that could allow individual countries or trading blocks to apply the 4P system and NCD taxes in their local economies without forcing producers overseas. It is within at least the spirit of the GATT guidelines to allow countervailing duties to be assessed to impose the same ecological costs on internally produced and imported products. The key is fairness. A country cannot impose duties on imports that it does not also impose on domestically produced products. But if a country chose to adopt the 4P and NCD tax systems domestically, it could also adopt a system of ecologically based tariffs that would impose equivalent costs on imports. This is a different use for tariffs than the usual one. In the past, tariffs have been used to protect domestic industries from foreign competition. The proposed (and more defensible) use of tariffs (in conjunction with the 4P and NCD taxes) is to protect the domestic (and global) environment from private polluters and non-sustainable resource users, regardless of their country of origin or operation. The mechanisms for imposing tariffs are well-established. All that changes is the motive and the result. The proposed ecological tariffs (ETs) would result in patterns of trade that do not endanger sustainability.

Revenues from the tariffs could (and should) be reinvested in natural capital. It would be particularly attractive to reinvest in natural capital in the country on which the tariff was imposed. This would "close the loop" and

1. Several studies of "social traps" have shown that the timing of information about costs is more important than the actual expected magnitude (Costanza and Shrum 1988; Costanza 1987; Platt 1973; Cross and Guyer 1980; Teger 1980; Bockner and Rubin 1985).

prevent trade from inducing net destruction of natural capital in less-developed countries, as it does now.

SYSTEMS OF RESOURCE RIGHTS

The success of either command and control regulation or market-based incentives for sustainable management are predicated on having an adequate, legally viable resource use and property rights system. Young (1992) argues that by designing overlapping, conditional systems of resource use and property rights to cover the many different aspects of natural capital within a region, the stage can be set for sustainable use. *Changing* these systems of explicit and implicit rights are likewise often the most difficult and neglected step in implementing (e.g., the former Soviet Union) or enlarging the scope (e.g., western Europe and the United States) of market-based systems of allocation. The resource use and property rights system, laws, and regulations set the stage and largely determine the goals for an economy, while competitive markets are efficient tools to help society achieve its goals. As Young points out, "competitive markets are excellent servants but bad masters." Our challenge is to employ these powerful servants in the service of sustainability.

CONCLUSIONS

Taken together, the three policy instruments suggested here (Natural Capital Depletion (NCD) taxes, the Precautionary Polluter Pays Principle (4P), and Ecological Tariffs (ETs) would go a long way toward assuring ecological sustainability while at the same time taking advantage of market incentives to achieve this result at high efficiency. The time for action is running short, but the political will to implement significant changes seems to be finally at hand. The three instruments suggested embody the mix of environmental protection and economic development potential necessary to make them politically feasible. The next steps are to further elaborate and test the instruments, and to build a broad, overlapping consensus to allow their ultimate implementation. It is not too late to protect our natural capital and achieve sustainability.

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