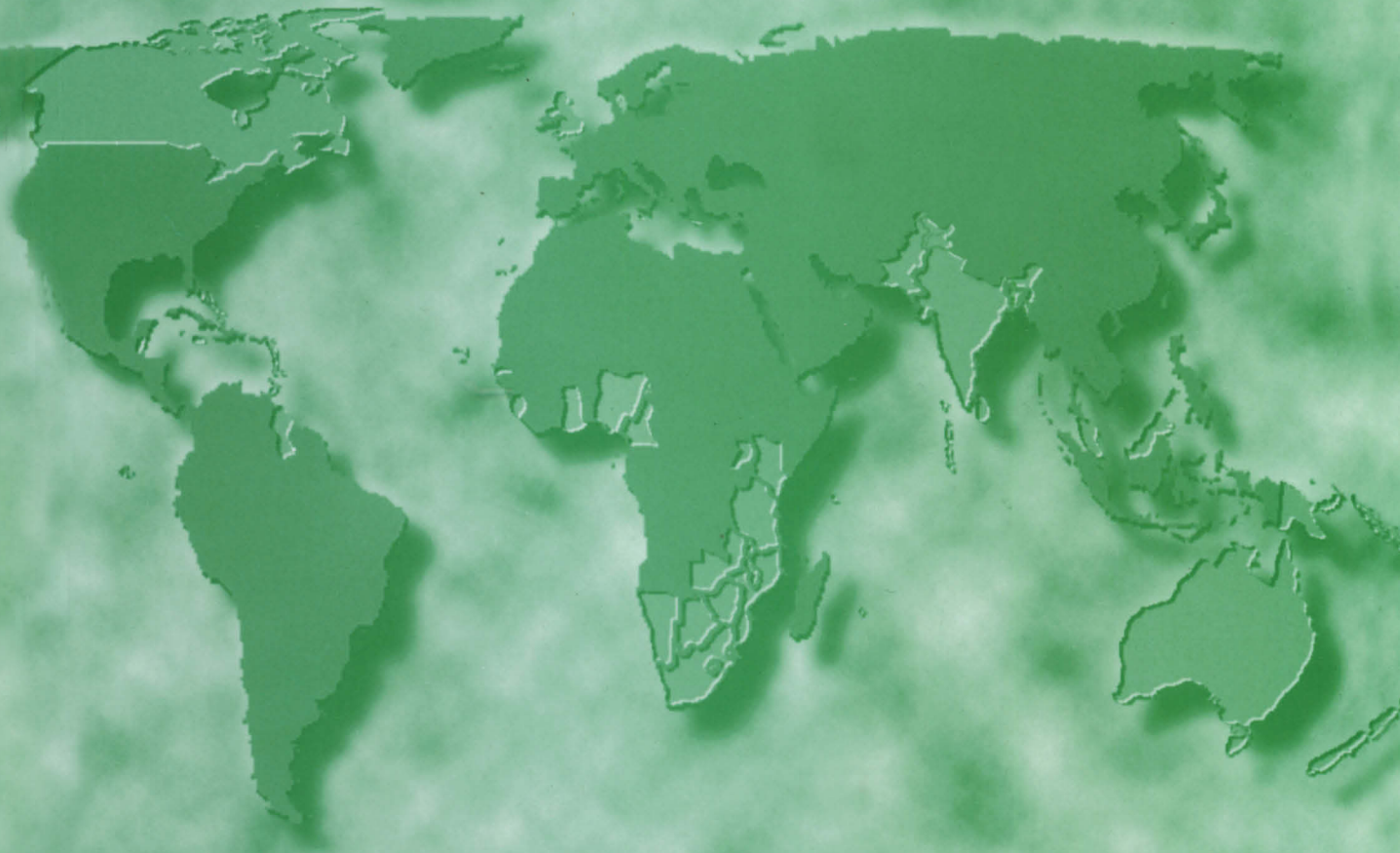


Integrating the Economy and the Environment

Policy and Practice



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COMMONWEALTH SECRETARIAT

A paper for the Commonwealth Secretariat by Professor David Pearce, (University College London) and Ms Ece Özdemiroğlu (Economics for the Environment Consultancy, London). The authors acknowledge extensive comments on an earlier draft of this paper from Mr C Krishnan of the Commonwealth Secretariat.

All enquiries for assistance should be directed to:

The Director
Economic Affairs Division
Commonwealth Secretariat
Marlborough House
Pall Mall, London SW1Y 5HX, Britain
Telephone: +44 (0)171-747 6261/6231
Fax: +44 (0)171-747 6235
Telex: 27678

Commonwealth Secretariat
Marlborough House
Pall Mall, London SW1Y 5HX, Britain
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This paper was produced with financial assistance
from the Commonwealth Fund for Technical Co-operation (CFTC).

Designed and published by the Commonwealth Secretariat.
Printed in Britain by Formara Limited, Southend-on-Sea.

ISBN 0 85092 504 5

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Foreword

Since the 1992 'Earth Summit' in Brazil, there has been increasing recognition worldwide that environmental and economic policies must work together in order to improve the quality of human life. If the environment continues to be degraded, economic development will suffer. Conversely, environmental policies are unlikely to succeed without rapid economic development, especially in poorer countries.

The Commonwealth Secretariat's policy development work on the environment is giving particular emphasis to the integration of economic and environmental policies, in response to the growing interest in this subject in member countries. This paper, prepared for the Secretariat by Professor David Pearce, University College London, and Ms Ece Özdemiroğlu, Economics for the Environment Consultancy, London, provides a comprehensive overview of the key conceptual, policy and practical aspects of integrating economic and environmental policies. Policy-makers confront several complex issues in trying to harmonise economic and environmental objectives. I hope that they will find this paper helpful in dealing with these issues so that the transition to environmentally sustainable development can be accelerated in the Commonwealth.

Rumman Faruqi
Director
Economic Affairs Division

Environmentally Sustainable Development

An Overview

The environment and the economy of a country are inextricably linked. Attempts to maximise economic growth without reference to the environment are doomed to fail. Economic growth and development will not be sustained. Conversely, attempts to solve the problem of environmental degradation without examining the impacts of economic policies on the environment, are unlikely to succeed. Following the 1992 UN Conference on Environment and Development, many countries are in the process of developing and implementing comprehensive national plans for sustainable development. It is vital to integrate economic and environmental policies in the development and implementation of these plans.

This paper highlights the links between the economy and the environment; shows how the causes of environmental degradation can be found in the workings of the wider economy; and identifies the ways in which the economy can be managed, and economic instruments used, in order to make economic development environmentally sustainable.

1.1 The Links Between the Economy and the Environment

The relationship between the economy and the environment is illustrated in Figure 1. The economy can be visualised as a system which processes materials and transforms products. Useful materials are drawn from the natural environment into the economic system (e.g. non-renewable resources such as fossil fuels) and then undergo a series of changes in their energy and usefulness. Unless recycled, all materials eventually return to the environment. This process of inevitably returning materials and energy to the environment is the result of the First Law of Thermodynamics: we cannot create or destroy matter and energy; all we can do is transform it. Coal, for example, becomes heat, ash and particles. We can recycle materials but not energy; hence, by definition, a '100% recycling' society is not feasible. Nor is 100% materials recycling achievable. This is because economic activity tends to be 'entropic' - it uses materials and converts them into diffuse components which are then difficult and expensive to recycle.

Figure 1: **The Links Between the Economy and the Environment**

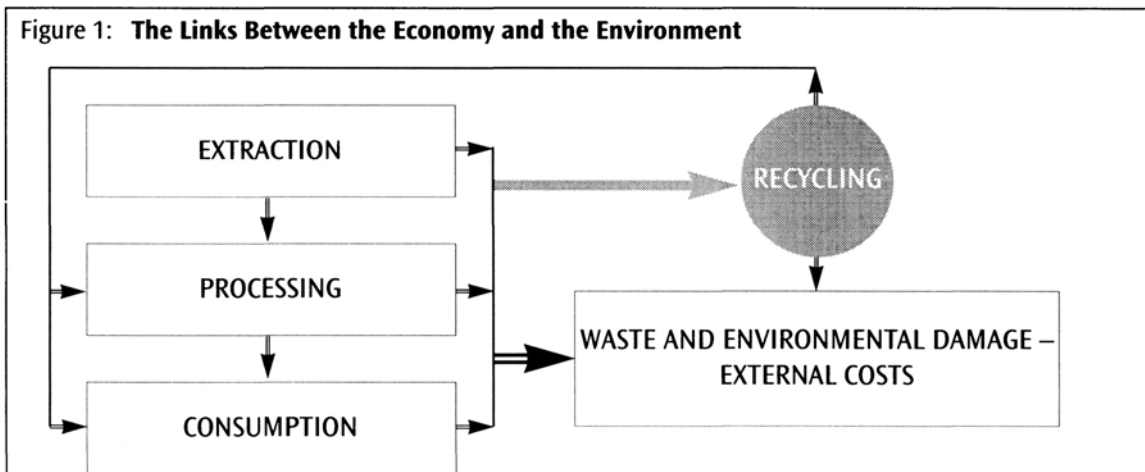


Figure 1 is a very simplified diagram of a 'materials balance' economy. Materials enter the economic system from the natural resources sector, and then exit the economic system to the environment as waste. The diagram immediately illustrates the *natural resource problem*. If the supply of natural resources is finite and we extract them each year for the economic system then, logically, we will one day run out of the resources. This is the 'resource scarcity problem'. Box 1 investigates this issue.

Figure 1 also gives us a clue about the *pollution problem*. Pollution arises as the obverse side of the natural resource problem. The more we take out of the natural resource sector, the more we emit to the environment. Less obviously, the process of transforming natural resources into usable products often changes the *nature* of those resources. Coal, as coal, is inert and non-polluting. Once converted, it produces solid waste and ambient emissions. The sulphur in the coal, for example, becomes sulphur oxides and these can damage health, buildings, and ecosystems. Even then, none of this might matter if the environment could receive the waste and cope with it. We might think of the environment (the seas, the atmosphere, soil, rivers etc) as having an 'assimilative capacity', i.e. a capacity to absorb and degrade wastes. This is true for many wastes, but untrue for some such as mercury and cadmium which do not degrade in the environment. Hence, the environment has varying degrees of assimilative capacity. If those capacities are exceeded then even low-toxicity wastes can cause problems. Essentially, what happens is that the assimilative capacity is itself damaged, making the environment less able to cope with further discharges of waste. If waste emissions continue, eventually the system breaks down or changes. Parts of the Baltic Sea, for example, are 'dead' in the sense that they support virtually no life forms. This is due to pollution. Finally, the diagram also shows that recycling can both reduce the rate of extraction of natural resources, and prevent waste reaching the envi-

Box 1: Measuring Resource Scarcity

One way of estimating physical scarcity is through the 'exponential index' of stocks. This measures the number of years before stocks are exhausted, given an estimate of stocks and an estimate of the rate at which consumption grows. The formula for estimating this index, T , which is in years, is

$$T = \ln(g.s + 1)/g$$

where $\ln$ is logarithm, g is the average growth rate of consumption, and s is the static reserve index (current reserves divided by current consumption).

For example, known global reserves of bauxite in 1970 were 1170×10^6 tons (US) and the average growth rate of consumption was 6.4% per annum. Hence,

$$T = \ln((0.064 \times 100) + 1)/0.064 = \ln 7.4/0.064 = 2.00/0.064 = 31.2 \text{ years.}$$

The index for 1970 and 1994, for other resources, are shown below:

Resource	T_{1970}	T_{1994}	Rate of Discovery
Alum	31	104	+5.2% pa
Copper	21	25	+0.7% pa
Iron	93	115	+0.8% pa
Lead	21	11	-2.3% pa
Mercury	13	20*	+1.8% pa
Silver	13	na	na
Coal	111	139	+0.9% pa
Nat Gas	22	42	+2.7% pa
Oil	20	35	+2.3% pa

(All figures ignore recycling and any efficiency gains.)

* the growth rate of mercury consumption is actually negative but set at zero here so that exponential index = static index.

Note that in all cases other than lead, resources have increased their lifetimes.

ronment, but, as noted above, this is not true for energy.

One approach to sustainability, then, is to see what conditions have to prevail in order for a society to carry on at least as it is at the moment. From the diagram we can see that continuous extraction of resources is unsustainable if resource supplies are finite. This suggests switching from non-renewable resources to renewable resources where the flow of resource services (e.g. heat) is indefinite, as with solar energy. A second policy would be to maximise the level of recycling, provided it costs no more in terms of materials and energy to recycle materials than are saved by the recycling process. A third policy measure is to ensure that waste is emitted in both quantities and qualities that are consistent with the assimilative capacities of receiving environments. All these policies are consistent with Kenneth Boulding's concept of 'spaceship earth' (Boulding, 1966).

Whatever the relevant policy prescriptions, Figure 1 also reveals the fundamental basis of environmental economics: if we have an environmental problem we should always look at how the economy behaves to see if the cause of the problem lies there. Often we will find it does. If this is true, then the policy dimension is also clear: solving environmental problems will best be done by changing the causal factors at work in the economy. While some commentators still call for ways of 'integrating economics and the

environment' the truth is that we have known the basis for doing this for some decades. The issue now is how to make it all work in practice and to gather experience to help us test some of the more detailed relationships involved.

1.2 Environment and Economic Development

Environmental degradation imposes costs on the economy. The most detailed studies of environmental damage and resource depletion costs in developing countries have been carried out for Indonesia (Magrath and Arens, 1989, and Repetto and others, 1989). Their analyses focus on the depreciation of forest assets and the costs of soil erosion. A forest can be viewed as a natural capital asset similar to a human-made capital asset. The asset yields a service over time for which there is a corresponding income. An asset can depreciate for two reasons: changes in value and changes in physical condition. Its value may change independently of any physical change; for example, its price can vary with demand. Obviously, value also changes if physical depreciation occurs. The issue is further complicated because the relevant cost should be that of non-optimal depletion: it cannot be assumed that all depletion is reprehensible. Table 1 shows the results of an exercise to value deforestation and soil erosion in Indonesia. Estimates of the cost of deforestation

Table 1: **Costs of Deforestation and Soil Erosion in Indonesia**

Types and Measure of Loss	(1984 US\$ million in current prices)
Deforestation	
total value	3,054
as % of GNP	3.6
Soil erosion	
on-site	315
siltation of irrigation systems	10
harbour dredging	2
reservoir sedimentation	46
total value	373
as % of GNP	0.4

Sources: For forests, Repetto and others, 1989; for soil erosion, Magrath and Arens, 1989.

are obtained by estimating the value of the depreciation. The estimates of soil erosion damage are based on the production function approach which is discussed in Chapter 2.

1.3 Pricing and the Environment

Once the environment-economy link is explored, certain basic features emerge. These are:

- a The environment tends to be degraded because it often has no price in the market place: we do not buy and sell clean air, or biological diversity, or nutrient cycling. But environmental conservation invariably has to compete against activities which do have market prices: agriculture, forestry, transportation. The result is that the 'playing field' is uneven. The environment loses because it appears to be worthless, whereas the activities that degrade the environment have economic value. Economists call this 'economic failure': the economic system has failed to take account of the many positive functions of the environment.
- b If we create markets for the environment, then we establish *incentives* for people to conserve it. For example, if we tax air pollution we have effectively created a market in clean air. Those who pollute have to pay for the privilege of using up a scarce resource, the environment. This provides them with an incentive not to pollute or at least reduce their pollution. Similarly, if people own natural resources they are far more likely to take care of them than if they shared those resources with a great many others and no rules of access and use are applied. This is why some of the world's oceans are badly polluted: no one owns them. Where territorial rights have been exercised, generally, greater efforts have been made to conserve resources such as fisheries.
- c It is fundamental that policies in these areas work towards empowering people. One might wonder whether this is another

politically correct phrase. In fact, 'empowering people' has an *economic* rationale, because:

- ❖ intervention has a high risk of failure if the people affected feel excluded from the decision-making which affects their lives;
- ❖ local communities often feel excluded because they have no *incentive* to cooperate with policy (e.g. national parks that bar them from traditional uses of forest resources); and
- ❖ the costs associated with the failure to consult, involve and compensate people are often large and may affect project returns (e.g. resettlement of indigenous people).

Hence, whatever other rationales exist for participation, the economic case is strong.

1.4 Environmental Economics in Action: an Example

To illustrate these principles, consider the case of wildlife conservation in Africa. While a great deal of effort has gone into measuring wildlife benefits, there appears to be less information about the true *opportunity costs* of conservation. Opportunity costs refer to the value of the benefits foregone by conserving land for wildlife, rather than using it for something else. Table 2 shows two estimates for Kenya and South Africa. It is important to determine the correct basis for comparison. Much of the pressure on land in Africa, as in some parts of Asia, is (and will be) for food, both for consumption and trade. Hence, it is legitimate to compare livestock versus wildlife or crops versus wildlife. But there are various 'mixes' that also need to be considered, such as mixed wildlife and cattle systems. In turn, some wildlife utilisation is consistent with consumptive uses of wildlife, while most wildlife is consistent with non-consumptive uses such as eco-tourism. The studies mentioned in Table 2 give very different results. Since land in Kruger

Table 2: **Estimates of Macro Benefits and Opportunity Cost of Wildlife**

Country	Author	GDP from wildlife tourism/ forestry per year (US\$million)	Foregone GDP= opportunity cost per annum (US\$million)
Kenya	Norton-Griffiths and Southey (1995)	42	203
South Africa (Kruger National Park)	Engelbrecht and van der Walt (1993)	about 110	6
South Africa	Wells (1995)	254-2,174	?

Park is in fact mostly unsuitable for dryland cropping, livestock is, effectively, the only realistic alternative land use. Wildlife would appear to more than pay its way in Kruger Park. In contrast, the Kenya study suggests that Kenya is paying a very high price for its wildlife-based tourism. Despite gross revenues of US\$400-450 million per annum, the actual net gain is found to be only US\$42 million. This is because of an adjustment of halving the gross revenues on the grounds that wildlife tourism is not the only purpose for the visits, and that the different purposes are largely separable. Well's estimates of the value of the wildlife sector in South Africa cover a wide range for the same reason that it is not easy to allocate revenues to sectors when the revenues have a multi-purpose characteristic. Well's estimates dwarf those for Kenya probably for this reason. Wells' numbers refer to GDP but appear to be gross tourist expenditures, i.e. gross revenues rather than value added. It is clear that considerable research needs to be undertaken to extend and refine the estimates of both the value of the wildlife sector and its opportunity costs.

One conclusion from the Kenya study might be that the country would be better off not conserving its wildlife at all, but converting land to other uses. This appears even more attractive as an option in the face of a rapidly rising population. But this is only part of the story. A number of studies have attempted to estimate the willingness to pay for wildlife conservation in Kenya. Table 3 assembles the estimates, which were obtained using techniques which are discussed in Chapter 2.

First, consider Moran's estimate of economic value of \$450 million per annum for Kenya, and compare it to the opportunity costs of conservation as estimated by Norton-Griffiths and Southey in Table 2. It exceeds the opportunity cost by a factor of two, whereas Table 2 suggests that the financial returns to Kenya are less than the opportunity costs. The two assessments are quite consistent: actual financial returns can be less than opportunity cost while economic value can be greater than opportunity cost. While the total willingness to pay to see wildlife in Kenya, and hence conserve it, greatly exceeds the oppor-

Table 3: **Willingness to Pay for African Wildlife**

Study and Approach	Resource	Willingness to Pay
Brown <i>et al</i> (1989): contingent valuation, foreign visitors	African elephant in Kenya	US\$182-218m per annum
Moran (1994): contingent valuation, foreign visitors	protected areas in Kenya	US\$450m per annum
Brown <i>et al</i> (1994): contingent valuation and travel cost approach	game parks in Kenya	US\$52-86 per visitor day (CVM) US\$77-134 per visitor day (TCM)
Navrud and Mungatana (1994): contingent valuation and travel cost approaches	Lake Nakuru, Kenya	US\$7.5 m (CVM) US\$ 13.7-15.1 m (TCM)

tunity cost of conservation, Kenya's current situation is that the actual financial returns from wildlife are significantly less than the opportunity cost. It follows that Kenya is failing to 'capture' the full economic value of its wildlife.

Second, and allowing for the uncertainty inherent in all these estimates, Kenya should be seeking to exploit this greater economic value by more careful pricing for entry to game parks, as indeed it has been doing recently. The willingness to pay estimates are basically showing us what the demand curve for wildlife conservation is like. This in turn means that it is possible to identify the price at which revenues to Kenya could be maximised. Such a charging policy would need to take account of carrying capacity measures, i.e. the 'optimal' price cannot be one that increases visitor demand, if that demand already threatens wildlife, as has been the case in some Kenyan reserves.

Third, the Brown *et al* (1994) and Navrud and Mungatana (1995) studies also show that revenue maximising prices would actually involve increases in prices and, hence, fewer visitors. Despite this, revenues would rise. The additional benefit would be less stress on animal populations. Pricing can be differentiated between residents, whose demand tends to be more responsive to the price of park entry, and foreigners, whose demand is fairly non-responsive to prices. This has been the policy in Kenyan game parks in recent years.

Fourth, while the studies quoted have not sought to find willingness to pay among foreigners who do not visit Africa, there is a strong likelihood that this 'existence' value is high (see Chapter 2 for the concept of existence value). Capturing this 'global value' is now the focus of many innovative schemes, such as debt-for-nature swaps, the Global Environment Facility, transferable development rights and other franchise agreements.

In conclusion, what this example illustrates is the following:

a when wildlife has a market, it has the

potential to compete with other economic uses of land;

- b nonetheless, the prevailing system might not maximise the gains from wildlife conservation;
- c hence, devising the best set of incentives and prices becomes very important so that gains from wildlife can be maximised and realised;
- d incentive systems will range from charging the correct price to 'capturing' economic value through various kinds of schemes; and
- e incentive systems must include those who otherwise suffer the consequences of conservation – communities that suffer from damage caused by wildlife, for example.

1.5 An Overview of Sustainability

When people refer to the factors which render an economy unsustainable, what exactly is meant by the term sustainability? Sustainable development was defined by the 1987 Brundtland Commission as the meeting of "the needs of the present without compromising the ability of future generations to meet their own needs."

An economic interpretation of this definition is that for an economy to be on a sustainable development path, the well-being of the present generation should not be increased at the expense of the welfare of future generations. In other words, society's well-being should not decline over time. Unsustainable development therefore implies that human well-being will decline at some point in the future.

The next generation can produce as much well-being as the present one only if it has the same resource base. This consists of all kinds of capital stocks and technology. Capital stocks, which can be used ever more efficiently through improvements in technology, comprise:

- ❖ Human-made capital (Km), e.g. factories and machinery;
- ❖ Human capital (Kh), e.g. education;

❖ Natural capital (K_n), e.g. forests.

To these some would add:

Social capital (K_s), by which is meant the presence of norms and culture which bind society together rather than divide it.

There are two principles for keeping the capital stock constant over time:

The **Weak Sustainability** principle requires leaving a constant aggregate stock of all forms of capital for the future generation. This provides the opportunity to substitute natural capital for human-made and/or human capital and vice versa. In other words natural capital can be used up provided, as we deplete it, we build up other forms of capital. In other words, $K/N = \{K_m + K_h + K_n + K_s\}/N$ should be constant or rising through time, where K and N denote overall capital stock and population, respectively.

The **Strong Sustainability** principle requires leaving a constant overall capital stock as well as a constant stock of natural capital. It is much more stringent than weak sustainability since it requires that natural capital should not be substituted with any other form of capital.

In other words:

Environmentally strong sustainability means K_n/N should be constant or rising through time and weak sustainability must hold too.

Socially strong sustainability means K_s/N should be constant or rising through time and weak sustainability must hold too.

Strong sustainability in terms of human capital means K_h/N should be constant or rising through time and weak sustainability must hold too.

It is also arguable that we could have a strong sustainability variant in which K_m/N is constant or rising as well.

Note the importance of weak sustainability. If any particular form of capital is singled out, weak sustainability must still be honoured, otherwise we could have a constant stock of 'nature' per

person, but fail to be sustainable because we let other forms of capital decay.

1.6 Measuring Wealth

The definition of weak sustainability gives us an immediate candidate for an **indicator of sustainability**. This is given by the total stock of capital assets, and the condition is that

$K/N = \{K_m + K_h + K_n + K_s\}/N$ should be constant or rising through time. We can and do measure K_m , although it is a complicated process and the estimates are uncertain. Estimating K_m requires using the **perpetual inventory method**, whereby each year's investment in K_m is added up over time and allowance is made for the rate of decay (i.e. depreciation) of the individual components. The sum of the net annual investment becomes the wealth measure.

Natural capital depreciation is estimated in two ways. For natural resources, the **rents** are calculated as **price minus average cost** (actually this is profit, but price minus marginal cost, the true measure of rent, is difficult to estimate because of data problems). Rents multiplied by quantities extracted or harvested equals depreciation. For pollution, we multiply emissions by the shadow price of pollution (see Chapter 2 on valuation).

Human capital (K_h) turns out to be the most difficult to estimate. One could take expected lifetime earnings of a person with a given level of education and discount these to get a present value. This could then be compared to the expected lifetime earnings of someone with less education. The 'incremental' return would be the rate of return to education. But the World Bank takes a broader definition to include returns to labour generally (on the basis of the principle that even the most unskilled worker is in reality using skills). They assume that 45% of the agricultural sector's output in any year is due to labour, add this to non-agricultural GDP and subtract from this total the estimates of rents for K_n . The resulting total is then aggregated over the lifetime of an individual aged 1 in the rele-

vant country and discounted. **Social capital** (Ks) is effectively subsumed in Kh in the approach adopted by the World Bank. As yet, no one has devised a way of measuring Ks separately.

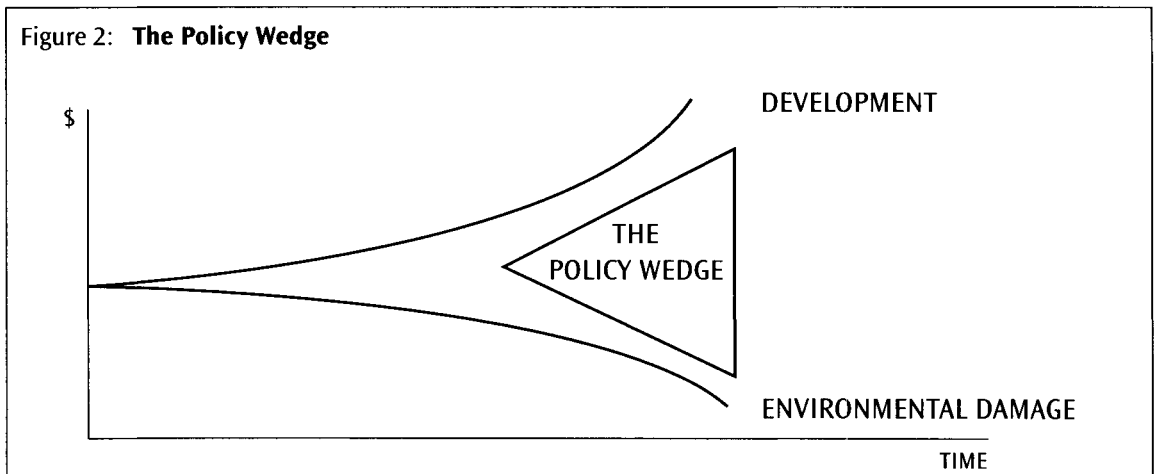
1.7 Capital, Substitutes and Complements

Weak sustainability effectively assumes substitutability, whereas in each form of strong sustainability, a certain kind of capital is special in some way and cannot be substituted by other forms of capital. The on-going debate on this issue in the literature perhaps defines one of the differentiating features of ecological as opposed to environmental economics, although many of the claims that these subjects are very different are almost certainly spurious. The kinds of consideration that are relevant are: can we do without the ozone layer? If not, it might be classified as critical natural capital. It does have substitutes for some of its functions: e.g. sunglasses, clothing, sun-tan cream and hats will substitute for the ultra-violet (UV) radiation protection functions of the ozone layer, to some extent. But if UV radiation is implicated in significant reductions in ocean biomass productivity, as some claim, it is difficult to see what the feasible substitute is; and are not Kn and Km complements rather than substitutes? Don't we use timber and tools to build houses

(i.e. Kn + Km make further Km)? Are not fishing boats (Km) combined with Kn (fish, oceans) to capture Kn? The reality is that we do use many types of capital to produce other forms of capital, and we do so because their combination yields a higher rate of return than not combining them (trawlers are more productive than fishing lines, for example). But these combinations do also destroy Kn, e.g. Km, Kh and Kn combine in fishing to destroy fisheries; Kn, Km and Kh combine to build roads which may also destroy Kn. Hence, it seems that talking in terms of substitutes and complements is not necessarily very helpful.

In practice, finding the level of strong sustainability is difficult. If, for instance, ecologists could define the minimum critical amount of natural capital that must be preserved to ensure continued eco-system survival, the weak sustainability principle can be applied until that critical threshold. Thereafter, the strong sustainability principle would be implemented. A great deal of uncertainty remains over defining a critical minimum stock of natural capital and the extent to which science will reduce uncertainty over time is a contentious point. Given the weak and strong sustainability options, is it possible to promote economic development and conserve the environment at the same time? Figure 2 depicts how this may be possible.

Figure 2: **The Policy Wedge**



The 'policy wedge', which helps achieve the dual aims of reducing environmental damage and increasing economic development consists of the following measures:

- ❖ Creating new or enforcing existing property rights
- ❖ Creating countervailing power (empowerment, participation, consultation)
- ❖ Creating markets (both on a local and global scale)
- ❖ Changing intervention policies
- ❖ Addressing the issues of scale (population, the decoupling of economic growth and resource use)

The importance of these measures will become clearer in the latter Chapters.

1.8 Bringing Sustainable Development Down to Earth

Many of the implications of sustainable development are familiar messages about ensuring that environmental effects are fully accounted for in pricing and investment decisions, policy appraisal and macroeconomic work, including green national income accounts. But some differences of emphasis and newer directions are also called for with regard to the use of discount rates, land-use planning/zoning, and designing projects in harmony with nature. Special attention needs to be given to inter-generational concerns: the imposition of costs on future generations because of actions taken today (see Chapter 2 for a discussion on different perspectives on the use of discount rates).

An Introduction to the Application of Economic Valuation Techniques to Environmental Problems and Cost-Benefit Analysis

The previous Chapter highlighted the links between the environment and the economy, which lie at the heart of the principle of environmentally sustainable development. If environmental resources were available in infinite quantities, and if they could be deployed at zero costs, there would be no economic problem. However, choice becomes a necessity once it is recognised that resources are finite in terms of their absolute quantity, or in terms of the costs of extracting or using them.

The purpose of economic valuation is to reveal the true costs of using scarce environmental resources. Choosing whether to use environmental resources is made easier if both costs and benefits of this action are expressed in terms of a common unit, e.g. money. Valuation is relevant at all levels of public choice:

- ❖ In *project appraisal* the environmental impacts of any investment need to be estimated and compared to the other costs and benefits.
- ❖ In *programme appraisal* the value of environmental impacts similarly needs to be integrated into the evaluation process.

- ❖ In *policy appraisal* environmental factors need to be treated on an equal footing with other costs and benefits so that sectoral priorities are not distorted. This is as important in choosing between marginal expenditures on, say, transport as against energy, as it is in choosing between conservation and development projects. Similarly the setting of environmental standards should be informed by valuation analysis. In short, environmental valuation should be an integral part of decision-making on sectoral priorities, the balance between conservation and development, and the choice of environmental standards.

2.1 Environmental Valuation Techniques

The monetary measure of a change in society's well-being due to a change in environmental quality is called the *total economic value* of the change. The total economic value is the sum of use value and non-use value.

Use-values comprise:

- ❖ Direct values – where an individual makes direct use of a resource (e.g. harvesting timber from a forest).

Table 4: Total Economic Value in the Context of Tropical Forest

1 Direct value	2 Indirect value	3 Option value	4 Existence value
• Timber • Non-timber products • Recreation • Medicine • Plant genetics • Education • Human habitat	• Nutrient cycling • Watershed protection • Air pollution reduction • Micro-climate regulation	• Future use as per direct and indirect values, e.g. future medicinal values of plant species	• Forests as objects of intrinsic value and as a gift of nature • Includes cultural and heritage values

- ❖ Indirect values – where an individual benefits from ecosystem functions (e.g. the protection of watersheds by forests).
- ❖ Option value – where an individual is willing to pay for the option of using an asset at some future date (e.g. future medical use of forest plant species).

Non-use values can take the form of:

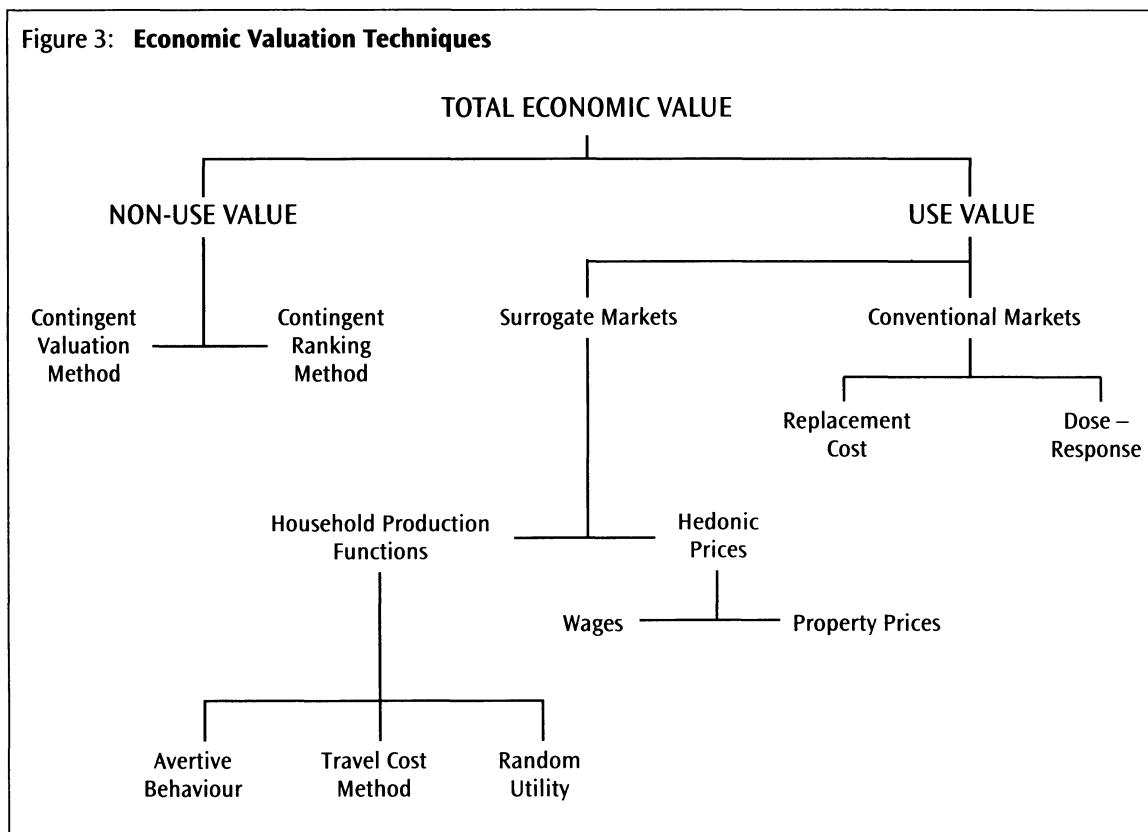
- ❖ Existence values – which measure willingness to pay for a resource for some moral, altruistic or other reason that is unrelated to current or future use.
- ❖ Bequest values – which measure people's willingness to pay to ensure that their heirs will be able to use a resource in the future.

Table 4 illustrates the components of Total Economic Value in the context of tropical forests.

Suppose a 50 km² area of tropical primary forest can either be destroyed and subsequently

developed or, alternatively, conserved in its present state. The policy-maker can use the techniques described below to estimate the total economic value of the forest as it stands (see Table 4). This total economic value can then be compared with the value of the land in some alternative use, e.g. agriculture. If the total economic value of the conservation of the forest is greater than the value of its development as agricultural land, then society is better off if the forest is conserved. On the other hand, if the forest area had greater value as agricultural land then the reverse would hold. Estimating these values for different land uses is known as *demonstrating economic value*. As we see later, demonstrating value is not enough: it will be necessary to ensure that these values accrue as real financial gains to those whose livelihoods are affected by the different land uses. This is known as *capturing, or appropriating economic value*.

Figure 3: **Economic Valuation Techniques**



There are two broad approaches to valuation, each comprising several different techniques, as Figure 3 illustrates. One approach consists of directly asking people questions designed to elicit their values. These techniques are usually termed *direct techniques* and can be used to value both direct values and indirect values. Alternatively, values can sometimes be elicited from conventional or surrogate markets, where environmental quality is an element of satisfaction people derive from consuming a good or service. This is termed the indirect approach, and is restricted to use values. The rest of this Chapter describes the different valuation techniques highlighting their applicability, procedure, validity and expense in a format which enables them to be compared.

2.2 Indirect Valuation: Dose-Response Function

Applicability:

This approach is extensively used where the dose-response relationship between pollution and impact or response is known and the impact can be measured. Examples include health, crop and forest damage from air pollution, or crop yield losses due to soil erosion. This approach cannot be used to measure non-use values.

Procedure:

Statistical methods are used to estimate the relationship between pollution (dose) and its environmental impacts (response). Some impacts can then be valued at the real price of the loss (net of any taxes and/or subsidies). In other instances, the value of the impacts cannot be readily estimated from a market price and require the application of other valuation techniques (e.g. in valuing the health impacts of air pollution).

Validity:

Despite being a theoretically sound approach, dose-response functions suffer from uncertainties in scientific data. There are also uncertainties in estimating the economic value of some health impacts.

Expense:

This method can be costly if large databases need to be manipulated in order to establish dose-response functions. If these already exist and can be transferred to the current context, the method can be quite inexpensive with low time demands.

Using the *Dose-Response Function* Approach to Value the Costs of Soil Erosion: a Case Study in Mali

Soil erosion reduces the productivity of the land. A dose-response function predicts the 'response', in terms of reduced crop output resulting from a unit 'dose' of erosion. Soil loss is a function of, among other factors, the erodibility of soils, the slope of the land, and conservation practice. Soil loss can then be related to loss in crop yield, based on results of a range of tests examining this relationship. This reduction in crop production can then be valued. By multiplying the loss in yields by the current market price for the crop. Soil erosion also reduces the need (and hence cost) for weeding and harvesting. This study, conducted in Mali, allowed for these effects by looking at the total impact on farm budgets with and without erosion.

Much of the work on estimating the dose-response relationship has been done in the USA, Canada or Australia. In the absence of any Mali-based research, the dose-response functions were estimated on the basis of research results in the US. This dramatically reduced the expense of the study, but also reduced its accuracy since soil and climate conditions in the US are different from those in Mali. The study estimated that the national annual income losses due to soil erosion were as follows:

Annual Loss (1988 prices)	= US\$ 4.6 million
As % of GDP	= 0.2 %
As % of agricultural GDP	= 0.6 %

The economic losses from soil erosion in Mali, at least as suggested by this study, appear high enough to warrant conservation investments in some areas of the country. Investing in

additional agricultural output may be less profitable than a simple financial appraisal would suggest. However, the important question of why soil erosion occurs has not really been tackled, and research on the dose-response relationship in Mali's own soil and climate conditions is necessary to make more precise estimates.

Source: Bishop et al, 1989.

2.3 Indirect Valuation: Replacement Cost Approach

Applicability:

The replacement cost approach is applicable in situations where the cost relates to achieving some agreed environmental standard, or where there is an overall constraint requiring that a certain level of environmental quality is achieved or maintained. The method cannot be used to estimate non-use values.

Procedure:

Ascertain the environmental damage done (in physical units) and then estimate the cost of restoring the environment to its original state.

Validity:

This method is only valid in contexts where agreed standards must be met. It cannot produce measures for the damage caused by pollution or resource use.

Expense:

Usually inexpensive as standard engineering and cost data often exist.

Using the Replacement Cost Technique to Value the Loss of Life Support Capacity of Wetlands: A Case Study from the Baltic Sea

The Martebo Mire wetland system on the island of Gotland, Sweden, provides a range of life support services such as cleansing nutrients and pollutants, maintaining the level and quality of drinking water, and sustaining genetic diversity. Extensive draining of the Mire has resulted in the loss of the wetland, consequently creating needs for replacement technology which can be costed on the basis of market data. Note that the cost of

replacement is only part of the *total economic value* of wetland.

Replacement technologies include artificial fertilisers, irrigation dams, water transportation, well-drilling, water purification, and sewage treatment plants. The additional purchase of these technologies would correspond to an annual sum of 2.5-7 million SEK (£220,000-614,000). Note that the required environmental standard in this example is the level of service that was provided by the wetland prior to destruction.

Source: Folke, 1990.

2.4 Indirect Valuation: Avertive Behaviour

The approaches examined so far tend to use data from conventional markets. The avertive behaviour technique along with others shown in Figure 3 tend to use data from surrogate markets which typically embody some form of environmental quality within a product or service.

Applicability:

This method is applicable in cases where households spend money to offset environmental impacts. In addition to the case study below, the method can be applied to estimate the economic value of clean water (e.g. cost of household water filters) and noise (e.g. cost of double glazing). The method cannot be used to estimate non-use values.

Procedure:

Measures undertaken by households to mitigate an environmental impact are identified and then their costs are estimated at the market price.

Validity:

Because the method uses actual expenditures, the results should be valid, as long as the only benefit people receive from the expenditure is in terms of greater environmental quality. However, there are very few studies to test the results.

Expense:

A large scale study requires econometric analysis of survey data which may be fairly expensive. However, small-scale local studies, which are cheaper, can also be useful in some contexts.

Using An Avertive Behaviour Model (ABM) to Value the Health Benefits of Reduced Ozone Depletion: A Case Study from the USA

Emissions of CFCs damage the ozone layer, which in turn increases the number of cases of skin cancer. What is the value of this damage? The ABM imputes the value people place on reducing the risk of contracting skin cancer by examining sales of sun-protection products. This value can then be compared with the costs of reducing ozone damage in a standard cost-benefit framework. A sample of people were interviewed, and information collected on:

- a the amount of time spent in direct sunlight
- b the clothes worn in direct sunlight
- c the use of sun protection products
- d inherent skin sensitivity to direct sunlight

Respondents were also asked how much they were willing to pay for a hypothetical sun-cream that prevented skin cancer. This information, once analysed with a variety of statistical procedures, estimated a mean willingness to pay (WTP) for a one per cent reduction in perceived cancer risk across the sample. If the sample were representative of the entire US population, the total willingness to pay for a one per cent reduction in skin cancer risk would be \$500 million. This is a relatively small amount, although most abatement measures would involve reducing risks by much more than one per cent. The following results show that there was no significant difference between the WTP of the young and the elderly.

Age	Mean WTP for 1% reduction in risk, 1990 prices
21 & older	\$2.73
21-30	\$3.06
31-40	\$3.03
41-50	\$2.97
51-60	\$2.66
61-70	\$2.24
71 & older	\$2.09

Source: Dickie et al, 1991.

2.5 Indirect Valuation: Travel Cost Method

Applicability:

The method is generally used to value recreational benefits of environmental resources which is important in analysing public policy responses towards ecotourism. It can also be used for the valuation of time (e.g. for collection of water and fuelwood). It cannot measure non-use values.

Procedure:

A detailed sample survey of travellers, their cost of travel, site characteristics and alternative recreation options is needed. The analysis of the survey requires the use of complicated statistical methods.

Validity:

The method is theoretically correct but complicated especially when alternative recreation sites and multi-purpose trips are involved. Similar studies produce comparable results. The method is widely used by official agencies and conservation groups. It is well suited to estimating the total demand for recreation associated with a site, but is somewhat limited in its ability to measure the value of a change in the site's characteristics.

Expense:

It generally requires large surveys and complicated statistical methodology and hence is expensive.

Using the Travel Cost Method (TCM) to Value Ecotourism: A Case Study of A Costa Rican Rain Forest Reserve

Should a rain forest be preserved as a nature reserve or cleared for development? Forests have values other than as a source of timber products, or as agricultural land when they are cleared. It is important to recognise all components of their *Total Economic Value* (TEV). The TCM technique is used to infer the value tourists place on the recreational experience of visiting a rain forest. Tourists must place some value on the site or they would not incur the expense of travelling there. However, the technique does not include

values of people who do not travel to the site, and it may therefore be an underestimate of its TEV.

The study team collected information on the addresses of domestic visitors to the reserve. Visitors were then zoned according to their addresses into one of the 81 'cantons' in Costa Rica, and the average number of trips from each canton calculated. This was divided by the population of each canton to calculate the average visitation rate from each zone. The estimated total cost of travel from each zone comprised:

- a Out of pocket costs to travel; e.g. petrol
 - +
 - b A proportion of the fixed costs of travel, e.g. vehicle wear and tear
 - +
 - c Value of time spent travelling.
-
- = Total Costs of Travel

The total costs of travel were calculated by multiplying an average cost per kilometre (0.15 US\$ per km) by the distance from the centre of each canton to the reserve. This average figure included (a), (b) and (c) above.

With information on both the price and quantity of trips from each zone a demand curve was constructed. This was then added across all zones to derive aggregate demand for recreation in the forest reserve. The study estimated a present value of between US \$2.4 and \$2.9 million = \$35 per Costa Rican person per year. The study then included an estimate of the value to local and foreign tourists as well, yielding a present value of US \$2.5 – \$10 million. Consequently the total estimated present value per hectare of the reserve was \$1250. The current price of forested land cleared for agriculture is \$30-100 per hectare. Hence, conversion of rain forest to agricultural land represents an economic cost of approximately \$1150-1220 per hectare. Conversely, the study suggests that the preservation of the reserve represents a well-justified investment from a social and economic perspective. These figures also suggest that social

well-being may increase if the conservation site is expanded. However, it should also be considered that as the reserve gets larger, the economic benefits foregone from not developing the site (the opportunity cost of conservation) will increase.

Source: Tobias et al, 1991.

2.6 Indirect Valuation: Random Utility Models

Applicability:

The model is applicable in the same situations as the travel cost method, i.e. to the valuation of recreational site characteristics, and the valuation of time as in the case study mentioned below. Like the travel cost method, it cannot measure non-use values.

Procedure:

In the case of studies examining the value of time, the choice among sources of the demanded good or service is a function of the characteristics of the available options. The function has a random, unpremeditated, component which is also believed to be determining the choice.

Validity:

The model can explain the choice between different options based on the valuation of time. However, it cannot explain the total demand for a good or service.

Expense:

The collection of data and modelling can be costly.

Using A Random Utility Model (RUM) to Value the Time Spent Collecting Water: A Case Study for Kenya

In developing countries, many women spend a significant proportion of their time carrying water from sources to their homes. A benefit from installing yard taps is the reduction in travelling time to and from water sources. Calculation of the benefits of saving time from installing a yard tap, requires information on the value people place on time spent hauling water. This is what

the Random Utility Model (RUM) was used to estimate.

Ukunda is a village of 5,000 people close to Mombasa. Residents can get water from three sources: purchase it from water kiosks, buy it from travelling vendors, or use village hand-pumps. Data were collected via a survey on demand for water from different sources, distance and travel time to each source, and socio-economic status of respondents. The RUM required the construction of a statistical model, which allowed estimates to be made of the trade-off between the price of water and time spent collecting it. The study suggested that the value of time spent collecting water was US\$ 0.31 per hour. Interestingly, this is almost 25% more than the market wage rate for unskilled labour in Ukunda.

Source: Whittington et al, 1990.

2.7 Indirect Valuation: Hedonic Price Methods

The Property Price Approach

Applicability:

This method is applicable to all environmental attributes likely to affect property prices such as water supply, noise and air quality. It is relevant to cases where the property market is developed and the property owners are aware of the environmental attributes/impacts and act accordingly. The method cannot estimate non-use values.

Procedure:

The method involves the collection of data on house prices over time and in different areas with similar characteristics. An implicit price for the environmental attribute in question is found by applying multiple regression to the data.

Validity:

Despite difficulties with data collection and analysis, various studies using this method have produced similar results.

Expense:

Large data requirements increase the cost.

Using A Hedonic Pricing Method (HPM) to Value Willingness to Pay for Water Supply: A Case Study of the Philippines

The HPM is used to calculate how much people value different types of water supply equipment, e.g. a private connection to a house; a tap in a yard; or a communal source. This study illustrates that the amount people are willing to pay for housing in different locations is partly based on the availability of different types of water supply. 1,903 households in a very poor area were surveyed, with the head of the house asked about value of the property, nearest water source, characteristics of the house, e.g. number of bedrooms; and location of the house. A statistical regression technique was used to measure the trade-off people made between attractive characteristics of the dwelling including proximity to water sources, and paying rent. The study revealed that willingness to pay for piped water to the house (1995 prices) was as follows among different income groups:

High income households:	\$US 2.62
Middle income households:	\$US 3.03
Low income households:	\$US 1.90

These amounts were additional to current payment for water services. In addition, the willingness to pay for a closer communal source of water was also calculated. Only higher income groups appeared willing to pay for a closer communal source, and only a small amount. This may have been because most of those interviewed lived quite near a communal source. The study shows that the housing market in a poor, rural area of the Philippines does reflect the value people place on different types of water source.

Source: North et al, 1993.

2.8 Indirect Valuation: Hedonic Price Methods

The Wage Risk Premia Method

Applicability:

This method is limited to the valuation of morbidity and mortality risks in occupations. It aims

to find the wage premium for risky occupations, i.e. the extra amount individuals are paid to accept risk. The 'value of a statistical life' has been widely used and applied elsewhere (e.g. to value the health impacts of air pollution as measured by dose-response functions). The method cannot estimate non-use values.

Procedure:

The method uses multiple regression to relate wages and salaries to the factors which influence them. Included in the determining factors is a measure of the risk of accidents. The resulting wage premium can then be related to risk factors to derive a 'value of a statistical life'.

Validity:

Although theoretically sound, labour markets are often not as well developed as the method demands.

Expense:

Data collection and analysis can be time consuming and hence expensive.

Using the Hedonic Wage Method (HWM) to Value Changes in Risk Faced by People: A Case Study in Britain

Many forms of environmental degradation inflict greater risk of illness or death on people e.g. air pollution. To evaluate the benefits of reducing these risks by abating air pollution, we need a measure of how people value a small change in risk. The HWM provides this.

Some people accept more dangerous jobs than others. We would expect these people to be paid higher wages than in otherwise comparable jobs. Empirical evidence on how much more they are paid can be used to measure the value people place on changes in risk. This study in Britain used data from 1970-72 on wages and expected risk in a variety of jobs. The risk variable used was the amount by which death rates exceeded the average due to accidents. Other possible factors explaining changes in wage rates were included in the regression: years of schooling, years of experience, presence of trade unions etc.

The results showed that a change in risk of

death of 0.001 (1 death in 1000 people) resulted in a change in wage of about £890 (1995 prices). Hence, 1000 people in total would pay £890,000 to reduce the risk of having a fatal accident by 0.001. The total change in risk becomes $1000 * 0.001$ which equals 1 statistical life. The Value of a Statistical Life (VOSL) according to this study was, therefore, £890,000.

Careful analysis is needed in order to be confident that the figures suggested are correct. There are many possible sources of bias in the data set, where, for instance, people who are ill change to less dangerous jobs, e.g. in the coal mining industry, ill miners were typically given jobs as office clerks. Despite these limitations, the technique is useful. It does, however, make simplistic assumptions about the workings of the labour market, not least in that people can choose how much risk they expose themselves to at work. It is best evaluated against other techniques used to measure the same value.

Source: Marin et al, 1982.

2.9 Direct Valuation: Contingent Valuation Method

The contingent valuation technique provides a method of estimating non-use values.

Applicability:

The method can be applied to any environmental impact.

Procedure:

The method involves setting up a carefully worded and structured questionnaire which asks people their willingness to pay to avoid (WTP), and/or accept compensation (WTAC) for changes in environmental resources. Responses to these questions can give a preliminary idea of people's preferences. Moreover, the results can be statistically analysed to estimate a mean willingness to pay/accept figure for society for the given environmental resource.

Validity:

Various forms of bias, i.e. the difference between the true value and the value stated during the interviews, have been identified. Two important

biases are 'hypothetical' and 'strategic' biases. Hypothetical bias arises because respondents are not making real payments but answering hypothetical questions: if the size of the bias can be estimated (e.g. by comparing hypothetical and actual payments) then adjustments can be made to expressed willingness to pay. Strategic bias arises if respondents state values which are less than their true willingness to pay, thinking that somebody else will be making the real payment. In some instances people have no idea of the value of the service they are being asked to value, e.g. biodiversity. In these cases, factual information can be provided to the respondent in advance of the valuation question.

Expense:

A reliable survey requires around 1,000 respondents to be contacted. As a result, it can be fairly expensive. But surveys with smaller samples have also been shown to be valid and useful.

Using the *Contingent Valuation Method (CVM)* to Measure Household Demand for Improved Solid Waste Management: A Case Study of Gujranwala, Pakistan

The study aimed to measure the household demand for solid waste collection and disposal in Gujranwala and tested two strongly held but untested beliefs. First, households consider the provision of these services to be an obligation of the government and resent paying for them; and, second, households consider solid waste disposal services less important than water and sanitation services.

The survey was conducted with a random sample of 1000 households (out of a population of 1,000,000 people). Both survey data and field observations indicated that single-family, owner-occupied dwellings are the norm in the city with an average household size of just under 10. Average monthly household income, as computed from survey data, was Rs2,770 for low-income neighbourhoods; Rs3,350 for middle income neighbourhoods; and Rs4,170 for high income neighbourhoods. The average monthly

income for the entire sample was Rs3,330 (around US\$180). Although the actual volume of waste to be disposed is low at 0.50 kg per capita per day, high residential densities result in the generation of considerable amounts of total waste in most neighbourhoods. The funding for solid waste management was Rs28 million, about 17% of the municipal budget for 1989-90 (Rs35 or US\$1.8 per household per month). This level is in line with what is being spent in Jakarta, Bangkok, Kuala Lumpur and Beijing. Only 20% of the total waste generated is disposed of; the rest is left either on empty plots, streets or garbage heaps, or drainage ditches, ponds and canals.

An iterative bidding procedure was used to elicit a respondent's willingness to pay (WTP). The respondent was first asked whether or not he/she would accept the service offered at a given monthly fee. Depending upon a YES or NO response the monthly fee was raised or lowered and the question repeated. A maximum of two iterations were employed. The procedure ended with an open-ended question enquiring the maximum WTP. Those who were not interested in the service at any price were asked the reason.

The results showed that 82% of the households were interested in the improved solid waste service offered and 71% were willing to pay for it. The mean WTP of the latter was Rs11.20 per month. If a zero willingness to pay is assumed for households not interested in the service, the average WTP over the entire sample was Rs8. The results also showed that the mean WTP bid increased with the years of education, the value of the dwelling and the employment of a servant. The results indicate some prospects for limited cost recovery with households currently willing to pay an average of Rs8 per month for improved solid waste services. It is encouraging to note that, contrary to general belief, only 20% of the households considered free provision of solid waste services to be a responsibility of the government; 80% of the households were willing to pay for the improved service. The absolute WTP for the improved service is low, perhaps because

there is no tradition in the city of paying for either public solid waste or sanitation services, nor is there much confidence in the capacity of the public sector to provide better services.

Source: Altaf et al, 1996.

Using the Contingent Valuation Method (CVM) in Project Planning and Evaluation: A Case Study in Orissa, India

About 100,000 hectares of village woodlots (VWL) were planted in Orissa through the Swedish International Development Agency (SIDA) supported Orissa Social Forestry Project during 1984-1992. Many of the plantations disappeared without giving the communities much more than the salaries they received from the project while planting the trees. Others became well established and now benefit the communities greatly, especially by making fuelwood more accessible.

Two CVM studies were carried out in 1993 and 1995 as part of a larger evaluation process. Household interviews were conducted in villages with and without VWL at different distances from the natural forest. The interviews, 170 in the first round and 743 in the second, included detailed questions regarding the use of VWL and natural forests, willingness to pay, fuel use in different seasons specified by kind and source, as well as additional household characteristics.

Villagers who expressed a zero-WTP were asked their reasons for this. In most cases their answer was that they were "too poor to pay" rather than "the government should pay". In order to account for this cash-constraint, the respondents were given the opportunity to restate their bids in terms of labour days. It turned out that in many cases where there was a zero-WTP in terms of money, because of poverty, there was still a positive WTP in terms of labour. The latter was valued at the average market wage. The average WTP per village per hectare of VWL for the 1995 survey ranged between Rs12,125 and Rs126,096. Based on the full cost of the VWL project and supplementary costs of

material and labour, plus the opportunity cost of land and overhead costs for the project, the present cost per hectare was Rs27,400. This comparison meant that 60% of the villages have an aggregate WTP that would cover all project costs and all villages have a WTP higher than the direct costs. This result shows that it is very likely that in some villages, investment in VWL would be a very profitable investment as seen from the point of view of the village community. However, this is not true in all villages, and this is probably an important reason for the failure of some VWL projects.

Given this result, CVM can be more successfully used at the project planning stage rather than for evaluation. Moreover, analysis of the WTP function can shed light on distributional effects of the project.

Source: Köhlin, 1996.

Using the Contingent Valuation Method (CVM) to Value A Protected Tropical Forest: A Case Study in Madagascar

Protecting forests gives rise to benefits from conserving biodiversity and the maintenance of environmental services. However, some costs are borne by local people who cannot use forests for firewood, food, and medicines. The CVM can be used to evaluate these costs imposed on local people. Failure to adequately consider the views of local people, or compensate them, has resulted in the poor performance of many projects.

This survey was conducted in only 351 households in 17 villages by a local NGO well versed in rural survey techniques. These villages lay in a 7 km radius around the Mantadia National Park boundary. The CVM values something which is not traded in a market e.g. the value of forest resources to villagers. In this study, since villagers were more familiar with trading rice than money, rice was used as the common unit. Villagers were asked:

Suppose you are asked to use only the buffer zone set aside for collecting forest products

and for growing crops, and are asked not to use the rest of the forest anymore.

Suppose in order to make up for asking you not to use the forests in the national park, you are given _____ vatas of rice every year from now on. Would this make you as content as before when you could use the forest in the national park?

(Note that since no additional information on possible future plant genetic value of the forest was provided to the respondents, their answers reflected only their current state of knowledge about forest benefits.)

The results indicated that, on average, rice equivalent in value to \$108 per year per household would compensate them for being denied access to forests in the national park.

The CVM is a useful tool for the economic evaluation of national parks, especially if the results can be compared with other techniques. Great care must be taken in conducting the survey in order to avoid biasing the results.

Source: Kramer et al, 1992.

2.10 Direct Valuation: Contingent Ranking

Applicability:

The contingent ranking method can be applied to any environmental impact, although its actual application has been more limited than the contingent valuation method. It can measure non-use values.

Procedure:

Respondents are asked to rank several alternatives for environmental quality rather than express a willingness to pay. The list of the alternatives differs according to the topic of the survey but include some from real markets. The real market transactions in the list provide the “anchor” for the willingness to pay estimate for the environmental resources.

Validity:

Although theoretically valid, too few studies have been conducted to test its empirical validity.

Expense:

Similar to the contingent valuation method.

Using A Contingent Ranking Technique (CRT) to Value the Benefits of Reducing Pesticide Use for the Production of Bread: A Case Study From the UK

The use of pesticides in agriculture has been a topic of concern for many decades. The more scientific evidence is gathered showing levels of high toxicity of pesticides, the more alternatives to pesticides are designed. Some of these alternatives reduce the risk of negative impacts on human health and the environment without any extra costs, while others may result in an increase in the price of the agricultural output in question.

The design of a contingent ranking survey entails a number of distinct stages: first, the focus product is identified; second, the relevant environmental impact and other attributes are selected; third, the levels of those attributes to be presented to consumers are established; finally, the sets of hypothetical products to be ranked by each consumer are constructed. This study was conducted to measure people’s willingness to pay to reduce the amount of pesticides applied to produce wheat in the UK. The focus product whose price changed with different rates of pesticides use was bread. “Number of cases of illness in the general public” and “number of farmland bird species in decline”, determined by the existing scientific evidence, were chosen as attributes of different scenarios of wheat production with different levels of pesticide application. The third and final attribute was the price of a loaf of bread.

A sample of 500 adults, randomly chosen from England, Scotland and Wales, was given a set of four pesticide use alternatives with varying levels of these attributes. The resulting mean WTP per household to avoid a case of ill health was £1.87 and WTP per household to avoid serious decline in the numbers of one bird species was £11.56. The fact that WTP for the human health attribute was less than that for birds may seem counter-intuitive. However, this was

because the human health and bird welfare attributes related to risks on very different scales. The former related to individual cases of morbidity (such as nausea and dizziness) while the latter related to almost certain extinction of a species.

These WTP values have been used as weights to develop a scientific toxicity index of different pesticides, e.g. physical level of impact (say 10 cases of ill health) times the WTP to avoid this impact (£1.87) = £18.7/person. The ultimate policy aim is to make pesticide application choices based on the position of a pesticide in this index. Similarly, differentiated taxes can be placed on different pesticides according to their score in the index.

Source: Foster et al, 1997 forthcoming.

2.11 Criticisms Levelled at Techniques of Valuation

By eliciting values for environmental assets, the techniques described in this Chapter can help answer the fundamental question of how much of our scarce resources should be allocated to the conservation of these assets. There are two competing approaches used to answer that question and, to a degree, criticisms of the techniques reflect a division between those accepting the economic approach, but who are worried by the robustness of the estimates, and those who disagree with the entire economic approach and thus see the techniques as futile. The competing approaches can be identified as:

- ❖ a 'rights-based' ecology approach; and
- ❖ an economic approach.

A rights-based approach argues that non-human biota and maybe even nonsentient things have a right to exist. The implication of this view is that all environmental assets should be conserved, regardless of the cost this imposes on people. An economic approach argues that conservation should be pursued until the point where the costs outweigh the benefits. This recognises the fundamental trade-off that exists when con-

servation is advocated: e.g. preservation of a rain forest imposes a cost on someone who could otherwise convert the land to agriculture and thereby earn money. Conservation implies an 'opportunity cost'. Criticisms of the economic approach include:

a Over-reliance on human preferences

The costs and the benefits of conservation are measured in terms of human preferences. But people may be very poorly informed about the true impact of conservation loss.

In response to this criticism, it is argued that:

- ❖ Economic valuation is not appropriate in all cases of public choice: e.g. paternalism of the State with respect to drugs, alcohol and tobacco. The presumption should be that economic valuation is the relevant approach unless there are good reasons for supposing otherwise.
 - ❖ Information is often no worse with respect to environmental goods than in other markets where 'ill-informed' preferences are the basis of allocation.
 - ❖ Where information is sparse, it can be supplied, as is often the case in contingent valuation studies.
 - ❖ Some techniques explicitly adopt expert opinions anyway: the dose-response technique relies on people to value the effect, without any regard for the effect of the dose of pollution on response. The role of the experts is to convey the requisite information.
- ### b Environmental standards can be set through social agreements

It has been argued that valuation is not needed. Society can simply agree a set of environmental standards. The cost of achieving those standards is then society's valuation of the standard: an implicit valuation occurs. This still begs the question of how the standards are set. There

is no social valuation of the standard. To use the costs of achieving the standard as a measure of the benefits, implies that the cost-benefit ratio of every standard is one, or greater. It follows that all standards are for the best. It is not necessary to revisit any standards and see if they were justified or not. Hence, this argument for implicit valuation does not impair the case for explicit valuation.

c Problem of future generations

Preferences elicited by these techniques, it is sometimes argued, reflect the preferences of one generation only, and thereby exclude those of future generations. However, generations overlap, and therefore the interests of future generations are at least partially included.

d Preference revelation does not capture everything

The techniques advocated above may still only value part of total value. In the context of biodiversity, for example, it is argued that no one really knows what destroying the rain forests will do: the forests are to some extent the lungs of the world and they contain a certain primary value as a sort of glue holding together the life support functions of the biosphere. This primary value is in some sense a pre-condition for the existence of other values.

However, this appears to be an argument about uncertainty. Uncertainty can be incorporated into the decision-making approach, and it need not be the case that because something is uncertain, no action should be taken. Uncertainty is not an argument for rejecting the valuation techniques out of hand. However, to argue that uncertainty implies that there should be no change at all, comes close to saying that all environmental assets have unmeasured values and should therefore be protected, i.e. the rights-based approach. This may be relevant for large changes in the quantity of environmental resources, e.g. no rain forest versus present rain

forest, but it is of little relevance in the marginal decision to develop another acre of rain forest. There are numerous concerns about the robustness and accuracy of preference revelation techniques. But these concerns often apply to other techniques as well (e.g. political voting).

In conclusion, it would appear that despite the criticisms levelled at them, economic valuation techniques are indispensable in making policy decisions on environmental conservation. But it is important to continue to refine these techniques through further research and empirical testing.

2.12 The Cost-Benefit Analysis Framework

Individuals and institutions are used to making decisions on the basis of a balance of gains and losses, advantages and disadvantages. The idea behind such a weighing up is that individuals only do those things that yield them net gains, and that where a choice between alternatives has to be made, they choose the one which offers the greatest net gain. Instead of gains and losses, benefits and costs can be used. This is the simple foundation of cost-benefit analysis (CBA) (Turner *et al.*, 1994).

The basic CBA rule is that an investment is to be judged potentially worthwhile if its benefits exceed its costs, where benefits and costs are defined to include any welfare gains and losses which occur because of the investment. The CBA should also present a comparison between cases “with” and “without” a given alternative. This implies that comparing the net costs and net benefits of a project with the existing situation or baseline is required:

$$\text{Net benefits of alternative A (NB)} = [Ba - Ca] - [Bb - Cb]$$

where *a* denotes alternative A and
b denotes the baseline.

The term ‘costs’(C) include capital investments, operation and maintenance, and opportunity cost of capital, i.e. the revenues which would have accrued if the capital in ques-

tion was used for the next best alternative. Benefits(B) can be straightforward revenue from an investment or the findings of economic valuation studies when non-marketed environmental goods are concerned. Given the shortfalls of scientific and economic data, CBA is a procedure for:

- ❖ measuring the costs and benefits to all individuals, i.e. the society, using money as the measuring rod of those costs and benefits, and
- ❖ aggregating the money valuations of the costs and benefits of individuals and expressing them as a net social cost or benefit.

There are five essential steps in undertaking a CBA. These are:

- ❖ problem definition;
- ❖ identification of costs and benefits of the baseline and alternative A;
- ❖ data collection and analysis (shadow pricing);
- ❖ Net Present Value (NPV) calculation (discounting); and
- ❖ critical presentation and assessment of results.

Two of these steps require special emphasis:

Shadow Pricing

The above discussion on the uses of cost-benefit analysis is familiar in the sense that it is regularly applied by private firms and governments to measure the financial or economic costs and benefits of projects and policies. A less familiar application is cost-benefit analysis of environmental impacts of projects and policies. Extending CBA to account for environmental impacts presents no conceptual problem. The CBA calculates measured benefits and costs and converts them into 'economic' values by correcting for distortions in the market such as taxes and subsidies. Environmental impacts are simply additional costs or benefits. The necessity for

shadow pricing tends to arise more from the fact that they lack associated markets altogether, rather than from the existence of distorted markets.

If the environmental impacts of a project result in damages to goods and services which are marketed, the shadow pricing is straightforward. For example, if scientific data can show that there is a decline in wheat yields due to soil erosion, then the cost of this environmental impact will be lost revenue from reduced wheat sales. In other words, price per tonne of wheat (net of any taxes and subsidies) is multiplied by the reduction in wheat yields measured in tonnes. This assumes that the reduction in wheat yields does not affect the price of wheat.

If the environmental impacts of a project result in damages to goods and services which are not marketed, the shadow prices will have to be estimated using economic valuation methods as discussed earlier. Such estimates depend on individual's willingness to pay to avoid, or willingness to accept compensation to tolerate, the environmental impacts. For example, if scientific data can show that the air pollutants emitted from a paper mill lead to damages to human health, then the cost of this environmental impact will be people's WTP to avoid or WTAC to tolerate these damages.

Discounting

The dynamic nature of economic and environmental costs and benefits is a complex issue within the CBA framework. Conventional cost-benefit approaches would regard £1 of future cost as being of less value than £1 of cost today because of the phenomenon of discounting. There are two basic inter-related reasons to why the discounting phenomenon occurs.

First, treating £1 in year 2 as being the same as £1 received in year 1 implies that society is indifferent as to when it receives the £1. But casual reflection will indicate that this is not so. For, by taking the £1 in year 1 we can put it into a savings account (or some other form of money

investment) and earn £1 plus the rate of interest on £1 by year 2. This means that we shall value £1 in year 1 at more than the £1 in year 2. We would rather have the £1 earlier than later simply because there exists a positive interest rate in the economy. If we argue that interest rates exist because of the *productivity of capital*, then we have one reason for arguing that a given unit of benefit (and cost) is worth less the further and further it occurs in the future. In other words, £1 invested now in real capital assets will be worth £1+r next year, where r is the rate of capital productivity. Hence, £1 now and £1+r next year are to be viewed as equivalent. Put another way, £1 next year is the same as £1/(1+r) now. Estimates of the rate of capital productivity, or more strictly, the rate of return on the marginal project displaced by the expenditure in question, vary.

Second, we could simply observe the behaviour of individuals and conclude that, regardless of interest rates, people do prefer their benefits now rather than later. They could simply be impatient. Or they might think that, as they will be richer later on, the £1 in the future will mean less to them. Hence the earlier the £1 accrues, the more they prefer it. On the basis of either or both these criteria, individuals will have *positive time preference* – they will prefer now to later. We cannot logically exclude their preference about the incidence of costs and benefits through time. In turn, this means that we must ‘discount’ future benefits and costs.

Since we are measuring the costs and benefits as they accrue to the society as a whole, the time preference of the society is what counts rather than the time preference of an individual. This is logical as the lifetime of an individual is much shorter than the lifetime of a society. Hence, it can be expected that individuals will be more impatient than society as a whole. Estimating the rate of time preference for the society as a whole is not straightforward. Pearce and Ulph (1995) show that a rate applicable to the UK is 2.5-3%. Other research suggests public investments should be evaluated at the risk free rate of

return of about 2.5%. (For more information see Pearce, 1993).

Discounting when environmental costs and benefits are concerned is more complex. If the current generations value benefits and costs more strongly now, they would prefer to choose projects and policies which produce benefits now and costs later. This raises the issue of intergenerational equity since most of the environmental costs and benefits of projects and policies are likely to be realised sometime in the future. There are two broad options for accommodating the distant nature of environmental costs and benefits in discounting. The first requires that some intergenerational criterion of sustainability be imposed (such as the requirement for the protection of a minimum number of organisms necessary for the survival of the marine ecosystem), leaving the conventional discount rate unmodified as a means of allocating resources within a generation. The second involves seeking some quantitative adjustment to the conventional discount rate. The problem with the former adjustment is that, as yet, few specific rules for practical operation have emerged. Indeed, it may be that there is no requirement for special rules: each concerned individual simply argues for a ‘fairer’ allocation of resources to the future. The problem with the second approach is that it takes fairly heroic assumptions to make a quantitative adjustment that is other than arbitrary. The discounting problem is not resolved either way in terms of real-world conclusions. If discount rates above 1-2% are used, an issue such as global warming is very unlikely to be seen as significant. Future generations would simply have to bear the cost.

Net Present Value (NPV) is then the discounted value of the benefits net of costs, i.e.:

$$NPV = \sum_{t=0}^{t=n} \frac{(B_t - C_t)}{(1+r)^t}$$

Where C_t is costs occurring between now and t ; B_t is benefits occurring between now

and t ; r is the discount rate; t is year t , and n is the time period over which costs and benefits are discounted.

Hence, the requirement for choosing project x is that $NPV_x > 0$ and that $NPV_x > NPV_y$, where y is the alternative project. Note that NPV_x need not be > 0 if some project has to be chosen. The same relationship can be expressed as a benefit-cost ratio, i.e. the ratio of present value of benefits over the present value of costs (B/C). The requirement for choosing project x is then that $(B/C)_x > 1$ and that $(B/C)_x > (B/C)_y$. Another measure of net benefit is called internal rate of return (IRR) and defined as the rate of return or the interest rate prevailing at the point of break-even when present values of costs and benefits are equal or NPV is equal to zero. If IRR is greater than the market interest rate, this is an advantage for the project.

Case Study:

Agroforestry in Malawi

1 Problem Definition

The rapid disappearance of extensive areas of woodlands in Malawi has been the subject of concern, particularly at the policy and planning levels. However, the evaluation of past projects showed that there was little information on how they related to the wider rural agricultural economy and the costs and benefits of alternative agroforestry projects. This study evaluates a Tree Planting Bonus scheme for *faidherbia albida*, an agroforestry species indigenous to Malawi which can return substantial amounts of nitrogen to the soil.

2 Identification of Costs and Benefits

The principal benefits of an agroforestry system which would increase nutrient availability are increased yields; costs per unit of nutrient that are lower than the costs for chemical fertilizers; lower risks of losing benefits from chemical fertilizers in the event of the failure of rains; improved soil structure due to the addition of organic matter;

and the increased availability of other outputs such as firewood and fodder. The principle costs relate to the relatively long time period involved before benefits are realised, the sometimes labour-intensive requirements of agroforestry management, problems of establishment, and the importance of the timing of the planting.

3 Data Collection and Analysis

Costs

Farmers need a stand of 25 trees per hectare (ha) in order to gain maximum benefits. This costs a total of MK 3 (at MK 0.12 per tree from the Forest Department). In this analysis, it is assumed that 100 seedlings are bought at MK 0.2 (to account for subsidies) plus two days labour to plant and another day of labour per year to protect. Labour was costed at MK 3.30 per person day. The present value of the establishment costs over the 30 years of project life would then total little more than MK40 per ha. Because of higher yields, additional labour of 12 person days per ton for harvesting, and 5.5 person days for shelling, would be required.

Benefits

The yields of local maize varieties would be increased by 15% and that of hybrid maize by 50%, over initial yields of 850 kg and 1,020 kg per ha, respectively. Added benefits which are not considered here include the production of fodder and firewood.

Time Period

It is assumed that the trees will be fully mature in the 25th year. Yield benefits would accrue slowly during the first five years, accelerate between the fifth and 15th years, and then slow down. It was estimated that half of the yield increases would be achieved by the 12th year.

Baseline

To produce similar maize yields using the best crop management and chemical fertilizers instead of *Faidherbia*, a farmer would have to use at least

20 kg of chemical fertilizer nutrient per ha every year. Under poor crop management, as much as 63 kg per ha would be required. At current prices, this would cost at least MK 67 for the 43 kg of urea which would be required in the former instance, or at most, MK212 for the 134 kg of urea which would be required under poor management. Compared with these very high annual costs for chemical fertilizers, the use of *Faidherbia* for increasing crop yields, at a one-time capital cost of MK40 per ha for tree planting, makes an enormous amount of sense.

4 Net Present Value

Based on all of the above assumptions, and a 15% discount rate, benefit-cost ratios of 2.3 and 5.3 could be expected for local and hybrid maize,

respectively, grown under *Faidherbia*, as opposed to the baseline case of chemical fertilizers. Note that a cost-benefit ratio greater than one is sufficient for the agroforestry alternative to be chosen over the baseline. In addition, internal rates of return are 23.8% for local maize and 41.4% for hybrid maize.

5 Sensitivity Analysis

The above analysis is repeated for different assumptions, baseline costs, and time periods for realising the benefits of agroforestry. The results show that the benefit cost ratios are most sensitive to the establishment costs, and to the proportionate increases in yields which could be expected.

Source: Dewees, 1995.

An Introduction to Environmental and Natural Resource Accounting

3.1 Notions of Sustainability

In this Chapter, the literature on two characterisations of sustainability and their measurement is reviewed. The first, strong sustainability, derives more of its foundations from ecological science than does the second, weak sustainability. In each case, the basic idea, as developed in Chapter 1, is that continued well-being depends on the assets available to each generation for generating that well-being. These assets are 'capital' in all its forms. Hence, this total stock of capital must not decline through time unless technological progress is such that it offsets the declining quantities of capital. The fundamental distinctions between the two concepts of sustainability are (Pearce *et al*, 1996):

- ❖ that strong sustainability denies to a greater or lesser extent that there is substitutability between natural assets and other assets – human and manufactured assets; and
- ❖ that strong sustainability tends to stress 'discontinuity' and 'non-smoothness' in ecological systems and, hence, in the economic damages to which ecological impairment gives rise.

No business is sustainable if it fails to put savings to one side at least equal to the depreciation of its capital assets. It is the same for nations. In fact, this is the weak sustainability principle. Savings can be measured from the national income accounts as well as depreciation on human-made capital equipment, although the data are not very good. If we can value environmental depreciation in money terms, the 'savings rule' for sustainable development becomes:

$$S > [D_{Km} + D_{Kn}]$$

and the magnitude:

$$S - [D_{Km} + D_{Kn}]$$

is 'genuine savings'

where

S = savings rate

D_{Km} = depreciation on human-made capital

D_{Kn} = depreciation on natural capital

In other words, the weak sustainability principle allows for a substitution between natural and human-made capital, as long as the total capital stock is non-declining over time.

With strong sustainability there is 'something special' about natural assets. The argument would be, for example, that we cannot substitute for the life-support functions of many natural assets such as the stratospheric ozone layer, or nutrient cycling in an ecosystem. If this is true then there must be certain 'critical' natural assets which can either be conserved at all times in the name of sustainability, or which can be damaged or reduced only after the most careful and cautious consideration. Deciding what is critical is hotly debated: all environmental assets, or just some? If some, which ones? Ecologists sometimes suggest that 'keystone species', species on which the functioning of an ecosystem depends, constitute critical natural capital, but it is not always clear what these species are, nor is it clear that their removal results in non-substitution by some other species. Other approaches suggest that sustainability is best thought of as 'resilience', the capacity of a system to respond to shocks and stresses and to return to some equilibrium path of change. In turn, some ecologists argue that resilience depends on the diversity of species and processes within an ecosystem. Hence one indi-

cator of sustainability, i.e. resilience, would be the diversity of species.

3.2 Measuring Weak Sustainability: Green Net National Product (gNNP)

Gross Domestic Product (GDP) is the value of all goods and services in the economy in a given period such as a year. Gross National Product (GNP) measures the same thing but includes net income from abroad. In the national accounts, Gross National Product (GNP) differs from Net National Product (NNP) by the amount of depreciation on capital equipment. Although GNP is invariably used as a measure of economic well-being, the net concept is more relevant because it allows for the fact that we have to replace worn-out equipment, and only after doing that do we have output that contributes to current well-being:

$$\text{GNP} = \text{NNP} + \text{depreciation on capital}$$

Since environmental assets are also capital, we can extend the definition of GNP to become $\text{GNP} = \text{NNP} + \text{depreciation on human-made capital} + \text{depreciation on natural capital}$

Writing K_M for human-made capital and K_N for natural capital, (respectively, and rearranging the equation to express NNP), we have:

$$\text{gNNP} = \text{GNP} - \text{depreciation } K_M - \text{depreciation } K_N$$

Where the 'g' reminds us it is 'green' NNP. The depreciation on K_N is measured by its 'rental', defined as the difference between the price obtained for the extracted or harvested resource and its marginal cost of extraction or harvesting. R is written for rental. For non-renewable resources we need to calculate R on the extracted resources (Q) but include in the rental, any newly discovered resources (N). So, depreciation K_N for non-renewables is $R(Q - N)$. Much the same goes for renewable resources but this time we have to allow for the fact that instead of discoveries adding to the resource base we have the natural biological growth rate of the resource (G). For renewable resources, then, we

get $R(Q - G)$ as the adjustment. The final formula for 'green' NNP is then

$$\text{gNNP} = \text{GNP} - d(K_M) - R(Q - N)_{\text{NON-RENEW}} - R(Q - G)_{\text{RENEW}}$$

What is the link between gNNP and sustainability? Unfortunately, it is rather complex and we cannot assume that if gNNP is positive and rising, the economy is sustainable. This is why other approaches, still based on gNNP, have been developed.

Case Study:

Applying Green Accounting in Papua New Guinea

Conventional indicators of national income such as gross domestic product (GDP) are typically used to measure economic growth. As discussed earlier, Green Net National Product (gNNP) accounts for the costs and benefits of natural resource depletion and environmental degradation, and can be used to measure sustainable development. This method estimates gNNP and does not estimate the genuine savings rate (discussed later), which may provide a better indicator of sustainability.

Green accounting has been applied in Papua New Guinea. The study estimated Net National Product (NNP), and Green Net National Product (gNNP), which was estimated in two stages. gNNP 1 deducted the costs of using scarce natural resources (gold, copper, silver) from NNP. Costs were calculated as market price minus marginal extraction costs. gNNP 2 deducted the costs of environmental quality loss from gNNP 1. These included losses from land cleared for agriculture, river damming for hydroelectric power stations, and pollution from mining activities. It was more difficult to value than gNNP 1.

The Net National Product (NNP) of Papua New Guinea grew from 1986 to 1988 by some 20 per cent, only to fall by 6 per cent in 1989. It rose again in 1990 by 2 per cent.

gNNP 1 reduced NNP by 1-8% over 1986-1990. gNNP 2 reduced gNNP 1 on average by 2% over the same period.

Green accounts therefore show that Papua New Guinea's income was 3-10% lower than that estimated through conventional measures.

The study concludes that Papua New Guinea grew sustainably from 1986 to 1988 but then may have failed to do so thereafter. However, estimating the genuine savings rate may be a more robust technique by which to judge sustainability.

Source: Bartelmus, 1994

3.3 The 'Genuine Savings' Approach

The genuine savings approach is different from the green NNP approach in that the adjustment for depletion of natural capital and pollution is made to national savings, not to national income. Nonetheless, the genuine savings approach is derived from the gNNP approach. Hamilton (1994) argues that green NNP *per se* is not particularly useful for policy applications, even though it is important to know the true level of income in an economy. The rate of 'genuine savings', i.e. net savings adjusted for environmental degradation has much greater importance. This is based on the principle that the total capital stock should at least remain constant over time. According to this rule, the returns from depreciating natural capital should be turned into savings and hence investments in creating either human-made (weak sustainability) or natural capital (strong sustainability).

Genuine savings can be estimated as:

$$SG = S - dK_M - dK_N - (MCP.E)$$

where SG is the genuine savings and S is the savings as measured in the conventional way; dK_M and dK_N are depreciation of human-made and natural capital, respectively; MCP is the marginal unit cost of pollution; and E represents total emissions of pollutants. MCP.E is therefore the total cost of pollution.

The provisional wealth measures used at the World Bank show an important conclusion: human capital tends to dominate modern wealth.

This is entirely consistent with modern economic growth theory which does indeed suggest that the factors 'causing' economic growth are human and social capital. Therefore, the genuine saving concept can be defined more extensively to include at least human capital. Hence:

$$SG = S - dK_M - dK_N - (MCP.E) + Ed - dKh - NFB$$

where the new elements are Ed: education expenditures, a surrogate for the **increase** in human capital; dKh : depreciation of human capital, usually taken to be zero; and NFB: net foreign borrowing.

Although a positive genuine savings ratio is not evidence by itself of sustainable growth, persistent negative savings rates imply that countries deplete their capital more than they save. This is not sustainable. Hamilton (1994) shows that Britain appears to have persistently under-saved during much of the 1980s. Between 1980 and 1986, genuine savings rates were between -1.6% and -3.1% of GDP. Britain stopped dissaving towards the end of the 1980s. Some of the increase in genuine savings is attributable to a reduction in the value of resource depletion as a result of decreased oil prices.

When a country destroys natural capital in order to export goods and services to another, a question can be raised as to whose national accounts should be adjusted – the exporter or the importer? Hamilton argues that only the country initiating the damage – i.e. the exporter – should adjust accounts, otherwise the resource depletion would be counted twice. The accounts of the importing country can, however, show the extent to which its own sustainability has been secured at the expense of resource depletion in the exporting country.

Preliminary estimates have been made of genuine savings rates in different regions of the world during the period 1980-1990 (Hamilton 1995). These suggest that East Asian, South Asian and OECD countries consistently had positive genuine savings rates, while the Middle

East/North Africa and the Sub-Saharan African regions experienced negative genuine savings rates (in the case of the latter, the rate of dissavings increased substantially during the period). In the Latin American/Caribbean region, the genuine savings rate was positive in 1980-1981, negative in 1982-86, and then positive again from 1987 onwards.

3.4 Potential Uses of gNNP and Genuine Savings

The purpose of estimating gNNP and genuine savings is largely to make the point that incorporating environmental costs significantly changes the picture of progress painted by conventional GNP. Estimates may well be successful in this purpose even if they fail to incorporate all costs and in spite of a high degree of inaccuracy and arbitrariness. The same does not apply where estimates are intended as a tool for policy-making (Lintott, 1996). However, both gNNP and genuine savings adjustments show that policies in many countries have not encouraged even weak sustainability. What sort of policies would help achieve sustainable development? For natural resource management, government rent (royalty) regimes should be designed to capture higher resource rents without unduly penalising extractors and harvesters. Tenurial arrangements or property rights for resource exploiters should encourage efficient production over time. Resource rents should be re-invested in produced assets, human resources or natural capital to ensure that wealth is maintained. For maintaining/improving environmental quality, optimal policies should be implemented at national, regional and global levels. Creating incentives for higher genuine savings also includes micro and macroeconomic policies such as government current expenditure, relative taxation of savings and consumption, positive real interest rates and viability of the financial sector. These and other incentive creating instruments are the subject of Chapter 4.

3.5 A More Technical Note [This note can be ignored without loss of continuity]

Conventional GNP is defined as:

$$\text{GNP} = \text{NNP} + \delta K_m \quad \dots[1]$$

where K_m is depreciation on human-made capital. We need to extend this to allow for natural capital, K_n , and for pollution damage. Take natural capital first. [1] is extended to

$$\text{GNP} = \text{NNP} + \delta K_m + \delta K_n \quad \dots[2]$$

Hence,

$$\text{NNP} = \text{GNP} - \delta K_m - \delta K_n \quad \dots[3]$$

How is δK_n measured?

For **non-renewable resources** for each kind of natural capital (K_{ni}) it is given by:

$$\delta K_{ni} = [P_i - MC_i][Q_i - N_i] \quad \dots[4]$$

where

P_i is the shadow price of the resource (= market price in a competitive economy),

MC_i is the marginal cost of extraction,

$P_i - MC_i$ is then the user cost or royalty on the resource,

Q_i is output of the resource (its 'draw down'),

N_i is new discoveries.

So, the first extension gives:

$$\text{NNP} = \text{GNP} - \delta K_m - \sum_i [P_i - MC_i][Q_i - N_i] \quad \dots[5]$$

where subscript i refers to non-renewable resources.

If $N_i > Q_i$, NNP grows relative to the conventional definition. Otherwise it is less. (Note: the way in which new discoveries are treated here is open to dispute).

For **renewable resources** (subscript j) the principle is the same but we now have to allow for the natural growth rate of the resource $g(X_j)$ and its harvest rate H_j . The net growth $[g(X_j) - H_j]$ is then valued at the royalty $P_j - MC_j$.

This second extension now produces:

$$\text{NNP} = \text{GNP} - \delta K_m - \{ \sum_i [P_i - MC_i][Q_i -$$

$$N_i] + \sum_j [P_j - MC_j][g(X_j) - H_j] \} \quad \dots[6]$$

Note that if the harvest rate exceeds the growth rate, the last bracketed expression is negative and, depending on non-renewable resources, NNP could fall.

For **pollution damage** we proceed as follows. Let D_k be the **flow** of pollution of type k in physical units; P_k is the shadow price of pollution damage (estimated, e.g. by contingent valuation etc.), and MC_k is the marginal cost of pollution abatement. There are **two** effects of pollution: one on households – the disutility of pollution – and this will equal the flow of pollution multiplied by the shadow price of pollution, i.e. $P_k \cdot D_k$; and the other on production and this will equal

$MC_k \cdot D_k$. The **sum** of these two impacts is then:

$$(P_k + MC_k) \cdot D_k$$

and this needs to be **deducted** from GNP to get to NNP. Thus, if $D_k > 0$ there is more pollution and a positive value of damage $P_k \cdot D_k$ to householders and this should be deducted from GNP. Hence $NNP < GNP$. If pollution damage **falls**, i.e. $D_k < 0$, and with both P and MC positive, the expression $(P_k + MC_k) \cdot D_k$ is *negative* and since it is being deducted from GNP the effect is to *add* to NNP. $NNP > GNP$.

So the final expression for NNP is:

$$NNP = GNP - \delta K_m - \{ \sum_i [P_i - MC_i][Q_i - N_i] + \sum_j [P_j - MC_j][g(X_j) - H_j] + \sum_k [P_k + MC_k] D_k \} \quad \dots[7]$$

The Use and Application of Economic Instruments to Promote Environmentally Sustainable Development

This Chapter addresses why environmental degradation occurs, and discusses the policy instruments available to reduce it at the lowest cost to society. It is argued that environmental degradation is the result of people being faced with the wrong prices for goods, or poorly defined property rights. Prices can be wrong either due to the failure of the market mechanism to incorporate the external effects of economic activities, or due to government policies which give wrong incentives. The former is termed 'market failure' and the latter 'policy failure'.

4.1 Market Failure

Markets work best when allocating private goods which are characterised by exclusivity, i.e. anyone who is unwilling to pay the market price for the private good in question is excluded from its use, and by rivalry in consumption (or divisibility). This latter characteristic ensures that a resource can be subdivided such that each individual who is willing to pay for it can exclude all others (rivals) from its benefits. Although there are some imperfections in private goods markets such as government interventions, monopolies and lack of information, on the whole, private goods fetch a price in the market. On the other hand, environmental goods tend to be non-exclusive and divisible (e.g. migratory fish shoals and groundwater reserves); exclusive and indivisible (e.g. closed access to nature reserves and private beaches up to a maximum use level); or non-exclusive and indivisible (e.g. scenic views and clean air and water). Due to these characteristics, markets fail to place a price on environmental goods.

While the market system appears to be highly efficient in the case of priced resources, it fails to correctly guide firms towards the efficient use of

unpriced environmental resources. This market failure arises because firms only take account of the market price of a resource when deciding how much of that resource to use. When a firm uses and degrades an unpriced environmental resource or service (such as the waste assimilation function of water), this incurs no internal (or financial) cost to the firm but it does create an external cost for society. An external cost is the cost which accrues to third parties from the actions of a buyer and a seller and which is ignored by the market. There can also be external benefits, though these are rarer than external costs.

Market failure can be broken down by the size of the market: local market failure refers to the failure within a domestic economy (e.g. no market for good quality water), whereas global market failure refers to the failure arising from a lack of global markets (e.g. no market for biodiversity). Figure 6 shows how market and policy failures lead to the loss of biodiversity due to land conversion (on the horizontal axis), but it is equally applicable to other forms of environmental degradation.

M_{profit} is the marginal private benefit (profit) curve showing that profits decline as more land is converted (marginal means extra: the extra profit from converting one additional unit of land to, say, agriculture). L_{profit} land (the point where M (marginal)profit reaches zero) would be converted if the free market was left to itself. Two factors give rise to more land conversion:

- ❖ infrastructure development – road building lowers conversion costs and hence raises profit margins, and
- ❖ population growth – demand for food rises and hence profit from land conversion increases.

Land conversion imposes local external costs such as greater soil erosion and loss of locally important biodiversity. This is shown in Figure 6 as MEC_{dom} (domestic marginal external cost – i.e. the external cost imposed at the domestic level by an extra unit of land conversion). When MEC_{dom} is taken into account, the optimal level of conversion becomes L_{dom} (where $M_{profit} = MEC_{dom}$). But land conversion also involves other external costs that accrue to people outside the country in question, e.g. scientific knowledge and carbon sinks are lost. We refer to these as global marginal external costs (MEC_{glob}). The local external cost, MEC_{dom} , must be added to the rest of the world externality, or MEC_{glob} . Taking the global externalities into account, the optimal level of land conversion becomes L_{glob} (where $M_{profit} = MEC_{dom} + MEC_{glob}$). Figure 6 shows how market failure occurs when the domestic and global marginal external (or environmental) costs are ignored:

the difference between L_{glob} and L_{profit} represents *market failure*:

the difference between L_{dom} and L_{profit} is *local market failure*

the difference between L_{glob} and L_{dom} is *global market failure*

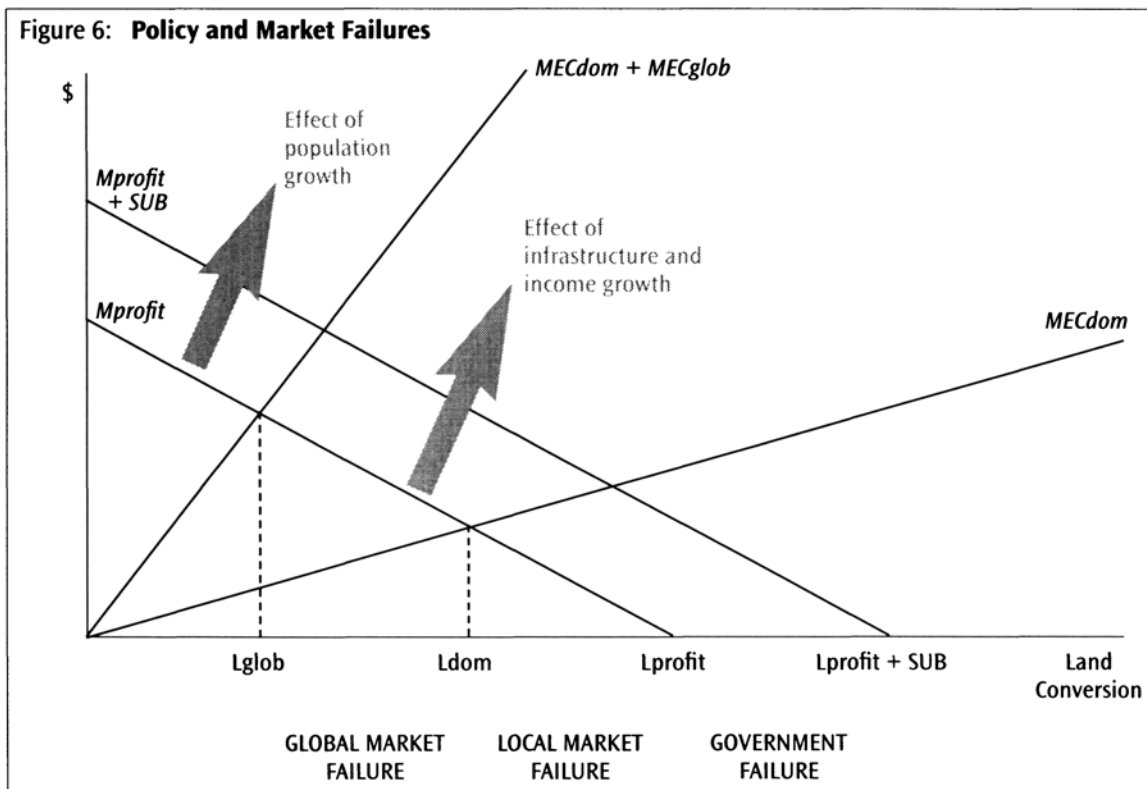
4.2 Policy Failure

Leaving aside environmental issues, in some markets the price charged for goods and services is even less than the marginal (private) cost of producing them. In some cases, this is due to policy (or government) failure. Policy failure occurs when the government creates incentives for prices to be less than the real cost of production:

$P < MC$ for outputs or inputs (where P is the price and MC is the marginal cost of production)

Most of these distortions not only lead to lost revenues for the government but also create neg-

Figure 6: Policy and Market Failures



ative environmental impacts such as the overuse of natural resources. Policies that lead to failure include input subsidies, output price controls, physical output targets, foreign exchange controls, and tariffs. These policies have typically been applied in several different sectors of the economy: energy, agriculture and forestry are notable. As an example of policy failure, subsidies tend to be regarded as being, on balance, harmful for the environment. The reasons are easy to see if we look at Figure 6. For example, subsidies to land conversion cause private profits to increase to $M_{profit+sub}$ and land conversion to increase to $L_{profit+sub}$. Therefore, it can be said that the cause of land conversion between L_{profit} and $L_{profit+sub}$ is *government or policy failure*.

The effect of a **consumer subsidy** is to induce consumers to buy more of the subsidised commodity. If that commodity is environmentally damaging, either in itself, or because it embodies harmful inputs, then there will be more environmental damage as a result. The effect of a **producer subsidy** is also likely to be harmful because it can encourage over-production and, hence, the excessive use of environmentally harmful inputs. Producer subsidies might take the form of input subsidies, such as subsidies to fertilisers, energy, pesticides, irrigation water etc. They might also take the form of guaranteed prices so that the more someone produces the bigger the subsidy they get. Apart from being wasteful in itself, this process encourages 'extensive' production, e.g. in agriculture, rooting up trees and hedgerows to increase acreage to get more subsidies. Other subsidies include those offered to agriculturists to clear land of forest cover and subsidies to mechanised agriculture. It should be noted, however, that some subsidies can be regarded as being 'good' because they reward beneficial behaviour (these are discussed later on). Some forms of farming, for example, are consistent with the conservation of the 'rural way of life'. Subsidies to public transport may help take traffic off the roads, thus reducing congestion and pollution. The precise extent to

which subsidies are good and bad is very uncertain and some would argue for a presumption that subsidies are bad unless proven otherwise.

Boxes 2 to 3 show a selection of evidence on the existence of policy failure. Agricultural price subsidies in Box 2 are measured by the 'producer subsidy equivalent', which is defined as the value of all transfers to the agricultural sector in the form of price support to farmers, any direct payments to farmers and any reductions in agricultural input costs through subsidies. These payments are shown here as a percentage of the total value of agricultural production valued at domestic prices. This implies, for example, that in Mexico in the mid-1980s, agricultural output prices could have been about half of their subsidised level. And in the OECD in 1992, prices could have been about three-fifths of their subsidised level. As P plus subsidy $>$ MC , there is great incentive for land clearance for cultivation. The stumpage fee is the rate charged to logging companies for standing timber. The

Box 2: Evidence on Policy Failure: Economic Distortions to Land Conversion

Agricultural producer subsidy equivalents %

Mexico	mid 1980s	54%
Brazil	mid 1980s	10%
South Korea	mid 1980s	55%
Sub-Saharan Africa	mid 1980s	9%
OECD	1992	44%

Timber stumpage fee as per cent of replacement costs

Ethiopia	late 1980s	23%
Kenya	late 1980s	14%
Ivory Coast	late 1980s	13%
Sudan	late 1980s	4%
Senegal	late 1980s	2%
Niger	late 1980s	1%

Timber stumpage fee as per cent of total rents

Indonesia	early 1980s	33%
Philippines	early 1980s	11%

Sources: OECD (1993); World Bank (1992); Repetto & Gillis (1988).

subsidy is expressed here as a percentage of the cost of reforestation (replacement cost) and as a percentage of total rents. In Niger, for example, the stumpage fee was only 1% of the cost of reforestation, thereby encouraging even greater logging. Moreover, since the government was left with 99% of the reforestation costs, this meant that, given limited budgets, reforestation did not take place.

Box 3 shows examples of input prices being lower than the marginal cost of producing them due to government subsidies. Although governments may justify such subsidies on the grounds of distributional considerations, they certainly encourage over-use of irrigation water and pesticides. Box 4 shows the extent of policy failure in the agriculture sector in OECD countries.

Box 5 summarises tentative estimates of subsidies worldwide. Although these are rough and come from various sources, significant conclusions emerge from them:

Box 4: Evidence on Policy Failure: OECD Agricultural Subsidies

	(Producer subsidy equivalents %)		
	1981-84	1985-88	1989-92
Australia	11	12	12
Canada	30	47	45
EC	32	47	46
Japan	63	74	68
Sweden	38	55	57
United States	27	35	27
OECD	33	46	43

Source: OECD, 1993.

- they are huge in number, being perhaps 4% of the world's entire GNP (which is about \$25 trillion);
- they are some 14 times more than the entire official aid flows in any one year;
- while they exist in developing countries and countries in transition, they are declining quite rapidly (mainly due to structural reforms); and
- the largest subsidies are in the OECD

Box 3: Evidence on Policy Failure: Agricultural Input Subsidies in Developing Countries (late 1980s and early 1990s)

	Irrigation (Subsidy as a % of price)
Bangladesh	82
Indonesia	86
Rep. of Korea	82
Nepal	93
Philippines	78
Thailand	95

	Pesticides (Subsidy as a % of retail cost)
China	19
Colombia	44
Ecuador	41
Egypt	83
Ghana	67
Indonesia	82
Senegal	89

Source: Repetto, 1986, 1989.

Box 5: Provisional Estimates of World Subsidies (\$billion)

Sector	OECD	Non-OECD
Water:		
irrigation	3+	20
sanitation	?	5
supply	?	28
Fossil Fuel	34-52	100+
Nuclear power	9-14	0?
Agriculture:		
pesticides	0?	2?
fertilisers	0?	4
outputs	336	0?
Transport	79-108	?
Total	461-513	159
Grand Total		620-672

countries, especially in the agriculture and transport sectors.

The size of these subsidies casts doubt on the widely discussed 'shortage of finance' for the implementation of Agenda 21, the global programme of action to promote environmentally sustainable development, agreed at the Earth Summit in Brazil in 1992. There appears to be plenty of finance – it is simply in the wrong place!

4.3 Full Cost Pricing

Given that neither markets nor government policies can account for the full costs of using environmental goods and services, the principle of 'full cost' pricing mentioned in Chapter 1 needs to be adopted. Before going into the tools with which full cost pricing can be achieved, let us clarify what we mean by this concept. It means that the price (P) of a good or service should be equal to:

	MC + MEC + MUC
or	P = MSC
here	
MC	Marginal (private or financial) cost of producing an extra unit
MEC	Marginal environmental (external) cost of producing an extra unit
MUC	Marginal user cost
MSC	Marginal social cost

MUC (marginal user cost) is most relevant when the resource in question is non-renewable and scarce relative to demand. It measures the cost of using a scarce resource today at the expense of its future availability and use. It can be calculated as follows:

$$\text{User cost} = \frac{[P - MC(B)]}{(1 + r)^T}$$

Where P is the price of the resource; B is the technology which will replace the current one once the resource is extinct or economically infeasible to use; MC (B) is the marginal cost of the alternative technology; r is the interest rate; and T is the time it takes for alternative tech-

nology to become feasible. User cost is regularly estimated for non-renewable resources.

An Illustration of Full Cost Pricing: The Energy Sector

The energy sector is one of the most important economic sectors as well as a major source of pollution. Therefore, decisions on conserving existing energy sources and creating new ones should be informed by both environmental and financial impacts of each option. Conventionally, such decisions have been based on the financial costs and measurement of emission to air, water and land. However, as discussed in Chapter 2, such a comparison has the shortcoming of having to deal with variables in different units. In other words, how do we know which alternative is better if one reduces the emissions of sulphur dioxide, while the other reduces the emissions of particulate matter? The answer is to measure the value of the relative damages of these pollutants in monetary terms. Since the result is in money terms, the analysis permits direct comparison between the energy generation alternatives in terms of their environmental impacts. The analysis also permits the comparison between private costs (MC) of an alternative with its environmental costs (MEC). This second comparison is especially relevant for the decisions concerning installation of pollution abatement technologies.

CSERGE *et al* (1994) use economic valuation analysis to compare the environmental impacts of renewable energy sources in Scotland, namely wind power, small scale hydro, energy crops, incineration of municipal solid waste and energy recovery from landfill. Three types of environmental impacts are analysed: (i) generic impacts, which do not vary with location, i.e. the emissions of greenhouse gases; (ii) semi-generic impacts, which vary with source and receptor, i.e. the emissions of acidifying pollutants and particulate matter, and (iii) site-specific impacts such as disamenity, noise, odours etc. The first two impacts are quantified in money terms. However, data for the third impact are

not sufficient for a quantified analysis, and hence the site-specific impacts of energy sources are qualified.

Each energy source is compared with a baseline of “no energy generation from that specific source, and hence no impact” and “alternative technologies of generating electricity”, depending on the alternative source. It is assumed that the electricity generated by a renewable source will displace the electricity previously generated by a fossil fuel source, leading to savings in emissions. Such a displaced source is the power station which will be the first to be switched off in the event of an increase in the supply. In the UK and many other countries, this is a coal-fired plant with minimum environmental controls.

Table 5 shows the results of the economic valuation analysis for alternative renewable energy sources in Scotland. The figures are in fact the marginal environmental benefits of renewable energy sources compared to the displaced energy source. Since renewable energy has marginal environmental benefits (MEB) as opposed to marginal environmental costs (MEC), the full cost pricing rule would require MEB to be deducted from the private costs (MC) of renewable energy production. This would then reflect the environmental advantage of renewable energy sources over fossil-fuels in the electricity market.

A number of policy conclusions emerge from Table 5:

- 1 Each renewable energy technology yields

net environmental benefits from generic and semi-generic impacts. This is because the value of the pollution displaced by the technologies greatly exceeds the value of pollution from the renewable technologies themselves.

- 2 The size of the benefit from renewable energy technology is significant.
- 3 A ranking of renewables emerges. While the differences between net benefits for various technologies may not seem large, they can be significant. They suggest that considering generic and semi-generic impacts only, wind and hydro are the most environmentally beneficial technologies in Scotland. The addition of site-specific externalities would reduce the net benefit figures but is unlikely to change the ranking.

Case Study:
Economic Valuation of User Costs – Natural Gas Scarcity in Bangladesh

The economic cost of natural gas is comprised of two parts: the marginal private costs of extraction and supply, and the marginal user cost, or depletion premium. Current consumption of gas is at the expense of future consumption regardless of when it takes place.

This marginal user cost has been estimated for the reserves at Dhaka. Making assumptions about the reserves of gas left, and the price of alterna-

Table 5: The Net Environmental Benefit of Energy Technologies (based on the damage analysis across Europe) (pence/kWh)

Energy Technology	Net Benefits/Costs
Coal Fired Power Plant	(-3.55)-(-5.4)
Wind	3.5-5.4
Small Scale Hydro	3.5-5.3
Landfill Gas Collection	2.8-4.6
Energy Crops	3.1-4.8
Incineration of Municipal Solid Waste	2.7-4.0

Source: CSERGE et al, 1994.
Note: Negative entries refer to net environmental costs. Positive entries refer to net environmental benefits.

Table 6: Market and Economic Prices of Natural Gas in Bangladesh

	all costs 1986 \$/'000 cubic feet		
	residential	commercial	small industrial
marginal user costs	0.06	0.06	0.06
marginal private costs	1.42	0.88	1.65
economic costs	1.48	0.94	1.71
price paid by utility	1.04	1.16	0.92

Source: Julius et al, 1990.

tive fuel, the marginal user cost was calculated to be \$0.06 per thousand cubic feet. Table 6 presents these estimates.

4.4 Correcting Economic Failures, the Polluter Pays Principle and Towards Full Cost Pricing

The polluters pay principle (PPP) is based on the premise that the price of a good or service should reflect fully its total cost of production, including the cost of all resources used. Thus, the use of air, water, or land for the emission, discharge or storage of wastes is as much a use of resources as are other labour and material inputs. The lack of proper pricing and the 'open access' characteristic of many environmental resources causes over-exploitation. Open access means the absence of any ownership right and use regulation, i.e. anyone can use the resource without constraint, increasing the possibility that this will result in complete destruction of the resource. The PPP seeks to rectify this market failure by making polluters 'internalise' the costs of using or degrading environmental resources. The aim is to integrate the use of the environment (as depicted in the 'materials balance' in Chapter 1) into the economic sphere through the use of price signals and the use of economic instruments such as pollution taxes, charges and permits. The use of regulation to internalise externalities is also, however, consistent with the PPP. Essentially an economic efficiency measure, PPP is intended to encourage industries to internalise environmental costs in the prices of their products.

To implement full cost pricing through the polluter pays principle, two steps must be taken:

Step 1: bring market prices to the level of marginal private costs, i.e.

$$P = MC$$

This can be achieved by identifying and removing the policies that lead to policy failure.

Step 2: internalise externalities in order to bring market prices to the level of marginal social costs, i.e.

$$P = MSC = MC + MUC + MEC$$

Prices should be equal to the marginal social cost of the good, which in turn equals the marginal private costs plus both the marginal user and environmental costs. This can be achieved by applying the appropriate market-based instruments and regulations. The steps should be taken in this order, since internalising externalities while the free market price is distorted by a government policy would be fruitless. Moreover, correcting local market failure can have double benefits ("win-win" policies), both in terms of increasing economic efficiency and reducing (even eliminating in some cases) the environmental impacts.

Correcting Policy Failure: Successful Subsidy Removal in Brazil

Box 2 showed that Brazil was paying substantial subsidies to land conversion. This predominantly was in the form of a generous tax credit available to investors who cleared the forest and undertook cattle ranching in the Amazon basin.

The tax credit has been removed by the Brazilian Government, saving it some \$300 million per year, and reducing one of the pressures on the rain forest.

Source: World Bank, 1992.

Correcting Policy Failure: Removal of Pesticides Subsidies in Indonesia

In 1985, the Indonesian Government was subsidising pesticides at 85% of retail price at a total cost of US\$128 million. These heavy subsidies were not only a burden on the government budget but also encouraged excessive use leading to damages to the environment. In November 1986, 57 brands of pesticides, 20 of which were heavily subsidised, were banned. This caused a 90% decline in pesticide use during planting seasons without a decline in yields. On the contrary, the yields increased from 6.1 tonnes per hectare to 7.4 tonnes. In October 1988, subsidies on the remaining pesticides were cut from 55% of retail price to 40%. In December of the same year, the subsidies were eliminated all together. In order to reduce the potential effect of these changes on the farmers' incomes, floor prices for unhusked rice, yellow corn, soybeans and mung beans were raised. This was fiscally possible since elimination of pesticides subsidies had saved the government around \$128 million per year.

Source: Panayotou, 1990.

4.5 Policy Tools for Correcting Market Failure

Command-and-Control Approach (CAC) is the enforcement of environmental quality through the setting of standards which must then be adhered to. Examples of this type of environmental policy approach are widespread. **Market-Based Instruments (MBIs)** are policy instruments that achieve environmental objectives by means of economic incentives to producers to lower their level of pollution or the use of natural resources.

With command-and-control approaches to environmental management, governments either specify the technology that must be used for this

purpose (a technology-based standard), or set an emissions or extraction limit that all sources or users must meet (a uniform performance standard). These approaches can be effective in achieving environmental goals, but tend to be expensive relative to market-based instruments. The government would need detailed information such as cost of compliance with the regulation which is already possessed by the polluters. The advantages of market-based over command-and-control approaches, on the other hand, can be summarised as follows (note that 'the polluter' is used to identify both the emitters of pollutants and users of natural resources):

- 1 Polluters vary in the ease with which they can abate pollution or reduce resource use. Polluters who can easily reduce emissions will have an incentive to do so. Conversely, polluters who find it very expensive to reduce pollution can carry on polluting but pay the financial penalty. However, under command and control regulation, each polluter has to achieve a given standard regardless of the individual cost of doing so. The total costs of reducing pollution by a set amount are usually higher under a command and control system. This has been confirmed by the available empirical evidence.
- 2 Regulations tend to set a floor as well as a ceiling to emission levels. In the command-and-control approach, there is no incentive for the individual polluter to do better than the uniform standard. However, under market-based instruments, where a polluter pays per tonne of emissions, a dynamic incentive is retained to keep reducing emissions.
- 3 If there are many polluters, under a command and control system, the administrative costs of monitoring and enforcing the system can be very high indeed. Regulations work best when they are applied to a few large polluters and users. As pollution increasingly comes from

many small sources, the monitoring costs increase and the effectiveness of the regulation decreases. Market-based instruments can reduce much of the government's administrative costs.

- 4 MBIs can also generate revenue for the government budget. This would be the case if polluters prefer to pay the tax rather than see it as an incentive to reduce their environmental impacts. The twin advantages of market-based instruments – revenue raising and altering incentives to change behaviour – may seem to be in conflict. However, this trade-off depends on how individuals respond to price changes as measured by the price elasticity of demand (i.e. the responsiveness of demand to changes in price). To increase revenue, it is best to raise prices for polluters who will not change their behaviour substantially (demand with low elasticity). But to change behaviour (incentive setting), it is best to raise prices for those who will respond significantly (demand with high elasticity). The revenues collected by MBIs can be invested in environmental protection or could be used to reduce some other taxation to encourage environmentally sound behaviour.

Most MBIs create “win-win” situations for polluters and resource users. This implies that applying these instruments increases the efficiency of economic activity as well as environmental performance. This is not the case with command and control measures. However, MBIs are not always necessarily the best policy response to environmental degradation. Baumol and Oates (1988) demonstrate that in situations where environmental damage can occur quickly and unexpectedly, fiscal instruments may not produce a sufficiently swift response. In these instances, direct government intervention in the form of regulatory controls is necessary. Similarly, if there is a small number of polluters, dialogue and negotiations between polluters and the State

may produce satisfactory results, though the relative strength of bargaining parties is crucial in this case.

It is also the case that, for MBIs to work well, they require a supportive institutional and legal framework. If an economy has a large non-market section of trade, either because of bartering, or because the market trade is illegal, then pricing incentives may not be very useful. Likewise, the role of courts may be important both in legitimising the use of some types of MBI and enforcing sanctions against non-payment. Hence, if the institutional/legal framework is poor, economic instruments should form part of a package of policy measures which include more direct measures. Of course, if institutions are weak, conventional ‘command and control’ policies will not work efficiently either.

4.6 Types of Market-based Instruments (MBIs)

MBIs can take the following forms:

Direct alteration of price and cost levels:

- ❖ Product, emissions and feedstock charges
- ❖ Deposit refund systems

Indirect alteration of prices or costs via financial or fiscal means:

- ❖ Subsidies and soft loans
- ❖ Fiscal incentives such as accelerated depreciation
- ❖ Non-compliance fees
- ❖ Performance bonds

Market creation and market support:

- ❖ Emissions trading
- ❖ Quota auctioning
- ❖ Market stabilisation for secondary materials such as recycled paper

Direct alteration of price and cost levels occurs when, for example, charges are levied on products or on the processes that generate these products, or when deposit refund systems are put into operation. Indirect alteration takes place

when, for example, direct subsidies, soft loans or fiscal incentives are provided to induce the use of environmentally clean technologies. Enforcement incentives can also be put in this category. Market creation is often achieved on the basis of changes to legislation or regulations. Market support occurs when public or semi-public agencies take responsibility for stabilising prices or certain markets. We now examine different types of MBI.

4.7 Charges

Emission charges are levied on the emissions of pollutants to air, water or land and on the generation of noise. They are related to the quantity and type of the pollutant and the damage costs inflicted on the environment. Box 6 shows the basic aims and advantages; best practice conditions; relevance to different environmental media; and limitations to the application of emissions charges.

User Charges have a revenue-raising function and are related to treatment cost, waste collection and disposal cost, or the recovery of administrative costs depending on the situation in which they are applied. They are not directly related to the costs of environmental damage.

Product/Input Charges are levied on products that are harmful to the environment when used in production processes, or when consumed or disposed of. The charge rate is related to the environmental damage costs linked to the target product (see Box 7 for details).

Marketable (Tradable) Permits are environmental quotas, allowances or ceilings on pollution levels. Initial allocation of the fixed number of permits is related to some ambient environmental target, but thereafter, permits may be traded subject to a set of prescribed rules. Thus, the most efficient polluter can abate more than the initial allocation of permits requires, and sell the extra quotas and gain from economies of scale. The less efficient polluter can buy these extra permits and avoid prohibitive costs of abatement (see Box 8 for details).

Individually transferable quotas (ITQs) are essentially tradeable permits in the fisheries sector. They are assigned to fishworkers according to their historic catch, or by auctioning, and then traded.

Deposit-refund Systems involve a deposit paid on potentially polluting products. If products are returned to some authorised collection point after use, thus avoiding pollution and enabling re-use/recycling, a refund is paid (see Box 9 for details).

Performance Bonds are similar to deposit-refund systems and require the payment of a performance bond or security deposit by a mining, logging or other development firm. If activities conducted by these firms do not comply with environmentally acceptable standards (land reclamation, wetland protection etc) then any clean-up or restoration costs are paid for out of the bond/deposit (see Box 9 for details).

4.8 Emission Charges

Case Study:

Combined Effluent Fee-Standard System in Malaysia

In 1975, the production of crude palm oil had emerged as Malaysia's worst source of water pollution, equivalent to the waste generated by 10 million people: almost the entire population of the country. In 1978, the newly established Department of Environment set maximum pollution discharge standards in terms of BOD (biological oxygen demand), but compliance was not compulsory. This gave factories sufficient lead time to develop and commission waste treatment systems. However, to push the industries along in this direction, a small fee was levied for effluent discharges above the prescribed maximum level. This was M\$100 per tone of BOD load above 5000 ppm. In addition, a licensing system was introduced for all factories discharging effluents. The licence fee was also M\$100 per tonne of BOD load, even below the prescribed limit. This gave factories an incentive to reduce their waste discharges as much as possible.

Box 6: Emission Charges

Basic Aims and Advantages	Best Practice Conditions	Environmental Media Relevance	Limitations
savings in compliance costs	stationary point-pollution	water – high	limit on number of pollutants that can be covered
dynamic incentive effect	variable marginal abatement costs between polluters	air – medium	monitoring problems
revenue raising potential	monitoring of emissions is practicable	waste – low	distributional effects
flexible system	potential for polluters to reduce emissions and change behaviour	noise – high	when revenue raised is earmarked, a coherent allocation system is required
	potential for technical innovation		

Source: Turner et al, 1994.

Fees could be waived in return for the conduct of waste treatment research. This resulted in some break-throughs in palm-oil effluent treatment technology. During the second year of implementation (1979), the maximum pollution level was reduced to 2000 ppm and compliance was made mandatory. Licence fees continued to be calculated in relation to the volume of BOD discharged. By 1984, effluent discharges had been reduced to the target level of 100 mg/l. In addition to the use of the polluters pay principle, the following factors played an important role in the success of the Malaysian programme:

- a regular dialogue and consultation with industry in formulating and implementing regulations,
- b an uncompromisingly firm yet fair attitude in enforcing regulations; and
- c fostering the development of waste treatment technology by co-operation between government, industry, universities and research institutions.

Following the success of the system with palm-oil industries, rubber industries were also covered by the same effluent charge system. The economic effect of the system on the palm oil industry has been minimal. According to Rahim (1991) the Malaysian palm oil export sector “lost

only 5% of the value of output as a result of environmental regulations from 1982-86 that reduced allowable BOD discharges by 90%. The crude palm oil sector lost less – only about 1% of the value of production... despite the highly competitive world palm oil market”. In contrast, Rahim found large losses among the primary input producers, the oil palm plantation sector, which bore over two-thirds of the total welfare losses of the industry. Although evidence for this has not been collected, imposition of the charge on BOD load rather than volume of discharge can potentially lead to problems. It can provide an incentive for some firms to dilute their effluent to avoid the charge, without actually reducing the total BOD load entering the river. Another problem with the system is the implicit incentive for inter-media substitution from water to land due to the lower level of charges for BOD discharge to the latter.

The system is still in effect but has apparently lost part of its original rationale (to promote waste treatment facilities) and its potency. With treatment facilities becoming a licensing requirement and standard feature of palm oil mills, the basic charge is no longer enforced. The excess fee for effluents above the standard is still enforced but it is so low that it no longer acts as a compliance incentive: some mills find it more advantageous

to pay the excess fee rather than treat their effluent sufficiently to meet the standard.

Source: ESCAP, 1990, Panayotou, 1995b and Vincent, 1993.

Case Study:

Nitrogen Oxide Charge on Energy Production in Sweden

In response to widespread damage from acidification of soil and water in Sweden, a charge of SEK 40 per kilogramme of nitrogen oxide emitted was introduced in 1992 for combustion plants with a capacity of 10MW or more. This covered the energy supply industry, pulp and paper manufacturers, chemical and metal industries, and the waste sector. The revenue generated by this scheme was redistributed back to the plants in accordance with energy production, i.e. it was not related to nitrogen emissions. Hence the incentive remains for plants to reduce the tax base of emissions of nitrogen oxide by installing de-NO_x equipment. However, the revenues could be redistributed in a manner which is unrelated to both emissions and energy production. This would provide an incentive to reduce pollution both by cutting back total demand for energy, and by installing equipment to reduce emissions from the energy required. The scheme could have established more efficient incentives, but did not because this would have decreased the political acceptability of the project.

Nevertheless, the scheme was very effective in reducing emissions. The parliamentary decision was made in 1990, at which point many firms invested in the relevant equipment, and by the time the tax was introduced in 1992, emissions had already been cut by 35%.

Source: Olivecrona, 1995.

Case Study:

The Potential Benefits of An Effluent Charge to Control Industrial Pollution in Sri Lanka

A key environmental problem in Sri Lanka is the quality of water supply. Industrial concen-

tration around Colombo, with the associated pollution discharges, coincides with the areas of highest population density. Large industries exploit groundwater supplies and government command and control regulations concerning waste water treatment are difficult to monitor and enforce. The Government could place a charge on effluent discharge from industrial sources. This requires information on both waste water flow and pollution concentration. It could monitor pollution levels in emissions, and could estimate approximate waste water flow based on likely industrial need. The burden of proof for the flow could be laid on the industry: either install a flow monitor or accept the government approximation. Depending on the level of charge, this scheme could create incentives for firms to reduce overall water use, and reduce pollution discharged per unit of water used. More recycling of water would occur. The charge will also generate large amounts of revenue: estimated to be \$12 million per year based on current estimates of the charge and effluent discharges, although this does not account for the reduction in discharge that will occur as a result of the charge.

The revenue could be re-distributed in many ways:

- ❖ Reduced corporate tax rate for water use
- ❖ Interest free loans to corporate sector to invest in pollution abatement equipment
- ❖ Lower income tax rates
- ❖ Higher cut off point for tax exemption

No decision has yet been taken by the Government on the proposed scheme. It is thought to be politically unpopular.

Source: Steele et al, 1995.

Issues:

- 1 Which income group benefits most from reducing water pollution? Which groups will pay the costs?
- 2 What difficulties is the Sri Lankan Government likely to face if it decides to go

ahead with this instrument? Which of the revenue redistribution options would best limit these difficulties? Could any of the options make the scheme a political success?

Case Study:

1996 Landfill Tax on Waste in Britain

Waste disposed of in landfill sites can be environmentally damaging. As materials break down, they emit some pollutants, notably methane, and may also form leachate which pollutes groundwater supplies. The British Government has recently introduced a £7 tax per tonne of organic waste deposited to reflect this external cost, and a £2 tax on inert waste. The Government announced two mechanisms to allocate the tax revenues: (1) reducing National Insurance contributions paid by employers and (2) contributing to local environmental trusts set up by local communities to improve environmental quality. The effects of this system on the amount and type of waste disposed of in landfills, employment and local environmental quality remain to be seen.

Source: for initial discussions Turner et al, 1995.

The above is taken from various press releases by the Department of the Environment.

Issues:

- 1 An emissions tax is a charge on each unit of emission released into the environment and equates to the damage each unit of emission will inflict. In the landfill context this would involve charging per unit of leachate and methane released from the site. Why was the deposition of waste at the site chosen as the tax base, rather than emissions?
- 2 The Government choose to re-cycle the revenue to employers to generate jobs. Were wealth re-distribution its prime concern, how else could the money be used? As it stands, what is the likely net impact of the tax on poor people?

Case Study:

Threatened Tax for Emissions in the Mining Sector in Chile

Exxon expanded an open-pit copper mine, which required the stripping of a very large tonnage of material. Before the development, the Chilean Government threatened Exxon that it would be taxed for any water treatment costs resulting from the expected acid contamination from the low grade material dumped in a local water source. The pressure from this threat resulted in Exxon investing in a new bacterial leaching project. The low grade ore, it was treated and the copper removed. The process turned out to be profitable due to the recovery of copper which was previously lost. The example demonstrates the potential economic benefits of building environmental controls into a mining project and is often referred to as a 'win-win' benefit.

Source: Warhurst, 1993.

Issues:

- 1 It may cost the government very little to threaten polluters with a tax, whereas an actual tax can be administratively costly. However a real tax generates revenue. What determines whether a government can achieve the desired result by threat of a tax rather than actually imposing the charge?

4.9 Product Charges

Case Study:

Taxes on agrochemical inputs in Iowa, USA

The use of chemicals (fertilizers and pesticides) in agriculture pollutes groundwater supplies and soil and may leave residues in food. Charges based directly on chemical or pesticide emissions are too difficult to construct; hence, a tax on the purchase of fertiliser or pesticides can be used. This is a useful policy option and it works well if there is a strong link between the tax base (fertiliser/pesticides purchase) and the pollutant (chemicals). The tax provides an incentive to reduce fertiliser/pesticide use and it is hoped that

Box 7: Product Charges

Basic Aims and Advantages	Best Practice Conditions	Environmental Media Relevance	Limitations
reduce use of products and/or stimulate product substitution	products used in large quantities or volumes	water – medium prospect	not applicable to hazardous waste (ban is preferable)
incentive effect	identifiable products	air – high, especially for fuels	low elasticity and substitution possibilities
revenue raising	price elastic demand for selected product	waste -high	seriously inhibit the effectiveness of the instrument
flexibility	substitution possibilities	noise – medium, no practical system as yet	trade and competitiveness implications
potentially applicable to diffuse (non-point) and mobile pollution sources	adapt to existing administrative and fiscal systems		potential administrative constraints

Source: Turner et al, 1994.

this will lead to less chemical pollution.

In this example, the fertiliser purchase tax was set at a very low level: \$0.75 per ton. This reflected concerns about the impact on farming competitiveness. Revenues collected were earmarked for educational funds to teach farming communities about nitrogen application. Nitrogen use per acre fell in Iowa by 14% between 1988 and 1991. It is interesting to speculate on the extent to which this was the result of the tax or the educational programme that tax revenues funded. Farmers, following agents' advice, may have been simply applying excessive quantities of fertiliser in the past, a situation easily rectified by the educational programme and not so much by the incentive provided by the input tax. This is a good example of the importance of utilising the revenues raised by a market-based instrument.

Source: Wexler, 1995.

Issues:

- 1 Product charges proxy emissions charges. What determines how effectively the proxy instrument works?
- 2 Iowa farmers were concerned that a sizeable fee would significantly affect their interstate and international competitiveness. Would the size or the distribution of these

costs be different if, instead of an MBI, the state government adopted a command and control approach, e.g. limiting by law the chemical composition of all bags of fertiliser?

Case Study:

Traffic Control in Singapore

The financial disincentives adopted in Singapore to discourage car ownership include the following:

High import duty on cars: The import duty on imported cars has been 45% of the open market value, net of retailer's margin since 1972.

Additional Registration Fees (ARF): ARF is in addition to the import duty set as a percentage of the cost of the car. The tax was 100% in 1976 and 150% after 1993. In 1994, basic registration fees were S\$1,000 for private cars and S\$5,000 for company cars.

Preferential Additional Registration Fee (PARF): ARF is moderated by application of PARF since 1975. ARF is reduced if an old vehicle is scrapped when a new one is purchased. The intention is both to discourage older, more polluting vehicles and to restrict the second-hand car market.

Certificates of Entitlement (COE): under a quota system introduced in May 1990, certificates are required in order to purchase a car. The government announces how many new cars each month it will allow to be registered, and poten-

tial buyers make a bid. In order to avoid speculation, secondary trading in them is prohibited.

Annual Road Tax: This is linked to the engine size and ranges from S\$0.7/cc for engine size less than 1000 cc to S\$1.75/cc for engine size greater than 3000 cc.

Although effective, the above disincentives are targeted at the ownership of cars whereas the environmental problems related to road transport arise from the use of cars. The *Area Licensing Scheme (ALS)*, established in 1975, is a programme to reduce the use of private cars in the Central Business District (CBD) and its surrounding area. The car owners wishing to travel to the CBD during morning and afternoon peak times have to purchase a daily or a monthly licence. The scheme is enforced by visual inspection at 25 entry points to the restricted zone. At the beginning, car pooling was exempt from the ALS. However, due to difficulties with monitoring, this exemption was abandoned later on. The system is to be improved and extended by the adoption of electronic enforcement mechanisms.

The effect of all the above measures on car ownership and use has been measured in many ways. The number of persons per car actually increased in the years 1975-77, after the introduction of ARF, and in 1986, coinciding with the brief economic recession of 1985-86. The number of licensed cars in 1992 was 32% less than that forecasted without the restraints. The pattern of commuting changed from 46% in public transport, 43% in private cars and 11% in other vehicles in 1974, to 63% in public transport, 22% in private cars and 15% in other vehicles in 1988. Inbound traffic in the restricted zone declined by a daily average of 28% after the 1989 revisions. The average daily decline for outbound traffic was 21%.

Sources: Buchan, 1994 and Olszewski et al, 1993

Case Study:

A Product Charge on Leaded Petrol in Britain

Lead emissions from petrol engine cars have been linked with adverse human health impacts. In

1989, the Government set an excise duty on unleaded petrol some 3 pence per litre lower than leaded petrol. By 1994, this differential had increased to nearly 5 pence per litre. Since value added tax (VAT) is calculated on price inclusive of excise duty, VAT on unleaded fuel also fell. The product charge was very effective in reducing lead emissions since consumption of leaded petrol is directly linked to emissions of lead. Also, leaded and unleaded petrol are 'close substitutes' – people could easily switch from one to the other. Hence, the small fiscal incentive had a big impact on leaded petrol sales and consequent lead emissions. In 1988, 95% of motorists bought leaded petrol. By the end of 1989 that figure had fallen to 72% and by 1993 it was 47% (most motorists still using leaded petrol had cars that could not be converted to run on unleaded fuel). Emissions of lead fell by a similar proportion during this period.

Source: Rajah and Smith, 1994.

Case Study:

A Product Charge on Leaded Petrol in Taiwan

The Chinese Petroleum Company of Taiwan has supplied unleaded gasoline since 1984. In 1988, due to a differentiated tax, unleaded gasoline was NT\$0.6/litre cheaper than leaded gasoline. The price differential was widened to NT\$1/litre in 1989. The goals for promoting wider use of unleaded gasoline are to reduce the lead content of leaded gasoline from 0.12g/l to 0.08 g/l by July 1993, and to 0.0026 g/l by July 1997; to increase market share of unleaded gasoline to 82% by 1997; and ensure that all vehicles run on unleaded gasoline by January 2000. Since 1992, all new cars must use unleaded gasoline and comply with new emission standards. The market share of unleaded gasoline has increased rapidly from 19% in 1990 to 52% in 1993. Monitoring reports by the Environment Protection Agency indicate that the average lead content in ambient air in Taipei decreased from 0.46g/m³ in 1989 to 0.18g/m³ in 1992.

Source: Pan, 1994.

Issues:

- 1 Lead emissions per litre of petrol sold is reasonably constant across different vehicles of different ages. The product charge proxies emissions closely. This is not the case with small particulate matter and nitrogen oxides. What other market-based instruments might be more effective at reducing these pollutants?
- 2 Why did Britain and Taiwan choose to reduce the tax on unleaded fuel rather than increase the tax on leaded fuel?

Case Study:

The Potential Benefit of A Diving Fee for Tourists in the Bonaire Marine Park in the Caribbean

The Bonaire Marine Park attracts scuba divers from all over the world. However, increasing ecological damage is being done to the coral reef. Economic instruments – namely a site entrance/diving fee – can be shown to both increase the effective carrying capacity of the site, by generating incentives to allow divers into the water but with less environmental damage, and generate income. This is simply a product charge, where the revenue generated pays for the park's management, and ensures that a larger share of the economic benefits remain within the Bonairean economy.

The current approach to development in the island is based on the assumption that since the benefits which accrue to the economy of Bonaire from each tourist are relatively small, increasing the volume of tourists would increase total benefits to the economy. However, it is increasingly feared that this policy is unsustainable.

A study team of ecologists and economists sought to find out how the benefits to the island could be maximised in the long term. The ecologists estimated that only 4500 dives should be allowed every year in order to conserve the reef. The economists, using a CVM technique, suggested that an undifferentiated fee of some \$40 a dive would be sufficient to attract only 4500

dives a year. A current fee of \$10 a dive was attracting some 18,700 dives per year.

The ecologists suggested that less damage would be done if the dives were spread out over the year rather than concentrated in one season. If all the 4500 dives took place in a short period of time, i.e. during the height of the summer, then the ecology of the reef would be damaged more than if dives were less concentrated.

The fee could therefore be differentiated by the season. A fee during the height of the tourist season would be significantly more than during the low tourist season. Depending on the level of fees chosen, the revenue generated by the differentiated scheme would be broadly similar to that collected under the undifferentiated scheme, but less environmental damage would be done.

Source: Dixon et al, 1993.

Issues:

- 1 The damage to the coral reef per dive is not the same across all dives. How effective would an undifferentiated diving fee be?
- 2 Who gains and who losses from the fee?

Case Study:

Royalties in Forestry Sector in Malaysia

Although forestry is a major source of income for the Malaysian economy, the ability of State Governments to capture a sizeable part of the rents in the sector varies. Royalties assessed on extracted volume constitute between 17% and 90% of the total forest revenue collected in the various states. Royalties vary by species or species groups and by State; however, they remain uniform within each State.

It is generally believed that the State of Sabah captures one of the highest levels of rent, which ranged from 46% to 81% in the 1966-89 period. The range of variation reflects the uncertainty in the data base and the fact that records of buyer and seller countries provide different figures. By comparison, only 6-14% of total rent is captured by the State of Peninsular Malaysia.

Although the rate of rent capture is important, its effect is more profound when coupled with the period of concessions. If the period of a concession is relatively short, and rent capture is high and expected to be even higher in the future, the logger will have an incentive to harvest the forest as fast as possible. On the other hand, stable rents coupled with longer term concessions would provide an incentive for more stable and sustainable harvesting rates.

The National Forestry Council has recently acknowledged this and agreed to the proposal by the Federal Government that logging concessions should be on a long-term basis, as has been the case in Sabah and Sarawak. It has been agreed that concessions (of a minimum of 9000 hectares) should be granted for a minimum of 30 years with an option to extend them by another 30 years, subject to good performance of the concessionaire.

4.10 Marketable Permits

Case Study:

Using Marketable Permits in New Zealand's Fisheries

Until 1978, New Zealand's fishing industry was an 'open access' regime. This was coupled with a

Government policy to encourage investment in the industry through a variety of fiscal measures. This resulted in over-fishing and major stock depletion.

In 1978, the Government introduced some controls to restrict entry for some types of fishing, but it unfortunately did not restrict the amount of fish that licensees could take. Stocks continued to decline.

In 1983, the government introduced an *individual transferable quota (ITQ)* scheme. This was designed to create property rights and, as long as the Government set a prudent total allowable catch, would create the incentive for an efficient and sustainable fishing industry. The authorities freely distributed quotas among fishworkers, based on historical catch, and each quota allowed a fixed tonnage of fish to be taken. All the quotas taken together equalled the total allowable catch judged by Government marine experts to be sustainable. A comprehensive administrative system was installed which allowed the Fisheries Board to monitor fishing from the catch through to sale to retailers. The amount of information on stocks and fish demand available to the marine experts improved dramatically.

Box 8: Marketable (Tradable) Permits

Basic Aims and Advantages	Best Practice Conditions	Environmental Media Relevance	Limitations
savings in compliance costs	differences in marginal compliance costs	water – low	limited applicability to more than one pollutant simultaneously
can encompass effect of economic growth	maximum ambient pollutant concentrations are fixed	air – high	pollution 'hotspots' may be exacerbated
flexibility	number of polluters large enough for market to form and operate	waste – low	initial allocation of permits requires careful consideration
international pollution abatement	better applied to fixed pollution sources potential for technical innovation	noise – low	administrative complexity high transaction costs if there are many polluters low levels of trading of permits in the existing US systems

Source: Turner et al, 1994.

But in early 1989, it was clear that certain key stocks were declining rapidly. Too many quotas had been distributed in 1983. The Government therefore decided to reduce the TAC and compensation had to be paid to fishworkers. The change proved to be politically difficult. The risks transferred from the government to the industry, but as a result of a lengthy and bitter dispute, the government was forced into paying the fishworkers significant amounts of compensation.

Some 80% of quotas have changed hands since 1983. About 10 major holders now own around 80% of total quotas. Laws prevent any one owner from having more than 35% of quotas.

Despite many other complicating factors, this scheme has enabled the Government to keep a tight control on fish stocks. Large amounts of information are now available which enable it to effectively control the total available stock. While the scheme has proven to be successful in New Zealand's domestic waters it does not apply to international waters. Since other countries are able to fish freely in these waters, New Zealand fishworkers have no incentive to lower their takes.

Source: Clark, 1991.

Case Study:

Using Marketable Permits for Fishing in Australia

In the mid-1980s, Australia and Japan entered into an agreement which divided the southern bluefin tuna fishery and introduced an individual transferable quota (ITQ) scheme. In the two years following the start of the ITQ system for that fishery, the number of boats in use dropped by 50%. Researchers estimated that the capital so employed in the boats was \$10-12 million less than under other management schemes. The system also encouraged catches of larger, more valuable specimens; the value of the catches increased by three to four-fold. Highly esteemed by sushi diners, a premium bluefin can sell for between \$6,500 and \$11,000 at auctions in Tokyo.

A general question, which applies to other countries, is whether a monopoly would be likely

to take over commercial fishing under an ITQ system? Thus far, this seems not to have occurred. When such concentrations appear likely, governments could make use of antitrust laws, impose taxes, place limits on quota transfers and levy user fees on windfall profits.

Source: Resources for the Future, 1996.

Case Study:

Using Marketable Fishing Permits in Bangladesh

Bangladesh has tried a number of different MBI approaches to manage open access inland fisheries known as *jalmahals*. The earlier policy was a leasing system based on yearly auctions to the highest bidder. This failed to reduce rent dissipation and open access since the licensees were non-fishing middlemen who then collected tolls from fishworkers that could be as much as one-third of the gross catch. These middlemen rigged the auction to keep prices down and the short period of licences, with no assured renewal, led them to maximise revenue by allowing as many fishworkers as possible to fish. In 1987, the New Fisheries Management Policy was introduced to redistribute the fishery rents to actual fishers by a licence system for fishworkers. The licence fee is set to cover administrative costs. This scheme has proved much more popular with fishworkers who now have incentives to self-regulate against entry by non-licence holders.

Source: Siddiqui, 1989 and Naqi, 1989.

Issues:

- 1 In New Zealand, the quota scheme has worked well in domestic waters. The Government has no incentive to extend the scheme to international waters because any self-restraint on New Zealand's behalf is profit to other countries. How should international fish stocks be protected?
- 2 The efficient solution offered by tradable permits assumes that the permits are freely traded in an open market. However, despite concerns about equity, economic theory

shows that were a monopoly present, MBIs are still useful as long as the gains to society from reducing fishing are larger than the costs to it from a monopoly preventing competition. Would a command and control type of regulation which limited the size of fishing vessels be any better?

Case Study:

Using Tradable Water Rights in Chile

Chile has both a system of tradable water rights and pricing at marginal cost. Individuals are granted perpetual, irreversible and freely tradable water use rights independent of land ownership and use. Water use rights are defined for a fixed quantity per unit of time and are awarded following application by a potential user. The General Director of Water grants the water right provided that (a) the new water right does not impair any existing rights and (b) an ecological threshold for the volume of water resources is not exceeded.

Water rights are freely tradable and the market is quite active. Seasonal water rentals are particularly frequent within the agricultural sector. Individual negotiations determine the price of each transaction.

The system allows demand management to accommodate growing water scarcity. Water users receive a price signal indicating the true opportunity cost of water and are thereby induced to adopt conservation measures. However, unregulated water markets may fail to internalise externalities such as minimum flow requirements, water quality changes, return flows and watershed protection which requires integrated watershed/river basin management. To deal with these externalities, a number of proposals are being considered including: (a) charges for new water rights; (b) a 5 year limitation or an annual charge for unused water rights (varying according to regional water scarcities); (c) guarantee of an ecological minimum water flow by the regulator and (d) the establishment of watershed management corporations to resolve intersectoral water

use conflicts, and improve water quality management and watershed protection, all of which are expected to be self-financing.

Source: Panayotou, 1995b and Hartje et al, 1994.

Issues:

- 1 What are the pros and cons of each of the four proposals suggested to internalise externalities such as watershed management?
- 2 How can water be priced more efficiently without hurting poorer income groups?

4.11 Deposit-Refund and Performance Bond Schemes

Case Study:

Deposit-Refund Scheme in the Republic of Korea

The purpose of the deposit refund scheme is to promote the use of returnable packaging and thus reduce the amount of waste. Prior to the introduction of a Government scheme, a market-based deposit refund scheme existed for glass bottles in Korea. It was designed to promote the re-use of glass bottles. Consumers deposited 6-25 US cents for each purchase of bottled beer and soft drinks. The deposits were refunded when the empty bottle was returned to retailers. The average recycling rate on beer and soft drinks bottles was approximately 90%.

The Government-initiated system was introduced in 1991. It is very different from the private scheme in that the responsibility for collecting and treating waste is assigned to producers. The producers of the product are required to deposit a certain amount of money for each unit sold. The size of the deposit is generally quite small. Once producers have safely treated the waste, their deposits are refunded. When items covered by the deposit refund scheme are not treated or recycled, the deposit stays with Government and can be used to finance recycling projects.

The deposit refund scheme covers five items which are either hazardous or generate large

Box 9: Deposit-refund Systems and Performance Bonds

Basic Aims and Advantages	Best Practice Conditions	Environmental Media Relevance	Limitations
Safe disposal, refuse or recycling of products and sustainable utilisation of natural resources flexibility rewards appropriate behaviour	hazardous or difficult components of the waste stream causing disposal problems markets for recyclable materials exist cooperative arrangements between producers, retailers and users development contracts allowing for performance bonds to be paid	water – low air – medium waste -high noise – not applicable	logging and mining – high set up costs, distribution and refilling costs for deposit refund systems possible trade implications difficulty in monitoring performance for performance bonds

Source: Turner et al, 1994.

quantities of waste after being used by consumers. The policy objectives of the system are to promote recycling (e.g. bottles, cans etc) as well as ensure safe disposal of hazardous wastes (e.g. batteries, lubricating oils etc).

Table 7 shows the empirical data available on the government scheme. The second year of implementation produced a much larger refund rate. The scheme is generating significant revenue. In 1993, Won 28.4 billion (US\$ 35.9 million) had been deposited, and only 8 per cent was refunded.

The refund rates on batteries and lubricating oils are relatively high, but those for insecticide and containers are still low. This discrepancy in

rates results from a number of factors, including the relative difference between refund and producer cost, the ease with which final consumers can return waste, and familiarity with the scheme.

Source: Hoe-Seog Cheong, 1996

Issues:

- 1 How could the Government increase the environmental effectiveness of the scheme? Could it both increase government revenues and improve the effect on the environment?
- 2 Why did the market scheme resulted in a much higher return rate than the government scheme?

Table 7: Deposit – Refund Systems in Korea

	1992 – million Won			1993 – million Won		
	Deposits	Refunds	Refund Rate (%)	Deposits	Refunds	Refund Rate (%)
Food, cosmetics, soft drink containers	16,481	238	2	17,365	261	1.5
Batteries	1,069	23	2	1,100	587	53
Tyres	1,792	–	0	1,415	583	41
Lubricating oil	2,738	39	1	2,591	796	31
White goods (e.g. refrigerators)	3,592	–	0	3,496	1	0
Insecticide	1,732	–	0	2,458	2	0
Total	27,406	300	1	28,425	2,230	8

(Note: 1000 Won=US\$1.25)

Case Study:***Deposit-Refund Schemes in Denmark***

Denmark's scheme has been remarkably successful in promoting the use of returnable beverage packaging, thus reducing the amount of packaging waste. Approximately 99.5% of bottles are returned, with each bottle making an average of 33 trips.

Danish legislation allows only carbonated soft drinks and beers in returnable packaging to be sold in Denmark. Until recently, the deposit between bottler and retailer, and between retailer and consumer, has been the same. But some retailers, who returned more empty bottles than they received from the bottler, complained that they were not being compensated for the additional handling costs.

The scheme costs the Government very little, as it is almost entirely implemented by the private sector. However, the scheme does have negative aspects. It places a great burden on the retailer with respect to handling and storage. At least some of this burden is passed on to the consumer in the form of higher prices. The costs of running the scheme have never been estimated. The scheme only covers certain products: carbonated soft drinks and beer, but not milk. The rationale for this is not clear.

Source: Brisson, 1993.

Issues:

- 1 Denmark has a long tradition of voluntary re-cycling schemes, and the Government introduced the measures without opposition. What in practice may limit the ability of a government to introduce such a scheme?
- 2 Compare this scheme with the Korean scheme. Why has this scheme been so much more successful?

Case Study:***Deposit Refund System in the Maldives***

The littering of beaches with beverage containers can become a problem, especially in the outer

islands of the Maldives as tourism expands. A private company producing beverage containers has been implementing a deposit-refund system voluntarily, which covers tourist resorts, retailers and households in Male, the capital. The system has not been as effective in outer islands since transport to the bottling plant has proved too costly for small retailers. Tourist resorts are less affected by the transport costs due to the large scale of their purchases and their need for regular travel to buy other supplies.

There are two other threats to the success of the deposit-refund system: imported aluminum cans and plastic bottles. An earlier attempt to collect the former and export it has failed due to the importer's withdrawal. Although the price of glass bottles net of the deposit is lower, difficulties with the return of glass bottles may lead to a switch towards cans and plastic bottles.

Issues:

- 1 What kinds of pricing measures can be used? What would be the likely effect of imposing an even higher deposit or a tax on cans and plastic bottles?

Case Study:***Performance Bonds in Australia***

Successful rehabilitation from a mining scheme begins at the beginning of the project and not the end. This system requires the mining company to deposit a sum of money in the form of a bond with the mining ministry at the beginning of the project. The sum is returned if the company complies with regulations concerning rehabilitation on the basis of explicit environmental criteria during the operation phase.

The details of the schemes vary. Some are more tailored to site requirements than others, and also vary in the terms and conditions of penalty clauses. Without such a bond, Australian mining firms cannot get an operation or exploration licence. There appear to be little data on their effectiveness to date. But the level of compliance seems to be high.

Source: Brisson, 1993.

Issues:

- 1 In what other sectors of the economy could deposit-refund/performance bonds be introduced?

4.12 Subsidies for Environmental Improvement

Subsidies to induce environmental improvement are rarely justified but may be used when it is necessary for transition to a new regime of pricing. Whereas an environmental charge is placed on the good generating the pollution, a subsidy is given to a technique that does not generate as much pollution. For example, if a particular method of processing coffee generates a great deal of water pollution, while an alternative technique produces less pollution, but at higher cost, this more expensive technique can be subsidised so as to tempt producers away from the other more polluting technique. Whenever subsidies are needed, it is crucial to select the most cost-effective type of subsidy. This depends on the subsidy vehicle, size of the subsidy and length of the subsidy. Generally, price subsidies are least efficient, while subsidies for training and investment in technical efficiency are the most cost-effective. Whatever their type, subsidies should be a short-term measure as this creates incentives for private producers to become commercially viable. Subsidies should not cover the entire costs of the activity. Complete subsidies become an easy source of funds rather than incentives for a certain action. These types of subsidies can quickly become a source of government failure as discussed earlier. Subsidies should be targeted to the groups who are most in need of them and who can use the subsidy to achieve better environmental performance in the most effective manner.

4.13 Environmentally Friendly Subsidy: Some Examples

Small-scale tree planting for community forestry or village woodlots that supply local domestic

demands for fuel are rarely profitable without government support. Any subsidy must be carefully targeted, as free distribution breeds indifference and over-use. The West Bengal forest department has successfully subsidised household seed banks that have combined environmental aims of raising 15,000 seedlings with providing landless farmers with Rs 3,000 per household. The government also set up a committee of local people who, in exchange for protecting forests from poachers, are collectively entitled in total to 25% of net sales of timber.

Source: Roy, 1994.

India has reduced excise tax on pollution abatement equipment from 25% to 15%. It has also increased depreciation allowance from 30% to 50%.

Source: World Bank, 1991.

In Taiwan, all pollution control equipment (including parts and components), upon proof of application, is exempt from import duties. Domestic manufacturers who have invested more than NT\$600,000 in the installation of pollution control facilities or technology during a fiscal year are eligible for a 20% tax reduction on the overall installation costs incurred. Overseas manufacturers are eligible for tax reductions on the transfer of pollution control technology.

Source: Pan Tin-Bai, 1994.

Much of the environmental damage caused by small-sale mining is because of the primitive techniques used, such as the inefficient use of mercury in gold mining. This damage could be reduced by appropriate subsidisation of capital for new techniques. In Mexico, lower-interest rate credit facilities for small-scale miners are provided by the government with the support of multilateral lending institutions.

Source: Proops et al, 1993.

In Costa Rica, loans have been made available for ecological projects such as the provision of new technology for coffee processing. These loans have an interest rate 2% below the rate for current agricultural lending.

Source: Segura, 1993.

Issues:

- 1 What precautions should be taken to avoid environmentally friendly subsidies turning into government (policy) failures?

4.14 Property Rights Reform

It can be argued that the lack of ownership of many environmental assets creates the precondition for market failure discussed above. Indeed, many economists would attribute 'market failure' to the absence of property rights. If ownership of an asset does not exist, this open access resource can be used by anyone, at any time, and for any purpose. So long as the uses and the technologies employed do not impinge adversely on each other or on the well being of future generations, economic scarcity does not arise and no issue of management per se arises (Convery, 1995). But the rationale for environmental management rests fundamentally on the point that for many assets economic scarcity now exists. The number of users and their value systems and technologies are such that, if these assets remain as open access resources, they will be destroyed (Convery, 1995). The following is a summary of ownership systems, each of which can lead to market failure:

Open access: There are no defined users or owners. Under an open access regime, there is no incentive for any one user to protect the resource unless all the users protect it.

Common property: A management group has the right to exclude non-members. Non-members have a duty to abide by the exclusion. Co-owners comprise the management group and have rights and duties with respect to the use of resources. Many argue that local communities best understand their own environment and are best capable of managing natural resources in a sustainable way. There is evidence which shows this to be the case. There is also evidence to show that community management can fail when: (1) there is high population growth which puts pressure on existing resources, and (2) technology induces overuse of resources.

State property: Individuals have a duty to observe the rules of resource use determined by the controlling agency. For state ownership to work efficiently, the state must be able to monitor the use of resources, establish rules acceptable to individuals and communities, and enforce those rules. Typically, this has not been the experience with state ownership.

Private property: Individuals have the right to undertake socially acceptable uses, and the duty to refrain from unacceptable uses. Others have the duty to respect individual rights. This is likely to conserve the resource since the owner would be able to receive the benefits of conservation. However, markets will still be unable to account for externalities as discussed above.

Once property rights are defined, ensuring that the land is used in a sustainable manner becomes the next priority. This is particularly important for biodiversity conservation. For ecological and economic reasons, it is more cost effective to conserve habitats rather than species. Hence, biodiversity conservation becomes a land-use issue. The idea of tradeable development rights is based on the practices adopted in the UK and the USA. In the UK, conservation agencies buy land or buy rights to use the land; specify the conditions of use of land by excluding environmentally damaging activities; and resell or rent the land with these restrictions attached. This is known as covenant or easement. The practice in the USA is similar.

Tradable development right schemes can be effective instruments in sensitive areas threatened by development. The owners of land in conservation areas are permitted to exercise their development rights ex-situ – in another area designated for development. Alternatively, they may sell these rights to the highest bidder. In this manner, society benefits by preserving environmentally sensitive areas without depriving their owners of their legitimate rights, and without paying astronomical sums in compensation.

Case Study:

Property Rights to Land and Productivity

Migot-Adholla *et al* (1991) provide the most comprehensive investigation of the impacts of property rights system on productivity in Africa (referred to in Convery, 1995). The study surveyed 940 households practising rainfed agriculture in Ghana, Kenya and Rwanda during 1987-88. Data on the socio-economic characteristics of households and the parcels farmed by them were gathered including how the land was acquired and what rights the household could exercise. The following taxonomy was used:

Limited transfer. No permanent transfer of alienation rights. May have temporary transfer privileges.

Preferential transfer. May be permanently transferred but only within the family or through gift or bequest.

Complete transfer. May have the right to sell, i.e. private property right.

The evidence from Ghana and Rwanda supports the hypothesis that increased population pressure and commercialisation increase the extent of privatisation of property rights. To test the relationship between land rights and land productivity using parcel level data, they estimated regression equations relating yield to a vector of household, parcel and land characteristics. The authors found no relationship between land rights and productivity in Ghana and Kenya. In the case of Rwanda, they found that short-term use rights (mainly rented land) were more productive than parcels in all other land rights categories. No significant relation was found between the use of formal credit and the proportion of land held with private property rights. In Rwanda and in one region of Ghana, a positive relation existed between investment in improvements and the extent of land rights.

These African findings are in sharp contrast to those recorded in studies of the effects of a World Bank-supported land titling programme in Thailand. Angus-Leppan (1989) carried out statistical analysis ex-post. Table 8 shows the

categories of land analysed and changes in the annual yields as a result of titling.

Table 8: Impact of Land Tenure on Production in Thailand

Property right	Production (Baht/Rai)	Annual Increase Yielded by Titling (%)
encroached state land (state)	998	18.9
undocumented land (open access)	1,020	16
certificate of utilisation	1,122	5.4
Title deed (private property)	1,183	0

Source: Convery, 1995.

Issues:

- 1 How do you think the striking gains achieved in Thailand and their absence in the three African countries can be explained?

Case Study:

Failure to Assign Property Rights and Share Revenues Equitably in Ecotourism – the Galapagos Islands, Ecuador

The Galapagos Islands of Ecuador are an example of state management of an open access ecotourism site. The islands are situated about 1000 km off the South American coast and have been the concern of naturalists due to their species endemism since Darwin's first visit in 1835. The Ecuadorian government declared the Galapagos a National Park in 1959, which now covers 92% of the 8000 km² land area. The rival economic activity to ecotourism is agriculture.

The Government bans substantial tourism infrastructure development on the Islands. Visitors have to eat and sleep on the cruise ships which transport them around the Islands. The park authorities charge large tour boats a concession fee and regulate prices, service quality, itineraries and boat capacity. In addition, the Government also charges a \$40 park entrance fee for foreigners and \$6 for Ecuadorians.

Despite these regulations, state management fails to establish sustainable tourism, because:

- i There is no effective control on the total number of tourists visiting the Islands, which has increased dramatically with the opening of the second airport in 1986.
- ii Only 25% of the park revenues are kept by the Galapagos park authorities to pay for the park guards and three patrol boats. Moreover, research showed that the entrance fee can be increased to over \$500 without decreasing the number of tourists substantially.
- iii Due to the ban on tourism development on the Islands, the local community earns very little income from tourists. Nor does it receive a share of the park revenues.

Particularly as a result of the last failure, the local population is switching to agriculture as an income earning activity. The problem is that agriculture poses an even greater threat to the endemic species than tourism. Research shows that 12 endemic species of plants will become extinct if agricultural activities expand at the rate they have until now.

The Government could take the following steps to make tourism more sustainable:

- ❖ Increase the park entrance fee in order to prevent the number of tourists from increasing any further, while at the same time increasing revenue.
- ❖ Enable the local community to participate in providing services for tourism by allowing it to operate local tours and/or small scale developments on land; and allocate a proportion of park revenues for the local community's development. This will help to ease the pressure to expand agricultural activities.
- ❖ Transfer a larger share of the revenue to the park authorities so that regulation and management duties can be undertaken more effectively.

Source: Steele, 1995.

Issues:

- 1 The case study shows that the local community has little incentive to support ecotourism since it does not share in its benefits. Is the fact that the National Park is owned by the state rather than the community or private individuals a part of the problem? If so, what measures might be taken to solve the problem?
- 2 Increasing the entrance fee will have some impact towards preventing the numbers of tourists increasing any further. What other measures will enable the Galapagos Islands to practise sustainable tourism?

Case Study:

Using Property Rights in Ecotourism Policy – CAMPFIRE Programme in Zimbabwe

Traditionally, national wildlife reserves have been owned, controlled and managed by the Government. The objective was, at least in part, to reap benefits from the tourist trade. Local communities, who had exploited the reserves for centuries, typically lost out. They were resettled, prohibited from hunting in the reserves and neighbouring areas, and often had to bear the brunt of the damage done to crops from marauding wildlife.

In the absence of any involvement in the management of the reserves, and the breakdown of community-based common property rights, illegal poaching and hunting became prevalent. Local people became disinterested in preventing this, and the Government gamekeepers were powerless to prevent all but a fraction of the activity.

A more direct approach to dealing with conservation, ecotourism and rural poverty may lie in community-based wildlife management. This restores a common-property basis to the reserve, and gives the local people the economic incentive to look after the reserve. This can take the form of:

- ❖ sharing tourism revenue with the local community and local employment generation;

- ❖ infrastructure investment; and
- ❖ direct utilisation of wildlife resources

The Government of Zimbabwe launched the CAMPFIRE (Communal Area Management Programme for Indigenous Resources) programme in 1984. The project arose from the regional land use plan drawn up for the Sebungwe region of north-west Zimbabwe. The programme was set up to involve the local communities directly in reserve management and enable them to receive benefits from it directly. It was hoped that preservation of the reserve would become the most profitable land use option for the community. Each area was to be run by a profit sharing co-operative with the help of a Government agency. Lack of funding delayed the introduction of the project, until 1989, when with the support of a local NGO, two projects were started.

The Nayaminyami district council formed a wildlife trust. The council was made up of the chairmen of local wards. The trust established hunting and culling quotas and instigated controls to deal with animals which posed particular threats to crops and human beings, and to reduce poaching activities. It also developed two impala culling operations, licensed two safari operators and paid out compensation for economic damages.

A total of Z\$319,353 was earned in 1989, largely from concession fees for hunting. It was redistributed equally among the wards, and earmarked for small projects such as footbridge building, nurseries, and health clinics. Compensation was paid out to local inhabitants suffering damages from wildlife, and subsidised meat was provided for local markets.

The scheme fared well in its first year in terms of the economic objective of increasing benefits to local communities. It did not do so well at fostering community participation, as surveys showed that local people felt that the reserves belonged to the trust rather than themselves.

Source: Swanson et al, 1992.

Issues:

- 1 How could a greater sense of community participation be fostered amongst local people? What are the benefits of greater community participation?
- 2 Government officials may perceive the scheme as resulting in less tourism revenue accruing to the Treasury. Is this a problem? If so, how can it be avoided?

Case study:

Community Forestry in India

Many tree planting schemes in India have encountered problems because: often the wrong land was used, inappropriate species were chosen and the benefits of the programme were distributed unfairly. The West Bengal government has developed Forestry Protection Committees made up of local villagers in order to mitigate these problems. In exchange for protecting forests and plantations from poachers, Forestry Protection Committee members are entitled to 25% of the net sales of timber and the rights to collect fallen twigs, grass, fruits, flowers and seeds. Following the success of the West Bengal programme, this shift to greater community involvement became an Indian federal government policy in 1990.

Source: Roy, 1992.

4.15 The Distributional Impact of Market-Based Instruments

The relative impact of MBIs, such as environmental taxes, on different groups within society has been a high profile policy concern. Surprisingly, few studies explicitly address the issue, especially outside the European context. However, a distributive analysis can clarify what is actually at stake for particular groups when economic instruments are used to deal with environmental problems and can point the way to possible mitigation or compensation strategies.

Some other areas of the debate have been misdirected. Both MBIs and command and control (CAC) regulations impose costs. These

costs tend to ultimately fall on the consumer, which is entirely consistent with the polluter pays principle. Therefore, it is not correct to single out MBIs alone for their distributional impacts. In fact, contrary to CAC, by using MBIs to effectively reduce environmental damage, revenues can be generated. These revenues can then be used to redress distributional imbalance if that is a political concern.

Moreover, there is strong evidence that the total costs of compliance with a CAC policy are greater than that of an MBI. Several empirical studies indicate that the ratio of costs under a CAC system to an MBI system range from 2 to around 14 (Tietenberg, 1991). In addition, many MBIs generate revenue for the government. Hence, even if the initial environmental tax disproportionately falls on the poor (regressive), the revenues can be 'recycled' in a way which neutralises this effect or even leaves the poor better off. The effect of any MBI that generates revenue cannot be evaluated without an assumption being made as to what is done with the revenue. Only then does it become apparent whether the instrument is regressive or not.

Clearly, what matters is the *net* effect of the two components of the distributional incidence – the effect of financing and the effect of benefits. The possibilities are therefore:

- a costs and benefits are regressive, in which case the net benefits are regressive;
- b costs and benefits are progressive, in which case the net benefits are progressive;
- c costs are regressive and benefits are progressive, in which case it is a matter of which has the greatest incidence; and
- d costs are progressive and benefits are regressive, in which case it is a matter of which has the greatest incidence.

As mentioned above, policy costs are likely to be higher under a CAC system than under a market-based instrument system. Hence, the distributional incidence of CAC is likely to be worse, if the effect is regressive, than that of an

MBI system. Evidence from the US suggests that CAC environmental policy costs are regressive, i.e. the poor bear a higher burden of cost relative to their income than do the rich. Less is known about the incidence of MBI-based policies. Research in the US does tend to suggest that the way incidence is measured matters a great deal: income-based measures suggest regressivity whilst expenditure-based measures suggest neutrality. Given these shortcomings of the 'distributional impacts' argument against MBIs, the following is a checklist for distributive analysis (OECD, 1994):

- 1 *What is the benchmark for comparison of different policy tools?*
There are two principle alternatives for the benchmark (or threshold): (i) the "no regulation" case in which the MBI is judged against the status quo; and (ii) the comparative case in which the MBI is compared to the impacts of an equivalent CAC alternative.
- 2 *Will the economic instrument lead to government revenues and to what use will these revenues be put?*
- 3 *What are the initial impacts of economic instruments?*
- 4 *What are the relevant groups for which impacts will be addressed (either quantitatively or qualitatively)?*
- 5 *What empirical steps are needed to determine the final impacts (taking into account the shifting of costs and benefits to other groups)?*

The following are steps for a typical distributional analysis to find out the final impacts of an MBI:

- a determine change in compliance costs by industry;
- b determine impacts of changes in compliance costs as well as the impacts of "opportunity costs" on product prices and output, by industry;

- c determine how many workers might become unemployed in the short-term due to output changes;
- d determine impacts of higher product prices on consumers in different income groups, based upon expenditure survey data;
- e determine impacts of price and output changes on firm profits, by industry;
- f allocate the shareholder and taxpayer changes to income groups based upon survey data on their shares of corporate profits and income taxes, respectively;
- g if government revenues are collected,

Table 9: **Economic Instruments: Mitigation and Compensation Options to Reduce their Regressive Effects on Income Distribution**

Economic Instruments	Mitigation Options	Compensation Options
Emissions Taxes	Cut-off: thresholds can be introduced for individual sources. This would be very complex to implement and reduce the incentive to make the most efficient abatement decision. Exemptions: similar to the exemptions for the food and clothing part of excise tax programmes in some countries. Exemptions can be given to sectors or individuals in selected income groups. This would lead to a higher tax rate on other sectors/groups; distorts the economy toward pollution-intensive activities; seems likely to become a permanent measure of protection compromising both the objectives of a cost-effective pollution reduction policy and those of free trade.	revenue neutrality: i.e. to offset increased emissions taxes with corresponding reductions in other taxes. There are empirical estimates showing that greater reliance on environmental taxes reduces distortions and leads to efficiency gains. However, for example, reductions in income tax as a result may not completely compensate the effects of an environmental tax, if those who are affected by the environmental tax do not receive sufficient compensation through the reduction in income tax. In other words, revenue neutrality should be carefully targeted.
Emissions trading	Allocation formula: the permits can be allocated for free or in “zero-revenue auctions”. These options do not lead to government revenue but reduces the cost to businesses. However, whatever the allocation formula, the impact on the distribution of costs between firms and consumers as well as between firms and workers should also be looked at. Shut down credits: In order to reduce the negative impacts on workers, firms are not allowed to use credits obtained from shutting down production facilities. However, this policy would be difficult to administer due to problems in determining which firms shut down because of the trading programme.	The ability to mitigate business losses through allocation formulas means that compensation issues relating to business or consumer losses are less relevant for emissions trading programmes.

Source: adapted from OECD, 1994.

allocate them to income categories based upon the same survey data showing the share of income taxes paid by each income group (modify this step if the revenues are targeted to reduce specific taxes or to pay for new programmes);

- h sum the results of the price impacts, the shareholder impacts and the taxpayer impacts for each income group; and
 - i summarise the results of the analyses for income groups, workers and regions.
- 6 *What options are available to mitigate or compensate for any groups harmed by the use of economic instruments?*

Table 9 presents some mitigation and compensation options for economic instruments in order to reduce their distributional impacts. It should be emphasised that each option creates a trade-off between efficiency and equity. What level of trade-off is acceptable depends on the magnitudes of equity and efficiency which are at issue, as well as other criteria discussed below.

4.16 Other Selection Criteria for Market Based Instruments

After the foregoing review of different types of MBIs, and issues concerning their distributional impacts, it would be useful to identify other key criteria that should be applied when selecting them to tackle specific problems.

Economic efficiency: An economically efficient outcome is one in which marginal costs and marginal benefits are equal, for all inputs and outputs. In other words, the concern is whether the environmental objective will be achieved at the minimum possible cost to society, where financial and environmental costs are net of financial and environmental benefits (including any secondary benefits discussed below).

Environmental effectiveness or dependability: In a world of imperfect information, different instruments will be associated with different degrees of certainty regarding the eventual outcome. MBIs offer certainty on the marginal

costs of abatement, but leave the quantity of abatement uncertain. In the case of CAC, on the other hand, there is some certainty about the quantity of abatement but the costs are uncertain. The significance of these facts will vary depending on the context of the policy. When the aim is to meet set targets, such as those set by an international agreement or for highly hazardous environmental impacts, certainty may be deemed highly important. In the context of reversible environmental damages, depletion of substitutable resources or generation of biodegradable waste, cost and efficiency of the instrument may be of more importance.

Administrative costs: All policy instruments (MBIs and CAC) incur some form of administration costs. There will be costs to government, or its appointed agency, which might be financed from general tax revenue, or which might be passed on directly to the regulated sector. There will probably be further costs to the private sector in complying with the administrative requirements of the instrument. Key components under this heading include the costs of setting the instrument (the fewer the information, administrative and legislative requirements are, the less costly the instrument will be), monitoring the performance of the regulated sector, verification of compliance and enforcement mechanisms as well as the costs of collecting charges or engaging in permit trading. Estimates of these costs are likely to carry some uncertainty, which can be reduced by revisions based on initial experiences.

Adaptability: The instrument should maintain its effectiveness in the face of changing technology, prices and environmental conditions. Indexing to inflation or setting the instrument as a percentage of the price are two ways of maintaining its value. Similarly, the instrument's value must rise with increasing resource or environmental scarcity. It should also respond to changes in monitoring, abatement and production technology. For example, mandatory use of the best available technology, an extensively used

command and control instrument, does not meet this criterion unless it is deliberately and regularly revised, at great cost (Panayotou, 1995b).

Dynamic efficiency: The instrument should continue to encourage environmental improvement and technical innovation beyond policy

Box 10: Performance of Policy Instruments Against Selected Criteria

Policy Instrument	Evaluation Criteria			
	Economic Efficiency	Administrative Costs	Equity	Dependability
Command-and-Control Approaches				
emissions standards	likely to be poor, i.e. excessive abatement costs variable	depends on the number and size of polluters	no <i>direct</i> redistribution effect, but if the costs of meeting the standard are passed on to customers, there is an equity impact on consumers according to income group	high
standards for inputs	likely to be poor	lower than emission standards	as for emissions standards	same as emissions standards provided that the relationship between inputs and emissions is known
technological standards for new sources	poor	lower than others	as for emissions standards, may also act as a barrier to entry	high for new sources but little effect overall
technological standards for existing sources	poor	lower than others	as for non-transferable emissions quotas scheme; may favour new sources	more assurance than technological standards for new sources
Market-Based Instruments				
emissions tax	good	variable depending on the bureaucracy and co-operation	variable depending on the redistribution of tax revenue	variable depending on the tax level
input tax	good	less than emissions tax	same as emissions tax	same as emissions tax provided that the relationship between input and emissions is known
differentiated input tax	very similar to an input tax. The difference is that the emissions vary with the quality of the input, as well as with the quantity.			
tradeable emissions quotas	good	could be high	variable depending on the allocation of initial quota permits	same as CAC emission standards

targets, and even promote environmentally sound and economically efficient structural change, if feasible. Panayotou (1995b) gives the example of how low gasoline prices in the United States have resulted in a dispersed pattern of development and land use that make the development of most mass transit systems unprofitable and the economy dependent on private driving. In contrast, European cities' mass transit systems are profitable because of the high density land use induced by high gasoline prices.

Political and cultural acceptability: Taxes and charges are generally unpopular with consumers and producers alike. On the other hand, market creation or emissions trading is seen as giving polluters the right to pollute. Strengthening property rights may be acceptable if there is a long tradition of individual or communal rights. However, in the case of a departure from prevailing and likely future practices, there may be opposition from those who think they will be on the losing side. In order to increase political and cultural acceptability, the best way is to present the costs and benefits of each policy option (including that of no action). This is the same as Cost-Benefit Analysis discussed in Chapter 2, although here the issue is policy appraisal. Other mitigation measures include consultative processes, gradual implementation and revenue neutrality for taxes.

Secondary benefits: In many cases, action to address one environmental problem is likely to have additional effects on others. Although it is usual to talk of these effects as secondary benefits (as in the case of reduced emissions of sulphur due to an action to curb carbon dioxide emissions), there can be secondary costs as well (e.g. reducing local air pollution from cars by fitting catalytic converters leads to increased emissions of carbon dioxide). In principle, any secondary benefits (or costs) should be counted within the total and marginal benefit arising from an instrument.

Box 10 sets out the performance of different instruments against four of these criteria: eco-

nomics efficiency, administrative costs, equity and dependability.

4.17 Global Market Failure: capturing global value

The discussion so far has concerned the ability of economic instruments, or MBIs, to reduce local market failure at the lowest cost to society. Where domestic prices do not reflect pollution damage, or where there is no market at all for environmental quality, MBIs can be very effective policy tools. MBIs can also address the problem of *global market failure*. Although the world may place a great value on the continued survival of certain species, the owners of the rain forest may get very little compensation from foregoing their right to develop the forest. The malfunctioning, or complete absence, of markets between countries has been described earlier in Figure 6. How can countries capitalise on the economic value of their environmental assets of global importance such as biodiversity, carbon sequestration etc? This is what we mean by 'capturing global value'. There are various mechanisms whereby global environmental value can be captured, including:

Intellectual property rights: countries which own rain forests can lay claim to the benefits arising from discovering, for instance, the medicinal qualities of plants which can be developed into pharmaceutical products. If the cure to Aids or certain types of cancer lies in the rain forest, one suspects that there is a very great global willingness to pay to preserve the rain forest. The problem, of course, is to translate this into revenues.

Debt-for-nature swaps: an agency interested in conservation buys the debt and then returns it to the country of origin in exchange for locally denominated debt which is used to provide income, often to a local NGO, to conserve a specified asset. In this manner, the willingness to pay of citizens in the developed world for biodiversity preservation has an opportunity to express itself.

Franchise agreements: a country accepts a restriction on the use of its assets (e.g. not burning forests) in return for an annual payment reflecting the value of the asset to the rest of the world. The willingness to pay of the rest of the world can express itself in local decision-making. If global WTP per hectare of the forest is higher than development values, then local owners of the land gain by preserving the forest, provided they are actually able to capture this global value as revenue.

The Global Environment Facility (GEF): GEF is a financial mechanism that provides grant and concessional funds to developing countries for projects and activities that aim to protect the global environment with respect to climate change, biological diversity, international waters and ozone layer depletion as well as land degradation as it relates to these four areas. The projects have to produce benefits to the global environment and incur costs which otherwise would not have been incurred by individual governments. If a project produces domestic benefits greater than domestic cost, it is in a country's interest to proceed with the project. If the country is financially constrained it can gain funding through development funding channels other than the GEF. The GEF uses its money to fund projects in which the global benefits outweigh the domestic costs, and domestic benefits are less than domestic costs, The GEF pays the difference between global and domestic benefits. Projects to reduce CO₂ emissions fall into this category. The GEF's present budget is too limited to enable developing countries to capture global benefits on a much larger scale.

Case Study:

Activities Implemented Jointly Under the Climate Change Convention

Under the UN Framework Convention on Climate Change, industrialised countries have an obligation to reduce their CO₂ emissions. After much controversy, it was agreed by the first Conference of Parties to the Convention that,

until the year 2000, there will be a pilot phase during which projects will be permitted whereby country A can pay for the cost of reducing emissions in country B (as this is cheaper for country A compared with reducing its own emissions domestically). However, no credits can accrue to country A as a result of greenhouse gas emissions reduced in country B during the pilot phase. This is known as 'activities implemented jointly'.

An example of this kind of project is that agreed between Norway, Poland and Mexico, whereby Norway has agreed to provide funding through the GEF for carbon-reducing projects in Mexico (energy-efficient lighting) and Poland (conversion from coal burning to natural gas).

Source: Global Environment Facility, 1992.

Case Study:

Debt for Nature Swap in the Philippines

In 1989, the Worldwide Fund for Nature (WWF) purchased \$390,000 of Philippine debt, which had a face value of \$590,000. The Philippine Government now owed \$390,000 to the WWF, rather than to commercial banks. WWF agreed that the Philippines should pay the debt in peso equivalent in support of designated conservation projects. A variety of projects have been implemented: e.g. enhanced management of national parks and training programmes for conservation professionals.

Source: Peuker, 1992.

4.18 The Role of Market-Based Instruments in Natural Resource Management

A range of market-based instruments have been reviewed, which provide a means of reducing *local and global market failure*. This section identifies which type of instruments are best suited to certain economic sectors: e.g. water, energy, waste, tourism, fisheries, mining, forestry and agriculture. The summary for each sector, presented in Box 11, starts from the assumption that environmentally damaging subsidies should be removed. If polluting activities are 'cheaper' than they would otherwise be, then subsidy removal is

Box 11: The Broad Focus of Policy and Market Failures, and Market-Based Instruments in Specific Sectors

Sector	Policy/Market Failure ⇒ Non-sustainable Outcome	Exemplary Actions Required
Agriculture	Government subsidies for irrigation water, pesticides and fertilizers, insecure property rights ⇒ deforestation for agriculture, land/water pollution, soil erosion, overgrazing	• removal of policy failure (both inputs and output) • secure property rights • tax on irrigation water, pesticides and fertilisers • subsidies for environmentally friendly technologies such as Integrated Pest Management • tradeable quotas for livestock production • ecolabelling
Energy	Government subsidies reducing the price of fuels and electricity Prices do not reflect social costs of air pollution from fuel and electricity production and use ⇒ inefficient energy production and consumption, lack of incentive for energy efficiency measures, water/air/land pollution	• removal of policy failure • tax/tradeable permit on air/water emissions • environmental subsidies for cleaner fuels and technologies
Fisheries	Open access, insecurity of existing property rights at local, regional and international levels ⇒ capital intensive fishing, overfishing	• removal of policy failure • tradeable quotas • clearly defined secure property rights (EEZ fishing licences) • fishing input pricing
Forests	Government incentives for deforestation and land clearance, insecure property rights, lack of incentives for sustainable management and non-timber products, inefficient taxation of revenues, lack of environmental controls ⇒ deforestation, and resultant loss of biodiversity. • removal of policy failure	• secure long-term property rights/concessions • forest product pricing • royalty/profit/concession taxes • performance bonds/deforestation charge • carbon offsets/joint implementation agreements
Mining	Government incentives for mining in short term, insecure property rights, inefficient taxation of revenues, lack of environmental controls ⇒ environmental impacts from mining, loss of revenue due to inefficient taxation	• removal of policy failure • performance bonds • emissions tax • royalty/profit tax – levy based on mine's output. • equity participation – local people owning shares in the mine can be beneficial
Tourism	Ownership/ management which excludes the local people, inefficient pricing of the sites ⇒ overuse of tourism sites, air/land/water pollution, poaching, loss of biodiversity and revenue	• removal of policy failure • entrance charge applied and revenues at least partially redistributed to local communities • property rights for local people • performance bonds

Continued opposite

Sector	Policy/Market Failure ⇒ Non-sustainable Outcome	Exemplary Actions Required
Transport	policy failure encouraging excessive use of vehicles and roads especially in urban environment ⇒ air pollution, congestion, noise • removal of policy failure	• road pricing • differential fuel and vehicle taxes • investment in/subsidy for public transport
Waste	lack of collection/disposal facilities, lack of effective user charges for waste management ⇒ generation of excessive waste; no incentive for recycling; health hazards from uncollected/inefficiently disposed wastes; air/water/land pollution; lost revenue from not recycling	• removal of policy failure (full cost pricing) • deposit refunds and performance bonds • product charges on packaging • landfill tax-proxy emissions tax • recycling incentives such as credits to parties other than local authorities to collect
Water	Government subsidies making domestic, industrial and irrigation water cheaper Industry allowed to discharge used water without treatment ⇒ excessive use, water shortages, waterlogging, and surface and groundwater pollution.	• removal of policy failure (marginal cost pricing) • communal/private water rights • user charges • differential land/water use taxes

the most cost-effective means of conserving the environment. It is also assumed that property rights are well defined and secure. Each country

needs to fine-tune MBIs to get the maximum environmental benefit at the least cost.

The Policy Implications

5.1 General Observations

The economy and the environment are inextricably linked. Policies that attempt to tackle one without reference to the other could render an economy unsustainable. The old perception of environmental protection as the luxury of the rich world has been shown to be short-sighted and misguided. Effective environmental management can be supportive of economic growth.

The term sustainable development has many interpretations. It has been argued that it should refer to non-declining human well-being over time. The previous Chapters suggest it is possible, through the manipulation of economic incentives, to move the economy to a sustainable position. Green accounting techniques can indicate, at the national level, whether an economy is growing in an unsustainable way. If an economy is not sustainable this will show up through a negative genuine savings rate.

The free market, if left alone, is unlikely to grow along a sustainable development path. Resources that can be used by everyone for free will be over-used. Incentives such as secure property rights should be created to ensure that people manage natural resources sustainably and derive benefits from doing so. Government interventions of the wrong type, which encourage high pollution and over-exploitation of resources by lowering the 'price' of pollution and resource consumption, will similarly threaten sustainability. Establishing the correct prices, i.e. ones that reflect both the true private costs and external costs of production, creates the incentives for resources to be used in a more sustainable way. The price of natural resources should reflect the true costs of production, without a government subsidy, i.e. the external costs of production and

the user costs. The final price of the good in the market should equate with the marginal social cost of production.

This principle can be applied to many sectors of the economy. The economic valuation techniques outlined in Chapter 2 are used by economists to measure the size of the external cost from consuming resources. This result can then be used by policy-makers to achieve marginal social cost pricing. Marginal social cost pricing also requires the removal of distorting subsidies. It is not always possible to identify the marginal social cost of consuming resources. Despite the absence of this information, governments often introduce a pollution standard: e.g. total emissions of lead must be less than x grams per litre of petrol. Economics demonstrates that the best way of implementing environmental policies, wherever possible, is by using market based instruments (MBIs) and not command and control measures. The end result would be the same level of reduction in the lead emissions but achieved by MBIs in a less costly way. It is this 'least-cost' quality of MBIs that makes them attractive, especially given the limited resource base in many developing countries and the need to maintain international competitiveness. The reduction in administration costs relative to regulatory approaches can also be very significant. Another very important advantage of MBIs, especially in developing countries, is their ability to raise revenue. It is, however, naïve to suggest that MBIs are the only answer; gradual introduction is required, but the potential for their use in all countries is very large.

Market based instruments (MBIs) can bring about the same result as a traditional regulatory policy but with significantly less economic costs;

in addition, they can raise significant revenues for the government. It has been noted that there may be circumstances in which MBIs, at least entirely on their own, are not suitable. In some instances public policy will demand an immediate response to unexpected circumstances – direct intervention is required. MBIs work most effectively in free market economies with strong government and legal institutions. In the absence of these, the effectiveness of MBIs may be limited.

5.2 Choosing the Right MBIs

Each instrument outlined in Chapter 4 has several variants. The instruments can also be used in almost limitless combinations. Choosing a ‘finely-tuned’ instrument in practice is important.

- ❖ The *scale of production* of the industry in question is important. For large industrial conglomerates tradeable permits and effluent charges can be very successful. Monitoring and enforcement are relatively simple. Small or widely dispersed industries with a large number of firms may be better suited to proxy taxes on inputs that reduce the administrative burden.
- ❖ The *degree of competition* within the industry is important. The more competitive the industry, the more reliant the firms are on the price charged to consumers, and the more responsive they will be to MBIs. Monopolised industries may not respond as well to pricing instruments. If this is the case, eliminating the monopoly power (which may itself be the result of a policy failure) should be the first step.
- ❖ *Acceptance by industry and the public in general* is crucial to a successful MBI. The basis of the instrument as an incentive for using new less polluting techniques, rather than simply a punishment for past pollution, should be stressed.

Concerns about the distributional impact of market based instruments has been a popular

‘excuse’ to defend regulatory approaches. However, it has been demonstrated that some of this reasoning is erroneous, as total impacts of MBIs are often less than those associated with a regulatory instrument. MBIs also generate revenues which can be re-distributed. No assessment of the social impact of MBIs can be made without an explicit analysis of the incidence of costs and benefits. MBIs do not have to have adverse impacts on the poor, and, in any event, alternative policies may have even more adverse impacts.

5.3 The Politics of Environmental Policy

Removal of subsidies in the water, agriculture and energy sector is politically difficult. The recipients of the subsidies are often powerful groups in society. The best way to overcome this type of resistance to subsidy removal is to mobilise the support of those who will gain to provide a countervailing force. Nonetheless, the difficulties of removing subsidies in practice should not be underestimated. Removing subsidies can be done in a politically acceptable manner, but the policy is clearly a difficult one to implement.

With the subsidy in place the poor often lose out anyway. Subsidies cause overconsumption of, say, water supplies; hence, during a water shortage the rich can often ensure supply of the resource by other means. The gradual removal of subsidy can aid political acceptability. Gradual reforms are often less politically damaging than swift ones. Increasing taxes on any product is also unpopular. The national treasury often gains by the introduction of marginal social cost pricing, as can a host of various other groups. If the treasury gains revenue, a critical issue becomes the question of how the money is re-distributed. As long as adversely affected people are compensated through some other fiscal measure, there is no reason to assume that they will oppose the measure. Gradual price change accompanied by explanation of the net economic effect on people can ease the passage of the suggested measures considerably.

Another major political obstacle to the introduction of MBIs is that pricing policy is already used for so many different, and often conflicting, objectives such as increasing employment, greater productivity, protection of infant industries (e.g. low energy prices), food security (e.g. subsidies to agriculture) and general income distribution. Therefore, whatever the environmental policy is (removal of policy failure or application of market-based instruments), its aims and application should be made crystal clear. MBIs have costs associated with them too, even though, in many cases, these are less than those associated with regulatory approaches. These costs must be measured against the efficiency gains and revenue raising potentials to determine whether MBIs are worthwhile in specific situations. MBIs may be costly due to technical reasons. For example, although water pricing is an effective way of reducing water wastage, installing water meters which are necessary to measure water use is highly costly. High costs also arise because of evasion. As the literature on income tax has shown, the higher the pollution tax or natural resource price becomes, the more incentives there are to evade. One way to avoid this would be to have variable prices based on incomes, so that those with higher incomes for whom evasion may be less worthwhile would face higher costs.

The costs of MBIs (and hence political opposition to them) can be lowered in various ways:

- ❖ *By altering ownership and control:* this requires that the central government and national treasury be willing to devolve more political and financial responsibility. Often private firms or fiscally autonomous agencies are more responsive to MBIs.
- ❖ *By incorporating the price mechanism into the existing social and cultural structure:* the study of economic anthropology has shown that many cultural and religious practices are conducive to economically rational behaviour, and these social sanctions can reinforce economic signals conveyed through the formal price mechanism.
- ❖ *By altering the policy climate:* long-term education, short-term information and publicity campaigns involving the press, and using non-governmental organisations to monitor compliance, are effective means to pre-dispose firms and households to follow MBIs.
- ❖ *By providing financial incentives for both improved collection and improved payment of MBIs:* for improved payment, these incentives either subsidise those who pay early or fine those who pay late or try to avoid payment. Fines should be adjusted to the size of the MBIs themselves.

The MBIs can be redesigned if they are faced by the problem of high costs. For example, a charge can be levied on the inputs rather than on polluting outputs which requires expensive monitoring. This use of blunt instruments relies on the effectiveness of inputs as proxy to outputs. The gains from administrative simplicity must be weighed against the losses from reduced effectiveness, since there is little incentive to reduce pollution further once the tax on input is paid. One way to overcome this problem is to make the tax refundable if the polluting output is not emitted. This is in line with the principal of deposit-refund schemes and performance bonds.

To conclude, the traditional approach for environmental policy was to invest in piecemeal projects, but the seriousness of the issues has necessitated a broader emphasis on the impact of general economic policy on the environment. Market-based instruments go straight to the heart of the link between the economy and the environment. They are generally lower in financial and administrative costs and are a more integrated way of achieving environmentally sound development.

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ISBN 978-1-84859-601-6

