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THE INTERNALIZATION OF ENVIRONMENTAL COSTS AND RESOURCE VALUES : A CONCEPTUAL STUDY

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1 Introduction

This study seeks to outline, in a non-technical way, the environmental issues relating to commodity production and trade. Our specific remit is to offer a conceptual discussion of the issues involved, and then to indicate how this analysis has relevance for international trade and commodity agreements, and to international relationships in a wider sense. However, the presentation of pure concepts, without concrete examples, is unlikely to make for stimulating reading. We therefore seek to motivate the discussion by the use of relevant examples throughout. So that these examples need not interrupt the flow of the argument, they are placed in boxes, and can be skipped with no loss of continuity.

1.1 Commodities and Environmental Issues

Everyone is keenly aware that human activity can be potentially damaging to the natural environment. On a global level, we know that chlorofluorocarbons (CFCs) are damaging the ozone layer, allowing greater penetration to ground level of harmful ultraviolet light. We also know that the concentration of atmospheric carbon dioxide is increasing, because of fossil fuel use and forest destruction. The potential for environmental andeconomic disruption of the climate change that could result from the resulting 'enhanced greenhouse effect' is a major worry.

There are other international, but non-global, environmental issues. Many European countries were adversely affected by the Chernobyl accident, while the effects of sulphur dioxide emissions on neighbouring countries is a source of growing concern.

At the national and local level, we know that unsustainable land use methods are causing soil erosion in many parts of the world. Many cities, particularly in the Third World, suffer terrible air and water pollution. Unsympathetic logging and mining practices are reducing resources available to this and future generations at a rate that may be hard to justify.

Many of these environmental issues are related, directly or indirectly, to the production and consumption of commodities. For example, coffee processing can be a major source of water pollution. Timber extraction may be both too rapid to be sustainable, cause the loss of biodiversity and also be a factor in soil erosion. Cereal growing, in many areas, leads to soil erosion and degradation, and also water pollution, through overuse of fertilisers and pesticides. In many parts of the world, mining is a cause of soil degradation and water pollution, while the smelting of metals can be a major source of air pollution.

A further source of potential environmental damage, especially in poorer countries, is the fall in commodity prices that has taken place over the past two decades.

Over the past two decades commodity prices have declined by about 45% for food, 25% for agricultural raw materials and 40% for minerals, ore and metals. Since 1985, the prices of tropical beverages and vegetable oil seeds and oils have continued to decline, while minerals, food and agricultural raw materials have risen (UNCTAD 1992).

The steady fall in revenue per unit to commodities may have encouraged some commodity exporting countries to seek to intensify their commodity production, to maintain revenues. This, in turn, may have been a significant contributory factor to more increased deforestation, with its attendant effects of soil erosion, siltation, species loss, etc.

What part can international agreements regarding the production, and particularly trading, of commodities play in reducing these negative environmental effects? A range of possible instruments is available, as will be discussed later, including: mutually agreed import taxes; mutually agreed quotas; export taxes; eco-labelling; investment subsidies.

At first sight, one might be tempted to see commodity production and trade as a suitable target for direct intervention, to satisfy environmental goals. If producing a certain commodity causes pollution, should we not restrict its production, perhaps by imposing tariffs on its importation? It is our considered view that such simple, direct intervention with regard to commodity production and trade is probably not appropriate. Instead, we propose that the role of the international community should be to provide a positive incentive to countries to shift to more environmentally benign techniques of commodity production. This could be by the provision of subsidies, which we call environmental benefit fees (EBFs). These EBFs would provide revenue for countries to overcome the capital costs and adjustment costs of changing technology. Unlike the penalty of trade restrictions, this will not have any competitive effects and will not affect national sovereignty, as the positive subsidy will encourage countries voluntarily to switch to more sustainable commodity production. Thus we can typify EBFs as an 'enabling' approach, rather than the 'controlling' approach of trade restrictions.

It is this issue, of changing technology, that is central to making commodity production sustainable. We suggest this be done by providing economic incentives for a shift in technology by commodity producers, causing the environmental externality to be automatically internalised. This approach of internalisation is rather different to that usually suggested, which raises the market price of commodities, the 'full-cost pricing of commodities' approach.

Full-cost pricing would involve increasing the costs of production by, e.g., imposing an environmental tax on the commodity. This would, in turn, increase the market price of the commodity, thus reducing demand and consequent environmental damage from production. However, while this approach would have the desired effect of internalising the environmental externality, it would have a negative effect on economic development.

1.2 The Contents of the Study

In this study, our particular remit is to explore how international, market based solutions to environmental problems might be found and implemented, especially with respect to commodities. Such instruments are said to 'internalise the externality' of the environmental effect. Our view is that confusion could easily be created if our discussion immediately turned to concrete issues, such as the roles of 'International Commodity-Related Environmental Agreements' (Kox 1993). Indeed, we shall argue that such agreements may do more harm than good, if they are not implemented sensitively. However, to make this argument will require some preliminary analysis, centred on the nature and role of markets, and how markets can 'fail', and give rise to 'external' environmental effects. We therefore spend Chapters 2 to 6 discussing the general problem of markets and the environment. Only then do we turn to a discussion of the relationship of international trade, and international agreements, with the environment.

As we stress the importance of market instruments for seeking to solve environmental problems, we consider it important to restate, briefly, the case for markets. In Chapter 2 we remind the reader that the case for markets depends, almost entirely, on the concept of allocative efficiency. So, when the case is made for a market instrument to counter an environmental effect, this is, in essence, an argument for increasing economic efficiency. As we note at the end of Chapter 2, if this efficiency criterion is forgotten, there is a danger of arguing for policies which are not efficient.

In Chapter 3 we note that one important source of environmental harm associated with commodity production is inappropriate government intervention, in the form of implicit or explicit subsidies, trade restrictions and state investment. This particular cause of environmental externalities is usually termed policy failure.

Having noted the necessity of first dealing with policy failure, Chapter 4 discusses the nature of market failure concerning the environment. We distinguish three types of environmental market failure, at three geographical levels. The types of market failure are: public good failure; open access failure; and intertemporal failure. The three geographical levels are: local; transboundary; and global. We illustrate the 3x3 combinations of these types of failure and geographical levels with respect to various environmental problems occurring because of

commodity production.

Having established the conceptual framework for analysing environmental market failure, Chapter 5 discusses the various means of seeking to correct this failure. As we have noted, this process of correction is known as internalising the externality. We outline a range of policy measures that can be introduced to reduce environmental damage, particularly relating to commodity production. These range from command and control methods of direct limitation of environmentally harmful activities, to market based instruments for encouraging environmental improvements, through an appropriate incentive structure, via taxes, subsidies, etc.

Having laid the extensive, but we believe very necessary, foundations of our analysis, in Chapter 6 we turn to the implications of international trade, and trade agreements, for internalising environmental externalities. Our conclusion is that, while there may be some role for such agreements, focussing on the commodities produced and traded is less useful than attending to the techniques used for their production, and the social and economic conditions that encourage the use of environmentally damaging techniques.

A particular problem with the use of trade agreements to restrict commodity production, we believe, is that it strikes at the very roots of the possible solution to many environmental problems, which is economic development. In Chapter 7 we discuss the central role of economic development in allowing and encouraging nations to move away from the use of environmentally damaging techniques of producing commodities. It is this encouragement of environmentally benign development that should be the focus of future policy analysis. Policy measures which could be effective include the removal of trade barriers to poor countries' exports, and the introduction of modern techniques with the assistance of suitable subsidies.

Chapter 8 examines the role the international community in providing incentives to shift to more environmentally benign technologies. This institutional analysis presents a way forward, through eco-labelling and investment subsidies for technology switching.

Chapter 9 is a summariy of the main findings, and outlines areas and directions for future research and analysis.

Also included are two annexes, dealing with technical issues that may stimulate and aid discussion, but are not central to the argument we put forward. Annex 1 gives a brief overview of the theory and application of the monetary valuation of environmental impacts. Annex 2 outlines the relationship between concepts of social welfare, the environment and national income accounts.

2 Social Welfare, Allocative Efficiency and the Price Mechanism

Before turning to a detailed discussion of environmental problems and the means of 'internalising externalities' relating to commodity production and trade, we consider it useful briefly

to set the scene concerning social welfare, allocative efficiency and the price mechanism.

2.1 Social Welfare

It is generally accepted that the role of government is to improve the social welfare of its citizens. The welfare of a society has many dimensions, and among the factors often mentioned as contributing to welfare are: consumption; leisure; income distribution; health; longevity; law and order; social cohesion; environmental quality (Anderson 1991).

If it is accepted that welfare has many aspects, it is apparent that governments may be able to improve social welfare in a number of ways. In particular, if the natural environment is being degraded, measures to improve environmental conditions can increase social welfare The natural environment, and efforts to improve it for human use, also have an effect on national accounting. The use and modification of national accounts when taking account of the environment is discussed in Annex 2.

2.2 Allocative Efficiency In the economics literature this is also known as 'Pareto efficiency'.

Another aspect of improving social welfare is to ensure that the productive factors available are allocated as efficiently as possible. For example, a government may decide to concentrate its productive factors upon a single venture (e.g. coffee production), even though there may be other more effective uses for some of these factors. In this case, the allocation of resources is clearly not efficient.

Similarly, a government may decide that water pollution is a problem that should be eradicated, even at the cost of closing down an important production facility. Again, it may well be the case that this allocation of resources could be improved upon, if a low but non-zero level of pollution were accepted.

The loss of allocative efficiency through inappropriate government intervention - policy failure - is discussed in more detail in Chapter 3.

Allocative efficiency can be shown to derive directly from the working of a 'perfect market'. In such a market all individuals seek to maximise their own well-being, through the exchange of goods for labour services and the use of capital. The outcome is a situation where no individual can be made better off without making someone else worse off. Clearly, if this state of affairs

can be achieved, all factors of production could be said to beallocated efficiently.

Of course, such allocative efficiency could not necessarily be said to give rise to the highest possible level of welfare, for two reasons. First, some goods and services may be produced outside the market system (e.g. housework, many environmental services). Second, the distribution of income which results from a free market may well be very inequitable, and so be judged not be socially optimal.

However, one can say that if there is not allocative efficiency, then almost certainly social welfare could be improved. This follows from the definition of allocative efficiency; if there is not such efficiency then at least one person could be made better off without making someone else worse off.

In summary, the achievement of the highest level of social welfare will require allocative efficiency. However, the achievement of allocative efficiency need not correspond to the achievement of the highest level of social welfare; i.e. allocative efficiency is a necessary but not sufficient condition for achieving the highest social welfare.

2.3 The Price Mechanism and Efficiency

We normally consider the price mechanism to be the means by which supply and demand are brought together. This operation of the price mechanism also serves to increase allocative efficiency. For example, if a price is set too low, sellers offer less than is potentially possible to supply, so are dissatisfied, while buyers cannot buy all they desire, because of shortage of supply, so are also dissatisfied. If the price is raised until there is an equilibrium of supply and demand, then both sellers and buyers are made better off. Indeed, simultaneous achievement of equilibrium in all markets must corresponds to allocative efficiency, as noted above.

It is this property of allocative efficiency which leads many, even most, economists to stress the usefulness of markets as a mechanism of social organisation.

It should be noted that observed 'market' prices may not be those that actually achieve allocative efficiency. This may be because of 'market failure', to be discussed in more detail in Chapter 4. In particular, many environmental effects reduce social welfare, but do not carry prices; air pollution is an obvious example. This non-pricing of pollution leads, in principle, to all other prices being 'incorrect'. In particular, the price of goods causing air pollution will be too low. The increasing of these prices, through various methods of intervention (e.g. taxes), leads to 'full-cost pricing'. Then the price of goods reflects not only the private costs of their production, but also the social costs of the pollution caused in their manufacture.

2.4 'Competitiveness' and Welfare

An issue which often occurs in trade discussions is that, when full-cost pricing is used, there may be a reduction in 'competitiveness'. For example, if the production of coffee generates water pollution, then this pollution can be reduced by taxing the emission of the pollutant. This will inevitably cause the total production costs of coffee to rise, and make that country's coffee less competitive on local and international markets.

However, this reduction in competitiveness is not necessarily a bad thing. In terms of allocative efficiency, the pollution tax improves the use of resources in the economy. Also, the tax gives an incentive to coffee producers to use other, less polluting, techniques for producing and processing coffee, and reduces the level of pollution. On either consideration, the overall level of social welfare increases, even though 'competitiveness' decreases.

This point should be borne in mind, particularly in the later discussions of the impacts on commodity trading of reducing environmental degradation. The key issue always to consider is social welfare; competitiveness is, in this context, a minor issue, even an irrelevance.

3 Policy Failure and the Environment

In addition to market failure, to be discussed in Chapter 4, market prices can be distorted by government policies. Possible distortions include: subsidies or tax incentives; direct price controls; foreign exchange controls; and international trade restrictions. Thus, before internalizing environmental externalities, we should investigate whether there is a policy failure affecting the environment. If there is, then the first step of internalisation should be the removal of this failure. Therefore, measures to reduce the environmental damage from commodity production must be introduced sequentially. First we must remove domestic distortions to ensure that prices for commodities are equal to marginal private cost. Secondly, then we can internalise any environmental externality, to ensure that price equals marginal social cost.

Governments justify these policy distortions in order to meet non-efficiency social objectives, such as alterations in income distribution, increased employment, food security and the protection of domestic industry. While these non-efficiency objectives may well be worthwhile goals, the policy instruments used to achieve them are often less efficient than they could be, as briefly discussed in Chapter 2. For example, if the government wants to improve income distribution, then subsidies targeted to the poorest are generally more efficient then universal subsidies. If governments use these inefficient policy tools to achieve non-efficiency objectives, then this is called policy failure.

There are numerous types of policy failure. Here we are primarily concerned with policy failure that increases the environmental damages associated with commodity production. These policy failures not only ignore the opportunity cost of resource use, but also encourage more rapid depletion of soil, water and biota than would happen just with market forces (Repetto 1988). These environmental policy failures occur widely in both developed and developing countries. We concentrate here on six main types of policy failure:

1. Low or reduced rent taxes on virgin natural resources. 2. Under-priced natural resource and environmental inputs. 3. Subsidies for environmentally damaging activities. 4. Controlled agricultural prices and agricultural taxation. 5. Trade restrictions. 6. Heavy state investment in mining and processing.

These policy failures not only harm the environment, they are also very damaging in economic terms. Thus the removal of policy failure is often called a "win-win" or "no regrets" policy, since it is both environmentally and economically beneficial. The three major economic gains of reducing policy failure are: 1. increasing the efficiency of the economy and resource use.

In the Republic of Korea, the marginal cost electricity pricing provided sufficient revenue for a fifty fold expansion in generating capacity between 1961 and 1988. The introduction of peak-load pricing for large users in 1977 is estimated to have saved 800MW of peak load power by 1987. Volumetric water pricing in Shandong province, China, has encouraged farmers to level fields so that the average amount of water need for irrigation per hectare has been halved.

2. Removing the fiscal costs of subsidies, price controls, etc.

In the western United States, particularly California, water subsidies are a major drain on the federal budget. The US Bureau of Reclamation provides a subsidy to the 146,000 farms that use its water of over US$1 billion per year.

3. Increasing government revenue from higher rent taxes.

It may be argued that the very aim of policy intervention is to achieve non-efficiency objectives, such as income distribution and food security. However, it can be shown that these

In Indonesia, forestry charges raised Rupiah 439 billion in 1989, and this is expected to rise to over Rupiah 800 billion, with increases in the afforestation tax. In Papua New Guinea, mining taxes provided over 25% of government revenue in 1988.

non-efficiency objectives are often not achieved by the policy interventions we have described. Even when the objectives are achieved, they come at an unnecessarily high price, by being promoted through inefficient policy distortions.

For example, trade restrictions, such as those of the European Union, are often defended as a way to protect small farmers. However, as the Union's Common Agricultural Policy is provided on a yield basis, it is regressive: 80% of the subsidy goes to the largest 20% of producers. A far less costly and more effective way to help smaller farmers would involve subsidies targeted specifically to these small farms.

State investment in mining is justified as increasing employment and government revenue. But again, the evidence is that the opposite is the case. Because of the inefficiency of these state-owned enterprises, many have had to close, or operate below full-capacity, which reduces the government revenue available. By contrast, where the government encourages private investment in the mining sector, both employment and very high government revenue can be achieved.

In Indonesia, the Ertsburg gold and copper mine of US based Freeport-Mcmoran, was the country's largest corporate tax payer. In 1990, the government collected US$271 million, and the mine employed 7,400 workers, 95% of them Indonesian.

Given the inefficiency of these policy distortions, it is no surprise that many countries are choosing to reduce them. This is largely as a result of the fiscal crisis that many countries have found themselves in, as well as a general switch to more market-orientated policies. This chapter will review the six main policy failures outlined above, and examine both their environmental and economic costs. Any reductions in these policy failures will also be highlighted.

3.1 Low or Reduced Rent Taxes on Virgin Natural Resources

Economic rent, or user cost, is the difference between the cost of extracting the resource and its price (including a reasonable profit margin and a possible risk premium). This economic rent arises because natural resources, whether they are

renewable or non renewable, have limited stocks compared to the demand for them.

This type of policy failure arises when the economic rent earned from natural resource extraction and harvesting by private concessionaires is not sufficiently captured by governments through taxation. The main commodities to which rent taxes apply in developing countries are timber and fisheries.

The experience with rent taxes on minerals is most successful andshows what can be achieved, with rent capture often over 80%. However rent capture in timber and fisheries is often much lowerat less than 50% of the full user cost. This is partly for technical reasons such as remote, dispersed nature of logging and fishing, but also due to poor management and political reasons.

This policy failure of low rent taxes on these commodities exacerbates environmental destruction by:

1. Creating super-normal profits, so that the rate of entry to the industry increases. This can be seen in the tropical logging industry, where low rent taxes create a rush by concessionaires to mine the forest while profits are so high.

The Philippines forests were hugely over-logged in the period 1961-76. The low taxes and windfall profits encouraged extraction by both multinationals and local investors. In 1969, forest products were the largest export item, with the result that very few forests remain.

2. Keeping the prices lower than the true private cost of the resource extraction (which is itself lower than the social costs of extraction). This has allowed high quality tropical timber to be used for plywood manufacture for construction purposes in Japan.

One of the main uses for tropical timber imported to Japan is the manufacture of plywood. The plywood is mostly consumed by the construction industry, often for moulding concrete panels. Estimates suggest that over 25% of the tropical timber imported was used to make these concrete panels (Nectoux and Koruda 1989).

3. Reducing government revenue. If governments were able to collect higher revenues per unit of resource extracted, they would have to sell fewer concessions to generate foreign exchange. They would also have a greater incentive to look after the forest and fishery, and would have more revenue available to invest in monitoring concessionaires and shift to more sustainable management.

Rent taxes are being increased for minerals, timber and fisheries.

Since 1987, Philippines has raised forest rent taxes, while the island nations of South Pacific set up the Fisheries Forum Agency (FFA) in 1980 in order to increase their share of the rent from fisheries.

3.2 Under-Priced Environmental Inputs

Governments under-price certain environmental and natural resource inputs, either by providing them below their marginal costs, or by subsidising private producers. This most commonly applies to the prices of water, energy, pesticides and fertilizers. Due to these subsidies, users pay well below the full private costs of consumption (while social costs will be still higher).

> In Mexico, farmers pay only 20% of the full production cost of irrigation water, while in Sri Lanka farmers pay only 60% of the full cost of nitrogen fertilizers (World Bank 1992).

The effect of these subsidies is to increase environmental damage from commodity production. Governments tend to under-price water, both for irrigation and industry. This has encouraged excessive use both by agricultural producers and by mining and agro-processing plants that require water. Under-pricing energy (including electricity) causes excess and inefficient use, depleting energy sources faster than is optimal, as well as causing excess air pollution. Underpricing pesticides and fertilisers encourages excessive and inappropriate use, which have important impacts on human health and the environment. A study of farmers working with pesticides in the Philippines found that 55% of them displayed abnormalities in the eyes, 41% abnormalities in the lungs and 54% abnormalities in the cardiovascular system (Coote 1992).

Many countries are now seeking to reduce these subsidies on inputs.

China is increasing its use of volumetric surface water pricing, energy prices are being raised in many countries and Indonesia has recently phased out its pesticide subsidy.

3.3 Subsidies for Environmentally Damaging Activities

Government intervention often creates incentives for certain environmentally damaging activities. The most pervasive example is the economic incentive for land conversion and clearance, which often lead to the loss of forests and wetlands.

3.4 Controlled Agricultural Prices and Agricultural Taxation

Governments intervene in agricultural commodity markets through price support, agricultural taxation and general macroeconomic interventions such as over-valued exchange rates. The

In Brazil, cattle ranching, which was encouraged by subsidised credit and tax allowances, accounted for 16% of deforestation in the state of Mato Grosso before 1970 and 20% in the state of Para. Subsidies for aquaculture farms, lead to the destruction of wetlands, which act as breeding grounds for capture fisheries. It is estimated that in Asia, where the problem is greatest, at least 1.2 million hectares of mangroves have been converted into aquaculture ponds (ESCAP 1992). In April 1989, fiscal incentives for new cattle ranching developments in Brazil were suspended by a Presidential Decree, although this was watered down in January 1991.

evidence suggest that while developed countries tend to intervene to keep agricultural prices above world market levels, developing countries generally intervene to keep domestic agricultural prices below world price levels.

In developing countries, agricultural production is often influenced by marketing boards. These have a monopoly in crop marketing from farm-gate production to exports and generally use a pricing system controlled by the government. By depressing prices, these interventions depress agricultural production.

Estimates show that the average growth rate of agricultural production per year in the period 1970-1981 was 2.9% per annum in countries with no or low farm price controls, 1.8% per annum in countries with medium farm price controls, and 0.8% per annum in countries with high farm price controls (Gammage 1990)

Many developing countries also have export taxes on certain exported agricultural commodities.

As a result of export taxes, in Togo the farm price for coffee was a third of the border price, in Mali cotton and groundnuts were half the border price and in Ghana cocoa producers received less than half the border price.

Agricultural pricing is also affected by macroeconomic policies, such as over-valued currencies. When a currency is over-valued, the producers of export products receive less domestic currency in real terms from international trade.

The net impact that reducing absolute agricultural prices has on the environment is ambiguous. However, the distortions between the relative prices of certain crops (e.g. the heavier taxes on export crops compared to food crops), will encourage farmers to ignore the productive capacity of the land. Ideally, sustainable agriculture requires that crop patterns are adapted to the underlying productive capabilities of the land (WRI 1992).

Many of these policy failures are now being reduced. The power of marketing boards has been decreased world wide, and many

commodity producing countries have devalued their currencies.

In 1986, the Nigerian Cocoa Board was abolished and the marketing system was privatised. Brazil has decreased its export tax on cocoa from 55% in 1982 to about 20% in 1983.

3.5 Trade Distortions by Developed Countries

It is not only developing countries that use trade measures to protect domestic producers and consumers. While many developing countries have been moving from import substitution to export promotion and a more open economy, developed countries have been increasing protectionism.

There is evidence of increasing protectionism in the European Community, the US and Japan. As a result about 26% of developing country agricultural exports face tariff barriers (World Development Report 1989).

It is especially the case that import tariffs on processed goods are much higher than raw products. The removal of these barriers to trade would generate significant revenues for developing countries.

Japan has a 15% tariff on processed tropical timber imports to protect its domestic processing industry.

The impact these commodity trade distortions imposed by developed countries have on the environment of developing countries is not very well researched. However, it is clear that trade distortions significantly reduce export revenue to developing countries. As with reduced domestic agricultural pricing, this reduces the funds available to introduce environmentally improved methods of production. It is also clear that tariff removal, by increasing rural incomes, would reduce rural poverty.

If the Uruguay round of the General Agreement on Trade and Tariffs proves successful, there could be significant reductions in developed country tariffs. The EC is also unilaterally pursuing a reduction to its Common Agricultural Policy, which effects particularly sugar prices, although its liberalisation of the banana trade threatens to ruin some small Caribbean economies.

3.6 Heavy State Investment in Mining and Processing

The period from 1965 to 1980 was characterized by large scale nationalization of mining extraction facilities. These nationalised mining operations have often had much worse impacts on the environment than the more dynamic foreign multinational corporations. High taxation of state mines for government revenue, overmaning and poor maintenance and political intervention, have reduced the revenue available for spare parts, let alone improved technology. Even when the state mine is relatively well run, it often does not face such rigorous environmental pressure as foreign

multinational corporations (MNCs). This is because of reduced pressure for environmental compliance both from domestic and external sources. Domestic government officials are less likely to take a tough stance with state run mines as they are both the owners and regulators of the mine.

In Chile, the country's only privately run smelter was forced to meet emission standards more stringent than current US practice, while in the same valley a state owned smelter and refinery continued operating without any reduction in the emissions of either SO2 or arsenic (Crozier 1992).

In response to mainly fiscal constraints, many developing country governments have been trying to increase the role of private investment and reduce the role of the state in mining. Even when the state does continue to play a role, it is usually through minority ownership of the shares.

Guyana, which nationalised mines in the 1970s, is now seeking to readmit private investment.

3.7 Overview

The problems of environmental damage because of market failure are often made worse by inappropriate government intervention. Often these interventions are made with the aim of improving social welfare, but environmentally damaging side-effects of such polices can occur if the instruments chosen are not economically efficient. While many of these policy distortions can be removed by unilateral action, there may be some the removal of which requires international coordination. The most obvious is trade distortions, which require that countries coordinate tariff reductions, through institutions such as the GATT. This will be discussed in detail in Section 6.2.

However, many other policy distortions are coming under greater scrutiny, with the growth of regional trading blocs. These are now appearing in the form of the European Community, The North American Free Trade Agreement and the ASEAN Free Trade Agreement. As countries open up trade, attention becomes focussed on other non-tariff barriers, such as subsidies to water, energy and pesticides. Since policy distortions are often strongly supported by small domestic groups of beneficiaries, it is often only this kind of international pressure which presents any challenge to their existence. Opening up to free trade and less over-valued exchange rates also encourages countries to remove domestic price controls, to allow their producers to compete more effectively. So the spread of regional trading blocs has created both domestic and international pressure for the reduction of policy failure.

4 Market Failure, Externalities and the Environment

In Chapter 2 we briefly noted that markets can give rise to allocative efficiency. We also noted that 'market failure' can

occur, when the market outcome is no longer allocatively efficient. In Chapter 3 another source of economic inefficiency, policy failure, was discussed. In this chapter we shall outline the types of environmental market failure that can occur, particularly as they relate to commodity production.

As a note on terminology, instances of market failure are often said to constitute 'externalities'; that is, they are effects which impact on the operations of the market, and on social welfare, but which are, in some sense, 'external' to the market.

When a policy is found to allow the correction of a market failure, we speak of the 'internalising of the externality'. In the discussion below we shall also briefly indicate the ways the environmental externalities may be internalised. This issue of internalisation will be dealt with in more detail in the Section

We stress the different types of environmental market failure because, as we shall see, the choice of an appropriate method of internalising an environmental externality depends crucially on an understanding of which type, or types, of externality occurs.

4.1 Types of Environmental Market Failure

We wish to distinguish three general types of market failure which relate to environmental effects. We term these: public good failure; open access failure; and intertemporal failure. Each of these externalities may have global, transnational and/or local impacts. This gives nine possible combinations of type of market failure, and geographical extent of its impact. We shall examine each of these nine case in turn, giving examples relating to commodity production. A brief outline of these none types is shown in the table below.

We also note, at the end of this section, that the way the rights of other species is considered can be of importance to the operation of markets.

4.2 Public Good Externalities

The essence of a public good is that it is non-rival in consumption, and non-excludable in its supply (Baumol 1977:521ff). 'Non-rivalry' occurs when one individual consuming a resource does not prevent others also consuming it. 'Non-excludability' occurs when it is technically unfeasible to prevent others consuming a resource.

The classic environmental example is air pollution, although as the effect of pollution is to reduce welfare rather than increase it, it might be better to refer to this as a public 'bad'. We can see that air pollution is non-rival, as its impact on any individual in a polluted area is not altered by the entry of another person into that area.

We can also see that air pollution is non-excludable as there is no physical means by which any individual in the polluted region can avoid being affected by it. The purchase of air conditioning equipment for one's home does not mean one has excluded the problem; one's welfare still suffers from the pollution as the air conditioning is a cost that otherwise need not have been incurred.

We now give examples of public good externalities, related to commodity production, for each of the three geographical categories. These amplify the brief examples given in the table in Section 4.1.

4.2.1 Public Good Externalities: Global

Global effects are when the public good affects every inhabitant of the Earth. The emission of CFCs causes ozone depletion, which affects us all. Similarly, the use of fossil fuels, and the destruction and non-replacement of forest cover, cause atmospheric carbon dioxide concentrations to increase, threatening global climate change through the 'Greenhouse Effect'.

Deforestation may be linked to commodity production, through both logging and land clearance for the production of beef, palm oil, coconuts and mineral resources. Deforestation contributes as much as 25% of anthropogenic CO2 emissions, through the release of carbon stored in biomass (WRI 1992)

4.2.2 Public Good Externalities: Transnational

Transboundary effects are when, say, air pollution seeps over from one country to another. For example, it seems that sulphur dioxide emissions from UK coal burning power stations are causing acid rain in Scandinavia.

In Papua New Guinea, gold, silver and copper are mined at the huge Ok Tedi mine. With heavy rainfall and frequent earthquakes, the mine discharges significant cyanide contaminated waste into the Fly River. This has become a transnational issue since Australian scientists have warned that these and other mining wastes could spread into the seas under Australian control (ESCAP 1992).

4.2.3 Public Good Externalities: Local

The air pollution in a city is an example of a local public good. The citizens of Mexico City suffer very greatly from air pollution, but this has little affect on those in other regions of the country.

4.2.4 Internalising Public Good Externalities

For public goods, the problem of internalisation is extremely complex, as not only is it necessary to seek ways of coping with non-rivalry, it is also necessary to provide an incentive for the

Excess or inappropriate application of pesticides can cause severe local pollution. In Central America, high pesticide residues in food were associated with the pesticide spraying of cotton crops. Fish, in particular, were highly contaminated with DDT. In Guatemala, levels of pesticide residues in cows' milk were linked to the proximity of a cotton crop, with concentrations rising in August after the July cotton planting (Conway and Pretty 1991).

provision of the good (or disincentive to the production of the 'bad'), as non-excludability is a strong disincentive for a profit maximising firm to provide any of the good. The normal means of provision is through government direct expenditure, or the use of subsidy.

Unfortunately, the non-rival nature of the good creates great problems in deciding upon the best (i.e. allocatively efficient) level of provision. Further, each individual's (or nation's) valuation of the public good is needed, but there is no incentive for any individual to provide this information. Indeed, there may be a tendency for each individual to understate their valuation of the public good, in the hope that this may reduce the levy the state may make on them for its provision. Everyone hopes that others will be levied at a higher rate, and the good will still be provided. This is known as 'Free-Riding', and its occurrence ensures that, in the absence of any other mechanism of information collection, asking individuals involved for their valuation of the public good will end up with too low a social valuation of that good, and consequently an underprovision of that good by the state. The general issue of how to evaluate non-marketed environmental goods and services is discussed in more detail in Annex 1.

As we shall see in the discussion regarding the scope for international action regarding global and transnational environmental externalities, a fundamental requirement is that the intervention be concerted, which is only likely to be achieved if all involved countries participate willingly and co-operatively.

4.3 Open Access Externalities

There is a class of externality that, in principle, should be simple to deal with. This is the case where there is open access to the good, while that good is not in principle a public good. That is, although the good is excludable, there is no exclusion.

The classic case of this is the open access availability of grazing land. If we suppose the land is available to all who may wish to use it, then users will tend to graze it to their own benefit, while recognising that if they do not use it someone else will, and they will receive no compensation for this. The outcome is much heavier use than would be achieved in a perfect market, where exclusion was in force. This overuse of open access goods has been called (confusingly) "The Tragedy of the Commons" (Hardin

1968). In reality, common property is often well-managed and regulated by groups of users. The case of open access is when such regulation does not occur.

This problem of open access affects not only grazing land, but has also affected such commodities as fish, oil, natural gas, forests, etc. It is an important and widespread problem. We now give examples of open access externalities relating to commodity production, for each of the three geographical categories.

4.3.1 Open Access Externalities: Global

Ocean fishing is available to all nations, and without international agreement a major problem of open access overfishing can, and has, occurred.

One of the main victim species of open-access fishing has been dolphins, which are caught in the purse seine nets used to catch tuna. This type of fishing has been commonly practised in the Easter Tropical Pacific where, for unknown reasons, tuna congregate under dolphins. Estimates are that as many as 6 million dolphins have been killed in this way since 1959 (Bourman 1992).

4.3.2 Open Access Externalities: Transnational

In some areas, oil fields span national boundaries, and disputes over withdrawal can occur. The same is true of access to river water, when a river passes through several nations.

Transnational disputes over open access fishing have reached major proportions, with Taiwan Province of China as one of the main culprits. In February 1991, a vessel fishing for squid inside Argentina's 200 mile economic zone was intercepted by the navy. A teenage crew member was killed in the struggle, and the crew was then imprisoned for 5 months, and only released after a deposit of US$60,000 was paid. Currently, seven boats and 26 crew members from this country were being detained in Indonesia, the Philippines and Malaysia (Baum 1991).

4.3.3 Open Access Externalities: Local

In many developing countries forests have ill-defined property rights, with consequent overuse. Similarly, some areas have ill-defined grazing rights, with consequent overgrazing.
Overgrazing by cattle has been a severe problem in Botswana, where much of the land is held in common. In many parts of the country, particularly the east, cattle stocking rates are well above the carrying capacity of the land (Veenendaal and Opschoor 1986).

4.3.4 Internalising Open Access Externalities

The problem of non-exclusion normally arises because there are ill-defined property rights on the good. It has been argued that

this problem can be circumvented easily; the state should define the property rights. For allocative efficiency it does not matter who has the property rights; all that is important is that someone has them, and they can be enforced. Then the externality is internalised and allocative efficiency, through the market, is achieved. This problem of property right allocation is known in the literature as Coase's theorem (Coase 1960).

For example, the rights to the use of an open access resource might be declared to belong to the state, and then be sold off to private users, who could assert the right to sole use of the resource. Alternatively, the state could rent access to the resource to anyone willing to pay the market rental rate. Further examples of this method of internalisation are discussed in Section

4.4 Intertemporal Externalities

A major problem in decision making concerning long-run environmental issues is that future generations are not present to engage in the decision making, even though the decisions made may affect them substantially. Thus it is quite possible, even likely, that the benefits of decisions may accrue largely to the present generation while the costs and disbenefits accrue to future generation. Thus intertemporal market failure is not only possible, but likely.

For example, many environmental resources are not used up immediately; instead their use is spread over time. In particular this issue relates to resources which could, potentially be used up rapidly, or alternatively could be husbanded and used over an extended, even indefinite, period. Examples are oil, forests, fish stocks, the Aral Sea, etc. Here the concept of 'sustainability' (Pezzey 1989) is relevant.

Concerning the use of resources over time, economists speak of 'discounting'. The higher the discount rate used, the less consideration is given to future welfare, and the more rapidly the resource is used up.

For example, at present we depend on fossil fuels for much global economic activity, and these fuels are finite globally. Presumably the current rate of extraction reflects, inter alia, the discount rate of the extractors. However, it might be the case that the discount rate used by the extractors is not that which society as a whole may wish. In particular, it may be that because the extractors have only a relatively short time left on this Earth, their attitude to the future may be such that they give little weight to extraction in the decades and centuries ahead. That is, there may be a divergence between the discount rate of the extractors, and that of society as a whole, including future generations.

This problem of the efficient intertemporal use of resources is at the heart of the current debate on 'sustainability'. Sustainability can been defined as follows: "Sustainable development is the development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED 1987:43). It reflects concern for an externality of a particularly complex type, involving decisions made in the present affecting future generations in unpredictable ways. We now give examples of intertemporal externalities relating to commodity production, for each of the three geographical categories.

4.4.1 Intertemporal Externalities: Global

Even if the public good problem of CO2 emissions can be brought under control, through international agreements, it may still be the case that the agreed rates of emission are not intertemporally optimal, because too little weight is given to future generations, through the use of too high a discount rate.

The latest estimates on global warming suggest that the global mean temperature will rise by approximately 0.3C per decade. Thus temperatures will be 3C higher by 2100. In comparison, average global temperatures during the last Ice Age were only 4-5C cooler than today. However, because these costs are borne in the future, they are undervalued because of discounting.

4.4.2 Intertemporal Externalities: Transnational

The acidification of lakes has been attributed to emission of SO2 and NOx, often emitted outside the affected countries. Again, even when international agreements limit the emission of these pollutants, the loss of amenity to future generations may not be sufficiently accounted for, because of the use of too high a discount rate.

Deforestation can lead to severe soil erosion that leads to siltation and flooding in the river basins of neighbouring countries. Those who deforest are often poor farmers, with very high discount rates. Much of the present siltation in the rivers of eastern India and Bangladesh is attributable to deforestation in the Himalayan states.

4.4.3 Intertemporal Externalities: Local

When countries destroy their forests, for timber or land clearance, the rate of extraction may well be higher than is justifiable, as the area of forests left may be insufficient for the purposes of future generations in that country.

4.4.4 Internalising the Intertemporal Externality

Intensive land use without any conservation measures causes soil loss, which lowers the productivity of the land for future generations. In the mid-country region of Sri Lanka, much of the tea land is degraded and does not have more than 40% vegetation cover. This under-investment in soil conservation lowers potential revenue for the future, as well as the present.

How can this externality be internalised? As the effect of too high a discount rate will be too high a rate of resource depletion, control on the permitted rate of resource extraction would proxy the effect of a lower discount rate.

Alternatively, the resource could be taxed. This will raise the supply curve, thereby lowering the equilibrium extraction rate. Generally, economists would favour the use of a tax rather than controls, as the tax will provide a market incentive for becoming more efficient in the use the resource, and also provide income to the government.

The widespread taxation of oil and petroleum products is an example of the (at least partial) internalisation of the externality of too rapid oil extraction, because of too high a discount rate by extractors.

Another way to internalise intertemporal externalities is by the establishment of trust funds for future generations, paid for by resource and/or pollution taxes. Environmental improvements can be paid for with the interest generated by the funds. Bhutan has recently set up such an environmental trust fund.

4.5 Markets and the Rights of Other Species

We should recall that markets are just one means of social coordination. Further, the operation of markets requires a moral and judicial framework in which to operate. What is regarded as morally acceptable to be produced and traded varies from time to time, and between cultures. For example, until the mid-nineteenth century, slavery was widely practiced, with humans treated as commodities, to be bred, sold and used as instruments. We now abhor that practice. Instead, we assert the moral right of humans to lives of liberty, so that their market roles be that of agents rather than commodities.

In a sense, the environmental movement, particularly that brand known as 'deep ecology' (Tobias 1988), is now acting to assert the moral rights of other species. Although it is hard to see how most species could act as economic agents, it is possible that they could cease to be treated as just commodities. For example, the present ban on whaling, and the concern over dolphin

deaths in tuna nets, can be associated with the large brains of these mammalian species. Their apparent intelligence leads many, at least in the West, to treat these species with more concern, more moral tenderness, than other marine species, such as sharks and squids.

The moral status accorded other species is not an economic issue in the sense of its effects on markets. However, it is an issue the resolution of which will have a great effect on the nature of the markets. In particular, if different cultures give different moral worths to species, then market difficulties are likely to be experienced. This will, and is, having an effect on trade relations between countries.

There was a US ban on Mexican tuna, which were being caught in away the US authorities judged to be detrimental to dolphins (GATT 1991).

4.6 Internalisation of Externalities and the Problem of Valuation

The essence of an environmental externality is that it occurs outside of the market framework, so there are no market prices available. For example, air pollution clearly reduces social welfare, just as the availability of goods increases social welfare. However, whereas we can measure the contribution to social welfare of marketed goods by their prices, we have nor price for air pollution, and so have no direct means of measuring the social disbenefits it causes.

This lack of prices for environmental externalities raises two important issues. First, is it possible to measure the social welfare effects of these externalities by indirect means? Second, if we can find proxy (or shadow) prices for these externalities, what effect will this have upon national accounts and such aggregate measures as Gross Domestic Product (GDP)?

Both these issues are rather complex, so they are discussed in detail in annexes. Here it suffices to say that indirect valuation techniques for environmental externalities have been devised, and can and are implemented with varying degrees of success (see Annex 1). Similarly, national accounting procedures can be modified to take account of environmental externalities; this is often achieved by the use of 'satellite accounts', which modify the normal national accounts (see Annex 2).

5 Instruments for Internalising Environmental Externalities

In Sections 3 and 4 we described the nature of market and policy failure which can give rise to environmental problems, particularly with respect to commodity production.

In this section we discuss the methods by which environmental externalities can be internalised. A range of policy measures are described, ranging from direct government actions on property

rights, to the imposition of 'Pigouvian' taxes and subsidies. In detail, the spectrum of internalisation instruments is as follows:

1. the assignment of property rights; 2. quantity restrictions subject to judicial action; 3. quantity restrictions subject to administrative fines; 4. performance bonds; 5. deposit-refund systems; 6. tradeable pollution permits; 7. Pigouvian taxes; 8 . Pigouvian subsidies.

5.1 Assignment of Property Rights

In Chapter 3 we noted that open access market failure can be rectified by the 'Coasian' technique of the assignment of property rights. For example, until relatively recently sea fish were available to all without restriction; they were common property. This gave every fisherman the incentive to harvest more fish than was appropriate for the long-run sustainability of fish stocks, as any left unharvested could, and would, be harvested by another.

This open-access externality of fish harvesting has been partly solved by the international agreement of 'exclusive economic zones' for nations with sea coasts. Thus the property rights of fish in these off-shore zones have been defined, at least at the level of nation states. The allocation of these rights by the nations among fishermen is usually dealt with by quotas, to be discussed next.

Of course, some allocations of property rights will be more conducive to equity, and thence social welfare, than others. If the government were to give property rights on previously open-access forests to the Minister of Forests, this would be efficient but not very equitable (nor probably acceptable politically to the population at large). On the other hand, the allocation of property rights to the current users, either individually or collectively, would be both efficient and probably equitable.

One aspect of the allocation of property rights is the recognition of liability for environmental damage, and the payment of compensation by those responsible. In Papua New Guinea, the operators of the Ok Tedi mine paid compensation to local land-users for the environmental nuisance caused by the mining operation (Thompson 1991).

While ownership is a necessary condition for internalising theopen access externality, it is not a sufficient condition. Full internalisation requires two further conditions. First, the owners must have ownership conferred for a sufficiently long time period to ensure that it is in their interests to reduce open access.

In Bangladesh, inland fishing grounds were auctioned to the highest bidder. However, as these auctions were annual, the short license period, with no assured renewal, led the owners to maximise revenue by allowing entry to as many fishermen as possible, and charging for entry. Hence overfishing (intertemporal externality)

occurred (Siddiqui 1989).

Secondly, the owners must be able to monitor entry to their resource, or the situation reverts to de facto open access. The government of Botswana launched a Tribal Grazing Land Policy in 1975, to encourage cattle farmers to shift their grazing from the east of the country to the west. However, this only encouraged open access overgrazing in western Botswana (Veenendaal and Opschoor 1986).

In conclusion, the problem of non-exclusion is often 'easy' to solve by the assignment of property rights. However, in practice the assignment of property rights may be very difficult. It may involve altering social customs of some antiquity, causing political dissent. Also, the assignment of property rights is bound to upset someone, who feels their share is insufficient. Finally, the assignment of property rights is a potential source of considerable venality; history is replete with cases of corrupt leaders asserting property rights on previously open-access resources (e.g. Scottish clan leaders in the seventeenth and eighteenth centuries, who claimed personal ownership of clan lands).

5.2 Quantity Restrictions Subject to Judicial Action

Probably the most common way that governments seek to internalise environmental externalities is through the imposition of quantity restrictions, which have the force of law and are backed by the threat of judicial action. This judicial action is fundamentally uncertain in its outcome, with the possibility of fines, confiscation of equipment, or even imprisonment. This differs from the use of administrative fines, which are certain in their size and nature, and are discussed below.

Quantity restrictions can be applied to all three types of environmental externality; i.e. public goods, open access and intertemporal. We now give some examples of such application.

5.2.1 Quantity Restrictions to Internalise Public Good Externalities

Air pollution is the classic example of an environmental public good ('bad'), and its control has, to date, been achieved almost exclusively by quantity restrictions. The 'Clean Air' legislation in the UK is partly based on the banning of smoke emissions of various types in urban areas. Failure to comply with this legislation leads to judicial action. This has had a considerable effect on the types of fuel used, with the almost complete abandonment of coal burning in cities, in favour of gas burning. The cleaning of UK city air must, however, also be attributedin part to the opening up of North Sea gas fields, providing a clean and cheap alternative to coal.

The pollution of groundwater by nitrate and pesticide leaching is also a public good externality that has been to some extent limited and internalised by the regulation of fertiliser use and the limiting or banning of pesticides and fungicides. Again, failure to comply with these regulations is usually met with judicial action.

In 1957 the Costa Rican government banned the import, sale or use of mercury-based fungicides for the control of coffee plant diseases. In 1975 further controls were introduced, on the use of fungicides that contained arsenic or lead. In 1990 a complete ban on the use of arsenic pesticides was introduced (Segura 1993).

5.2.2 Quantity Restrictions to Internalise Open Access Externalities

As mentioned above, access to sea fish stocks by nations has, to some extent, been internalised by the assignment of property rights to coastal nations. Within countries, overfishing is controlled by restrictions on mesh size, frequency of catch and by the use of 'tradeable quotas', as in New Zealand, for example.(Tradeable quotas work like 'tradeable pollution permits' - see Section 5.6.) The assignment of fishing rights to individual fishermen within these zones has generally been achieved by the allocation of fishing quotas. These allow individual fishermen to take no more than a specified weight of fish, often specified by species.

The South Pacific nations have imposed licensing as a quantity restriction on fishing. To deter transgressions of these fishing limits, South Pacific nations have responded with tough punishments. In 1987, Kiribati fined the owners of US trawler Tradition US$300,000 and charge US$1 million for the return of the vessel (Waugh 1989).

With open access forestry one could similarly impose quantity constraints, by permitting each logger to fell no more than a specified maximum number of trees.

5.2.3 Quantity Restrictions to Internalise Intertemporal Externalities

Even if a forest or a fish stock does not have open access, it might be the case that the owner of the resource has a high discount rate, and so might seek to use up the resource more rapidly than is socially desirable. In such a case this intertemporal externality might be internalised by placing quantity limits on the rate of resource use.

Indonesia has implemented a policy of limiting the quantity of timber to be harvested per hectare, through a permits system. To prevent abuses of logging permits in Indonesia, in 1989 48 concessions were revoked and 37 others suspended. Also, fines totalling US$4 million were issued, for cutting outside designated

blocks, harvesting more than was allowable, or felling unapproved species (Poore 1989).

5.2.4 Limitations of Quantity Constraints

There are two major limitations to the usefulness of quantity constraints when supported only by judicial action. First,quantity constraints are unlikely to give allocative efficiency.Second, such constraints are unlikely to provide effective incentives for polluters/extractors to seek out and use more environmentally benign techniques of production.

Regarding allocative efficiency, it might be the case that, say, pollution constraints on two firms are such that one is allowed to emit more than it desires, but another less than it desires. Clearly, by adjusting the constraints in favour of the pollution limited firm, that firm can become better off without the other firm becoming worse off, thereby increasing allocative efficiency. As this problem of the differential effect of quantity constraints on firms will always occur, such constraints can never give allocative efficiency. They therefore will give outcomes of lower social welfare than might otherwise be achieved.

The problem of lack of incentives to firms arises because of the uncertain penalty occurring when the constraints are breached. It is quite possible that a minor infringement will not even be noticed, while a major infringement may be treated so severely as to bankrupt the firm. In either case there is no clear incentive for the firm to seek to reduce the environmental impact of its operations in any consistent way, through the introduction of new techniques of production.

5.3 Quantity Restrictions Subject to Administrative Fines

In this case the internalising of the externality is again by constraints on the behaviour of firms, but if there is any infringement the firm is fined at a rate determined administratively rather than judicially. That is, the fine is determined by some administrative formula, related to the degree to which the quantity constraint has been breached. This approach has been widely used in China for water pollution, where it is a substantial source of government revenue.

The Chinese Environmental Protection Agency charges enterprises a fee for violating emission standards. Although there was a 40% increase in the fee level in 1991, it still remained only about 0.1% of most enterprises' production costs. In Beijing, 8% of all enterprises were charged fees in 1988, raising a total of Yuan 30.5 million (Krupnick and Sebastian 1990).

While the certainty of the administered fine differs from the uncertainty of judicial action, this approach will still not be allocatively efficient, for the reasons discussed above. The certainty of the fine (if caught) will give rather more incentive

to seek less damaging techniques by those who are constrained in their production, but the incentive is still not very direct.

5.4 Performance Bonds

A performance bond is a quantity of money paid to the government, or its agent, prior to undertaking an action which may be environmentally damaging. If the action is completed so that no more than a pre-specified level of damage/depletion occurs, the bond is repaid. However, if the limit is exceeded, the bond is forfeit.

In concept this is very similar to an administrative fine system, except that whereas with an administrative fine the transgression must first be noted by a government inspector, with a bond system attention to the environmental impact is assured. Also, as the bond is prepaid, the firm cannot avoid payment of any environmental fine by declaring bankruptcy (though the forfeiture of the fine could lead to bankruptcy).

Performance bonds can be applied to the internalising of all three types of externality. For example, firms or individuals may be bonded to restrict their emissions of smoke below certain levels (public good externality), or to restrict their use of open access forests (open access externality), or to restrict their rate of depletion of privately owned resources (intertemporal externality).

Performance bonds were introduced in Malaysia in the 1960s, for mine rehabilitation. The amounts required ranged from US$1,000 per acre in Jahore to US$5,000 in Kuala Lumpur and Selangor.

5.5 Deposit-Refund System

A deposit-refund system applies to users of certain goods which may have negative environmental effects if abused in their use or disposal. For example, bottles are often disposed of by dumping, because there is no incentive to reuse them. Such dumping constitutes an open-access externality, because of insufficiently well defined and/or implemented property rights. It may also constitute a public good externality, because of the welfare loss through the appearance of litter.

Even if the bottles are not dumped they may be trashed, requiring costly disposal as land fill. This will increase the speed of landfill, constituting an intertemporal externality.

Deposit-refund schemes seek to internalise these externalities by giving bottle users an incentive to return the bottle for reuse or recycling, so that the deposit can be refunded.

If the deposit it set at a level equal to the marginal social damage caused by the bottle not being returned, then this scheme is the same as a Pigouvian tax (to be discussed below), and gives allocative efficiency.

Since 1988 the Republic of Korea has operated a deposit-refund system on food containers, tyres, batteries, lubricants, pesticide containers and plastics (London Economics 1992).

5.6 Tradeable Pollution Permits

Tradeable pollution permits (TPPs) are a new, and relatively untried, method of internalising externalities. Unlike the methods described above, they attempt to use the market to internalise the externality of pollution. In their operation the state decides on a target level of emission. This target level will presumably be set at a level that is thought environmentally and economically effective, and is also politically acceptable.

To enforce this target level of emission, firms are distributed with pollution permits. A firm holding, say, 100 units of permits would be allowed, say, 100 units of smoke emission (however the units were defined). If a firm found itself holding more pollution permits than it felt optimal for its operations, it could sell them for whatever price it could realise. Conversely, firms desiring more permits could seek to buy them from other permit holders. That is, the pollution permits are tradeable. This gives rise to allocative efficiency in pollution permits, though not necessarily in the production of pollution, as this is still determined by the government.

5.6.1 Allocation of TPPs

Different circumstances might dictate different methods of initially allocating the pollution permits. It could be done on the basis of current pollution emission, say pro rata. Alternatively firms could be invited to bid for the permits, and the permits sold at the market-clearing price. This second approach has the advantage of raising revenue for the government; it would even allow environmental groups to enter the market and buy up permits with the express intention of not using them.

The TPP approach can be called a semi-market solution because, while the permits would be allocated, at least eventually, by a market mechanism, the quantity of permits issued would not be determined by the market, but by the government.

5.6.2 Advantages and Disadvantages of TPPs

As a method of regulating the production of environmental public bads (i.e. pollution), TPPs would be considerably simpler to implement than Pigouvian taxes, to be discussed below. They have the great advantage of clarity of purpose, and could be made more stringent in a progressive way, by the government reducing the quantity of permits available, either by giving them a finite life, or by simply purchasing permits on the market. They also give clear incentives for firms to seek less environmentally damaging techniques of production, particularly if the permits are steadily reduced in number.

However, considerable monitoring would still be necessary. This would be to ensure that firms emitted no more pollution than allowed by the permits they hold.

5.6.3 Applications of TPPs

Because of their obvious benefits, TPPs are most economists' preferred instrument for internalising environmental effects. They clearly can be used to internalise public good and intertemporal externalities, but have no obvious application to open access externalities.

Related to TPPs are Individual Tradeable Quotas (ITQs), for renewable resources, such as fish. ITQs have been introduced in Australia, New Zealand, Iceland, Canada and the Netherlands. Australian ITQs were introduced in 1984 in the Southern Bluefin Tuna Fishery to reduce the size of the fleet by a third. The effects were dramatic: the number of vessels dropped from 136 to 63 in 1987 and the tuna were being harvested later, so the value of each tonne caught increased fivefold (Wesney 1989).

5.7 Pigouvian Taxes

Pigouvian taxes are a means by which an environmental externality can be internalised directly and allocatively efficiently. They are the precise embodiment of 'full-cost' pricing, with the cost of a good being adjusted so that it reflects the reduction in social welfare caused by any environmental externalities associated with it.

The adjustment from market price to full-cost price is achieved by adding a tax which exactly equates to the social welfare effects of the externality. Such a tax is called 'Pigouvian', after its originator (Pigou 1920).

This full-cost pricing technique is clearly applicable to public good and intertemporal externalities, but not to open access problems. In this respect it is similar to TPPs, discussed above.

5.7.1 Practical Achievement of Pigouvian Taxes

How easy is the establishment of a Pigouvian tax? Generally, it is extremely difficult, if the aim is to get an exactly correct tax. The establishment of the Pigouvian tax would be in several steps (Pearce and Turner 1990:Ch.6).

First, one would need to construct a marginal social benefit schedule for the externality. This is the extra benefit society gains from every extra unit of the externality; this benefit would derive from the extra output and consumption that is allowed.

Second, one would need to construct the corresponding marginal social cost curve for externality. This would derive from the costs of ill-health, discomfort, etc. attributable to the

externality.Third, one would seek the level of externality at which the marginal social cost just equals the marginal social benefit.Producing more externality than this would generate larger marginal costs than benefits, indicating society would gain overall by a reduction in the externality. Conversely, lower levels of the externality would generate larger marginal benefits than costs, indicating a higher level of externality is better.

Fourth, having identified the optimal level of the externality, one needs to find the corresponding level of externality tax. This would affect firms' costs so that their supply curves would rise, until the market supply and demand equilibrium output was at that level of output which corresponded to the optimal output of the externality.

5.7.2 Advantages of Taxes for Internalising Externalities

Because of the difficulty of calculating an exact Pigouvian tax for an environmental externality, any actual tax on environmental public goods will almost certainly not be Pigouvian in a strict sense. The most we could hope for in environmental taxes is to move the imperfect market outcome towards the expected (though imaginary) perfect market outcome, without going too far. That is, the most we can hope an environmental tax to be is a means of moving an economy to produce less of the environmental externality; but caution is needed to ensure that the tax is not such as to discourage production below the optimal level.

However, the tax-based approach to dealing with environmental bads has the great advantage that it is, to a degree at least, self-policing. Firms may choose to emit any amount of pollutant they wish, as long as they pay the corresponding tax. There remains, of course, the problem of ensuring the correct level of tax is collected, which would require a considerable process of monitoring. The tax collected is also a source of government revenue.

A further benefit of an environmental tax relates to considerations of equity. An environmental tax will impact on the prices of the goods the firms produce, and this will be reflected in higher prices, and presumably lower consumption, for purchasers. Now in a sense, both the producer and the consumer must bear 'responsibility' for the pollution, as it is generated by the producer, but to manufacture goods demanded by the consumer. As we see, the tax will both reduce firms' outputs (and profits) and reduce consumption, so that both the 'guilty' parties suffer a penalty. This is often called the 'Polluter Pays Principle'.

5.7.3 Taxes on Externalities, Not Products

In this discussion of taxing externalities it must be borne in mind that it is the externality which is targeted for taxation, not the good associated with the externality.

For example, if the growing of wheat leads to groundwater contamination by nitrates (public good and intertemporal externality), then the tax should be upon the pollution, not the wheat. For if wheat were taxed, no matter how it was grown, there would be no incentive to wheat growers to seek less polluting techniques of production.

Further, the tax should not be on the fertiliser, as some farms may be on soils from which little leaching occurs, so their use of fertilisers need not be reduced.

Of course, actually taxing the leachate is extremely difficult, as it would involve knowledge of topography, geology and drainage patterns for all wheat growing farms. However, this is what a Pigouvian tax should, in principle do. Any tax on the output (wheat) or input (fertiliser) would at best approximate to the effect of a Pigouvian tax.

In Malaysia, the palm oil industry is a major contributor to environmental pollution. Since July 1988, this externality has been internalised by the imposition of a pollution charge on effluent from the processing mills (ESCAP 1992).

5.8 Pigouvian Subsidies

An alternative to imposing a tax on environmental externalities is to give a subsidy to techniques of production which produce the same good or service, or a close substitute, but by a technique which generates none, or less, of the externality. This is called a Pigouvian subsidy.

The theory of Pigouvian subsidies is identical to that of Pigouvian taxes, except that it concentrates explicitly on giving incentives to move to a different technique of production, rather than seeking to give a disincentive to the use of the current technique.

For example, if a particular method of processing, say, coffee generates a great deal of water pollution, while an alternative technique produces less pollution, but at a higher cost, this more 'expensive' technique can be subsidised so as to tempt producers away from the other, dirty, technique.

5.8.1 Advantages and Disadvantages of Pigouvian Subsidies

When discussing Pigouvian taxes it was noted the difficulty in their application because they need to be on the externality itself. Pigouvian subsidies, on the other hand, are to the use of alternative techniques, and as such are likely to be much easier to apply.

A further major advantage of Pigouvian subsidies, particularly in poorer countries, is that they can be targeted to the provision of the new capital equipment necessary for the introduction of alternative and environmentally less damaging techniques. This can be very important when sources of finance are difficult to obtain, and allows the relatively rapid introduction of the new technique, and the phasing out of the environmentally more damaging old techniques. For example, much environmental damage by small-scale 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.

One form of subsidy is the provision of cheap credit for the purchase of new machinery. Zimbabwe operates a hire-to-purchase arrangement, with terms between 123 and 36 months. In Chile, miners can receive short- and medium-term loans. In Mexico, credit facilities for small-scale miners are provided by the government with the support of multilateral lending institutions.

A disadvantage of Pigouvian subsidies, particularly in poorer countries, is the drain on government funds they would involve. However, this might be met by bilateral and multilateral transfers from richer countries, and this issue will be returned to in Chapters 6 and 8.

In Costa Rica funds have been made available for ecological projects such as the provision of new technology for coffee processing. These funds have an interest rate 2% below the rate for current agricultural lending (Segura 1993).

5.8.2 Pigouvian Subsidies to Techniques, Not Commodities

It should be stressed that a Pigouvian subsidy must be to a technique rather than a commodity, if it is to achieve its desired effect. For example, if a particular form of farming of, say, wheat is producing an externality, then the subsidy of the production of an alternative crop, say barley, is unlikely to have the desired effect of internalising the environmental externality. This is because, while one may expect that the growing of barley will be by a current technique, which is not environmentally damaging, the subsidy of barley might stimulate the adoption of alternative, more expensive, and perhaps environmentally very harmful techniques.

5.9 Summary of Methods of Internalising Externalities

Before drawing conclusions regarding the means of internalising environmental externalities, we summarise these techniques, the types of externality on which they can be effective, and their advantages and disadvantages in operation.

Method	Externalities Affected	Advantages	Disadvantages
1. Property Rights	a. Open access	a. Direct internalisation	a. Distribution of allocation b. Effects on customary behaviour
2. Constraints (Judicial)	a. Open access b. Public good c. Intertemporal	a. Clarity b. Ease of administration	a. Allocatively inefficient b. Poor incentive structure
3. Constraints (Administrative)	a. Open access b. Public good c. Intertemporal	a. Clarity b. Ease of administration b. Source of finance	a. Allocatively inefficient b. Relatively poor incentive structure
4. Performance Bonds	a. Open access b. Public good c. Intertemporal	a. Clarity b. Ease of administration	a. Allocatively inefficient b. Relatively poor incentive structure
5. Deposit-Refund	a. Open access b. Public good c. Intertemporal	a. Clarity b. Ease of administration c. Potentially allocatively efficient d. Clear incentive structure.	a. Deciding level of deposit
6. Tradeable Pollution Permits	a. Public good b. Intertemporal	a. Clarity b. Ease of administration c. Potentially allocatively efficient d. Clear incentive structure. e. Potential source of revenue	a. Deciding on number of permits to issue
7. Pigouvian Taxes	a. Public good b. Intertemporal	a. Allocatively efficient b. Clear incentive structure c. Potential source of revenue	a. Determining appropriate level of tax b. Administratively complex
8. Pigouvian Subsidies	a. Public good b. Intertemporal	a. Allocatively efficient b. Clear incentive structure c. Targeted on identifiable techniques d. Rapid adoption of new techniques	a. Determining appropriate level of subsidy b. Administratively complex c. Cost of subsidy

5.10 Conclusions on Internalising Environmental Externalities

A wide range of techniques of internalising environmental externalities is available to governments and regulatory agencies. Of these, some are allocatively efficient, or could be if sufficient information were available (Deposit-refund, Pigouvian taxes, Pigouvian subsidies), while others are also market oriented but not necessarily allocatively efficient (Constraints-administrative, TPPs). Some instruments can act as sources of revenue (Constraints-administrative, Pigouvian taxes), while other may involve significant costs (Pigouvian subsidies).

Of course, when reference is made to 'costs' in the context ofinternalising externalities, this is not the cost net of reducing the externality. It should certainly be the case that for any reasonable instrument, sensibly applied, the net costs of reducing the externality will be negative, in welfare terms. Of course, this welfare improvement may not be reflected in the national accounts, as usually established, but this is an argument for reforming the accounting procedures rather than against attempting to internalise the externalities.

There is a wide range of ease of administration associated with these instruments, and in poorer countries ease of administration may be an influential factor in deciding upon which instrument is appropriate. However, those which are administratively simple also tend to be the instruments which provide poor incentive structures, and which also do not offer allocative efficiency (e.g. Constraints). When selecting which instrument to use, there will need to be a balancing of the ease of administration with the benefits that more complex systems bring (or at least promise).

6 The International Dimension of Internalising Externalities

There are several ways in which international trade can be an issue for, or be affected by, the internalisation of environmental externalities. Before examining these in turn, we briefly review the way trade can be expected to operate in the absence of externalities. In particular, we note that the social welfare benefits to be gained from trade can be threatened by lack of mutual trust between nations.

We then examine the likely effects of attempts to internalise environmental externalities on trade. We also note that trade constraints may be used as an instrument to seek to internalise environmental externalities, though we argue that such instruments are likely to be ineffective and more likely to reduce social welfare than to increase it.

Finally, we outline six categories of international agreements that have been used to internalise environmental externalities.

6.1 Trade in the Absence of Externalities

Since Ricardo, economists have conceptualised trade as a result of the international specialisation of production, because of the comparative production advantages countries enjoy over each other. Also, it is generally accepted that free trade, unfettered by tariffs or quotas, gives an allocatively efficient outcome. Here the notion of allocative efficiency refers to countries as the economic agents, rather than individuals. This allocative efficiency leads to higher income and consumption for all trading nations.

The gains from trade (or the costs of protectionism) are calculated to be about 1% to 5% of GNP annually for as long as the current situation of protectionism lasts (Shoven and Whalley 1984).

As is well known, free trade is observed mainly in the breach; all countries impose tariff and/or quota barriers to trade. These barriers to trade can be understood as arising from a combination of: development aims; the appeasement of special interest groups; and retaliation against other countries' trade barriers. Often two or even all three reasons are given for the existence any specific tariff or quota.

Under the EC Common Agricultural Policy, consumers have paid every producer an average of over US$9,000 per year. Consumers have had to accept food prices that are about 20% higher than world price levels.

A further justification for trade barriers, which is being heard more and more often, is the reduction of environmental damage. The import ban on certain tropical timbers is an example, as is the ban on the importation of seal skins by the EC. This raises the question of whether trade restrictions are an efficient instrument for internalising environmental externalities. Before we address this issue, though, it would be useful briefly to outline how international relations may be such that countries see the imposition of barriers to trade to be in their self-interests.

An econometric study of the diffusion of a more environmentally friendly technology for wood pulp manufacture showed that this was adopted much faster in developing countries with freer trade (Wheeler and Martin 1991).

6.2 International Agreements and Cooperation

We begin by noting that relations between countries differ from relations between individuals. The notion of a perfect market relies on there being a large number of economic agents, so that the actions of one agent have a negligible impact on the other agents. In the case of international trade, this is clearly not the case. Most trade is conducted between a relatively small number of countries, with a handful of these trading countries having an enormous influence on the entire trading system (e.g. USA, Japan,

Germany).

In the case where market relationships are between a few countries, then one can no longer expect that the workings of simple self-interest will necessarily give rise to an allocatively efficient outcome. The classic example of how relationships between a few agents can give rise to allocatively inferior outcomes is the 'Prisoners' Dilemma'. (The general study of such strategic interactions is known as 'Game Theory'.)

In a Prisoners' Dilemma, it is supposed that two (guilty) individuals are charged with robbery. They are interrogated separately, and are both offered the following alternatives.

1.

Confess and implicate your partner. If the partner refuses to confess, then you get a pardon. If you both confess you both get a moderate sentence (1 year).

2.

Do not confess and run the risk of getting a heavy sentence (3 years) if your partner confesses. If neither of you confesses, there is enough evidence to ensure you serve a light sentence (6 months) on an alternative charge.

The problem each criminal faces is whether to confess or not. It is often thought that a rational way to make this decision is to suppose the worst concerning the behaviour of one's partner, and seek to minimise the damage from these two outcomes. (In the literature, this is called a minimax solution.) The worst case is always if the partner confesses, when the two possible outcomes would be a moderate sentence (if you also confess) and a heavy sentence (if you fail to confess). Clearly, of these two alternatives, confessing gives the lesser harm.

However, on this argument of assuming the worst behaviour by the partner, both the prisoners will confess. The outcome will be that both will receive a moderate sentence. This is known as the non-cooperative outcome. This is clearly not a allocatively efficient outcome, for if neither prisoner had confessed, both would have received a light sentence. The case that neither confesses is known as the cooperative outcome.

The problem arises because of a lack of trust between the prisoners. Both suspect the other of seeking the free pardon at their expense, rather than trusting the other to have the good sense to refuse to confess but accept a light punishment. So a lack of trust between the parties concerned leads to a non-cooperative and non-allocatively efficient outcome.

Recent work has shown that cooperative outcomes are possible, and indicates that as long as the problem has to be faced repeatedly rather than just once, trust-raising behaviour is possible, even likely (Axelrod 1984).

The moral to be drawn from the Prisoners' Dilemma is that without mutual trust, relations between countries can become non-cooperative, to the detriment of both. The application of tariffs is the classic example. If both countries fear the imposition of tariffs by the other, then without mutual trust both countries will impose tariffs, to their mutual disbenefit.

History suggests that, as far as tariffs are concerned, trust has been signally lacking in international trade. Indeed, the role of the GATT, and the GATT 'rounds' during the past forty years, has been to seek to establish mutual trust between countries, so that tariff barriers can be lowered incrementally.

6.3 Trade Barriers as Tools of Environmental Policy

Having outlined the reasons why trade barriers can arise through lack of trust, we now turn to their potential use as a tool of environmental policy. To assess the efficacy of trade barriers as a tool of environmental policy, we need to distinguish between environmental effects which are local, affecting only one nation, and those which are transboundary or global in effect. We begin with the case of transboundary/global environmental issues.

6.3.1 Trade Barriers and Transboundary/Global Environmental Effects

When public good environmental effects impinge upon other, or all, nations, then clearly there needs to be negotiated agreement between the relevant nations. For example, the USA is presently responsible for about 30% of global carbon dioxide emissions(Proops et al. 1993:37). If other nations feel strongly that they are unwilling to accept the (potential) climate change resulting from this emission, then they may seek to internalise this externality by requesting compensation from the USA. If the USA were unwilling to pay this compensation voluntarily, then it could be sought involuntarily, by the imposition of tariffs on goods imported by the USA. Alternatively, goods exported by the USA could have tariffs imposed, the rationale here being that this would be a cost to the USA in lost exports, and of benefit to the nation imposing the tariff, in that it would allow expansion of domestic production in substitution of the reduced imports.

This use of import or export tariffs would go some way to internalising the externality resulting from carbon dioxide emissions, but it would be very far from allocatively efficient. In particular, the tariff could not act as a Pigouvian tax, as this would need to be on only carbon dioxide emission. The tariffs could be made rather more Pigouvian in nature if the import tariff were proportional to the carbon dioxide emitted by the USA in the production of the particular exports. Alternatively, the export

tariff could be on only the fossil fuels purchased by the USA, as their combustion causes the emission of carbon dioxide emissions. In neither case would even these focussed tariffs completely internalise the externality, as it would not substantially affect the (relative) pricing of goods produced in the USA for consumption in the USA.

However, if the alternative to this non-efficient use of tariffs would be no internalisation of the externality, because agreement could not be reached, it would certainly be better to impose the tariffs than to make no attempt at internalisation, as long as there were no retaliation by the USA. The above discussion, on the importance of mutual trust, indicates that retaliation is likely. In the case we are considering, the trade barriers were imposed because the USA would not pay compensation voluntarily, suggesting that a spirit of cooperation was absent from the discussions. If there is no cooperation available, then retaliation is very likely.

Here we need not pursue the possible environmental ramifications of a tit-for-tat trade retaliation, following the imposition of trade barriers which seek to internalise an international environmental externality. It is clear that such retaliation would be extremely damaging to social welfare, and the cure would rapidly be seen to be worse than the disease.

The moral is that international trade is of enormous benefit to all, but it depends upon the non-imposition of trade barriers. The reduction of such trade barriers is known to be a delicate process, vitally dependent on the establishment of mutual trust between the trading nations. It would seem to be extreme folly to attempt to internalise an international environmental externality in a way that reduced mutual trust, and thereby threatened far greater welfare loss than gain. The imposition of trade barriers that are effective is liable to be extremely damaging to social welfare globally, so this method of seeking to internalise environmental externalities has absolutely nothing to commend it.

6.3.2 Trade Barriers and Local Public Goods

An argument sometimes used is that some nations, particularly in the Third World, have lax environmental standards, and thereby gain an 'unfair' trading advantage; this is sometimes called 'environmental dumping'. This disparity between national environmental standards has been used as a reason to argue for the erection of trade barriers against low standard countries, to give a 'level playing field'. However, this argument does not stand up to scrutiny.

6.3.3 Environmental Standards and Comparative Advantage

The first thing to note is that different nations may very reasonably evaluate the disbenefits from pollution differently. For example, countries with very low population densities may be able

to use 'dirty' technologies without significant effects on the welfare of their populations or the well-being of the natural environment. If the production activities are well-spaced, the natural absorptive capacities of the environment may be able to cope with the pollution produced. In this respect, the ability to cope with pollution is simply a 'natural comparative advantage',comparable with having a warm climate or a rich mineral stock. To argue that a corresponding environmental standards in some nations are 'unfairly low' would be equivalent to arguing that some nations are 'unfairly warm' or 'unfairly fertile'! (In practice, of course, countries with fragile ecosystems - e.g.those in the tropics - may be faced with lower absorptive capacities for pollution.)

6.3.4 Environmental Standards and Welfare Judgements

A second reason that countries may have different environmental standards is that they have different levels of wealth and income. We know that as countries, and individuals, become wealthier, environmental awareness rises. In economic terminology, environmental concern is a 'superior good'. As a consequence, poor countries may be willing to accept lower environmental standards, and higher pollution levels, than rich countries. In this the individuals in these countries may be following rational self-interest; that is, these pollution regulations may be allocatively efficient for them.

If it is the case that the environmental standards adopted are allocatively efficient, then there is no environmental problem, at least using our market efficiency criterion. Thus there would be no further externality to internalise, and any objections made by other countries regarding the level of environmental standards would be irrelevant.

One objection to low environmental standards that does have merit would be that the standards are lower even than the people of that country would wish. It may be that because of poor government (i.e. policy failure) the environmental externality has not been internalised, so that the pollution suffered is more than is allocatively efficient. In this case a trade barrier to reduce that country's exports of goods produced in a polluting way may tend to internalise the externality.

However, this argument is still open to objection. It is an article of international law and international relations that countries do not interfere in the internal affairs of other countries. Trade barriers to seek to internalise another country's externality would certainly infringe this principle of sovereignty.

Finally, it is worth noting that the principal (relative) benefactors of constraints on trade are the wealthy countries, while the countries which would benefit most from free trade are the poor countries of the Third World. This is particularly well-documented with regard to agricultural protectionism. If,

within the context of completely free trade, tariffs for strictly environmental purposes were to be imposed to internalise another country's externality, then some potential benefit might accrue. However, in the context of trade which is already constrained to the considerable disbenefit of the poor countries, arguments that further constraints on trade are aimed at benefiting those countries would raise some eyebrows. Even special pleading must have its limits.

In 1992 Austria introduced a unilateral levy on tropical timber imports, justified as an environmental measure. It was argued that the Austrian economy could have benefited from the levy, as no similar measures levy was applied to domestic (or indeed temperate) timber production. ASEAN timber exporting countries threatened a retaliatory boycott on Austrian imports; the levy has since been rescinded (Taylor 1993).

6.3.5 Externalities, Commodity Production and Trade

There is one final argument against the use of trade measures to internalise environmental externalities, and this is based on the distinction between the commodity traded and the externalities its production causes. It is well known that the production of many internationally traded commodities leads to environmental externalities of one form or another. For example, the destruction of rainforests generates public good externalities (the increase in global carbon dioxide concentrations) and intertemporal externalities (the too rapid use of a resource). Similarly the intensive production of many agricultural crops is causing soil erosion (intertemporal externality) and groundwater pollution (public good externality).

It has been suggested that the control of these externalities related to the production of internationally traded commoditie smight be achieved by control of the trade in these commodities. For example Kox (1993) has suggested the use of International Commodity-Related Environmental Agreements (ICREAs), where the trade in commodities related to the generation of environmental externalities is constrained. We would argue that this is a completely mistaken approach, as generally the externality derives not from the commodity, but from the techniques used to produce the commodity. The one example where there is an identity between the commodity and the externality is when resources are being used up too rapidly (e.g. tropical timber). But every other externality, such as pollution in its myriad forms, relates to the technique, not the commodity.

For example, much agricultural production causes water pollution and soil erosion. However, these externalities are not a necessary consequence of growing those crops, which can also be produced by techniques which are environmentally much less harmful. A constraint on the trading of these commodities would not necessarily have any effect in reducing the externalities. Indeed, the effect could be to worsen the externality, by impoverishing the

farmers and causing them to become even more intensive in their production to seek to maintain their incomes.

We therefore argue that any attempt to internalise externalities be directed at the externalities themselves, and the techniques that cause them, rather than at the commodities, which may be produced with different and more benign techniques.

6.4 The Effects of International Trade on Global Sustainability

For economic behaviour to be 'sustainable' it must allow for the needs of future generations. One way this can be achieved is for natural resources used in the present to be converted into capital available for the future. Indeed, a simple criterion for sustainability would be that the value of net capital accumulation exceed the value of resource and environmental service depletion.

This criterion is a very weak one, and by no means guaranteesthat this economic behaviour actually is sustainable. However the theoretical literature (Hartwick 1978) suggests that this substitution of 'natural' capital with human-made capital is at least a simple starting point from which to begin practical analysis. Simply put, an economy which does not satisfy this criterion for sustainability is unlikely to satisfy any more realistic criterion (Pearce and Atkinson 1993).

Applying this criterion without reference to international trade patterns suggests that many rich, developed countries are 'sustainable', but most third world countries are 'unsustainable' (Proops and Atkinson 1993). However, a moment's reflection shows that this criterion is inadequate for a situation where international trade exists.

For example, Japan has few natural resources, but it has a high savings ratio. As a result, by the above simple measure Japan appears sustainable, as its use of its own natural resources is small, but its rate of accumulation of human-made capital is high. However, Japan makes extensive use of raw materials imported from Third World countries, and one could argue that Japan maintains its high standard of living through the use of natural resources from its trading partners.

What is needed therefore is an understanding not of the resources a country exploits within its own boundaries, but an understanding of the resources a country exploits globally through trade. Here the ramifications may be complex. For example, country A may import steel from country B. To produce that steel country B may import raw materials from country C. Thus country A may be benefiting doubly indirectly from country C's exploitation of nature.

One could be more specific and refer to carbon dioxide emissions as a global environmental problem leading to unsustainability. As a response to this problem a country may

decide to impose a carbon tax on domestic fossil fuel use, to seek to reduce emissions through fuel substitution (away from coal and towards natural gas) and by technical change. However, in the absence of any corresponding carbon taxes in other countries, the effect might be simply to cause the production of carbon intensive goods to be moved to other countries, with a negligible impact on global carbon dioxide emissions.

Therefore, in assessing the impact of a single country's environmental instruments on global sustainability, two pieces of information are vital; first, the trade interconnection effects on current sustainability; second, the likely impact on trade patterns of applying policy instruments to environmental issues.

These considerations reinforce the need to take global approaches to the internalisation of global externalities.

6.5 International Strategies for Internalisation

Finally, we turn to a discussion of international agreements relating to the internalisation of environmental externalities. We offer six categories of agreement, and relate each to the nature of the environmental externality concerned. We should note that the relationships of categories of agreement to actual international treaties need not be exclusive. As we shall see, treaties concerning CFCs include both outright bans on their long-term production and an element of subsidy, to aid changing techniques by poorer countries. Similarly, international subsidies to encourage sustainable forestry use has both a global public good effect (iess CO2 emissions) and local public good effects (iess soil erosion), as well as an intertemporal effect (forest maintenance).

6.5.1 Exclusive Economic Zones and the Law of the Sea

An important example of open access market failure historically has been the use of the sea. The Law of the Sea has had a major impact on fishery open access, with its creation of 200 nautical mile Exclusive Economic Zones.

After more than a decade of negotiation, the UN Convention on the Law of the Sea was opened for signature at the end of 1982. When it was closed for signature at the end of 1984, 159 states had signed it. Among those who did not sign are the United States, the United Kingdom and the former Federal Republic of Germany. As of 31 March 1992, 51 states had ratified the convention, 9 short of the 60 required for the Convention to enter into force.
Although the Convention has not yet entered into force, many of the fishery provisions have been adopted unilaterally and have become part of "customary international law".

6.5.2 Global Banning of Harvesting or Production

Certain species are becoming extremely scarce, and to the possibility of extinction (intertemporal market failure) their harvesting is banned (e.g. whales).

The International Whaling Commission (IWC) was set up in 1946, financed by contributions from 40 member governments. The IWC has banned the harvesting of specified species of whales, except for the taking of a limited number for 'scientific purposes'. This has been done to allow stocks to recuperate after extensive over-harvesting, and to avoid the extinction of species.

On the other hand, some materials are potentially so damaging globally (global public good market failure) that their production is banned.

CFCs have been judged to be so harmful potentially damaging to the ozone layer that the Montreal Protocol of 1987 is an international agreement to phase out the use of these chemicals by 2000, for richer countries, with a global phase out by 2010. Within the agreement there is the provision for technology transfer to poorer countries to allow the substitution of CFCs by other, more benign, materials.

6.5.3 International Agreements on Reducing Emissions

Some air pollutants have a global effect (e.g. CO2), causing global public good market failure, while others have effects outside the country of their emission (e.g. SO2), causing transnational public good market failure. There have been extensive international discussions on reducing CO2 emissions globally, and on reducing SO2 emissions within the EC.

The Helsinki Protocol on reducing SO2 emissions was signed by 21 countries in 1985. In 1989, EC member states agreed substantially to tighten exhaust controls on cars in 1993. In 1991 the EC Commission proposed levying a carbon tax, rising to the equivalent of US$10 per barrel by 2000. However, the tax has not yet been accepted by member governments.

6.5.4 International Subsidies Regarding Global Public Goods

As we have been at pains to stress, the internalisation of externalities associated with commodities derives from the techniques of production used, not the commodity per se. Subsidies from richer countries to poorer countries to allow them to switch to less damaging techniques are an obvious way that this global externality can be internalised. Such subsidies are being made to aid the move towards the sustainable use of tropical forests, to limit the global emission of CO2. These subsidies also, coincidentally, help internalise the local public good externality of soil erosion.

The International Tropical Timber Organisation was founded in 1986, and is based in Yokohama, Japan. It aims to be a trade forum, with three permanent Committees on Reforestation and Forest Management, Forest Industry, and Economic Information and Market Intelligence. In addition to administrative costs, the ITTO operates a Special Fund for projects, with funding primarily from Japan.

6.5.5 International Subsidies Regarding Local Public Goods

Some richer countries are offering aid to poorer countries, often through international organisations, to allow the introduction of techniques to deal with local public good externalities.

The FAO helped the Philippines in 1986 to embark on an Integrated Pest Management Strategy. This was started in Antique Province, but turned out to be so successful that the provincial government was willing to support the follow-up of the programme after foreign funding expired. The FAO then moved on to Nueva Vizcaya province in 1993, starting with the training of 30 provincial trainers (Segura 1993).

6.5.6 International Agreements on Commodity Production

As has been discussed throughout this study, the production ofcommodities may cause environmental externalities, of one or more of the three categories (open access, public good, intertemporal). One possible way to reduce these externalities is to increase the price of the commodities (i.e. the application of a Pigouvian tax), and one way this increase in price might be accomplished is through the restriction of production, through international commodity agreements.

Commodity agreements have existed for many of the major traded commodities. Most have now have declined in importance in their role of stabilizing or increasing commodity prices. However some have now started to shift towards the internalisation of environmental externalities. The two examples so far are the International Tropical Timber Agreement (ITTA) of 1983, as well as the International Agreement on Jute and Jute products of 1982 and

its successor of 1989.

The ITTA is controlled by the International Tropical Timber Organisation with its headquarters in Yokahama, Japan. The agreement is now beginning to have considerable results. In September 1992, the state of Sarawak reduced timber felling by 60% in order to comply with an agreement with ITTO. As a result of this and further reductions, the price quoted for Sarawak logs has jumped up from US$255-265 per cubic metre in January 1993 to US$280 by mid-February 1993 (Friedland 1993). By June 1993 they had risen still further to US$420 (Vatikiotis 1993).

The role of commodity agreements is usually to seek to stabilise the price of internationally traded commodities, and also to increase the price above its 'free-market' level. An outcome of a commodity agreement allowing its members to act, to a degree, as a cartel is to increase the price, thereby reducing the quantity demanded, though increasing revenue (supposing demand is sufficiently inelastic). A consequence of reduced demand is reduced output and, probably, reduced environmental damage. The increased revenue received may also allow the commodity producers to invest in more modern, and less environmentally harmful, techniques of production.

7. Economic Development and International Environmental Policy

The analysis so far, of the internalising of environmental externalities, has mainly used static efficiency arguments. Even when time was explicitly taken into account, as in the discussion of intertemporal externalities relating to the welfare of future generations, it was still mainly assumed that environmental problems could only be dealt with at considerable cost, and by the application of specific efforts. However, this need not be the case, because of technical progress. Further, the very process of economic 'development' can be the means of eventual reduction of the negative effects of economic activity on the environment.

7.1 Technical Change as a Positive Environmental Externality

As noted above, many environmental externalities are specific to the techniques used, and especially related to the technique-specific capital goods employed. Also, over time we find that technical progress allows the substitution of old techniques with new techniques, where these techniques are not only more efficient, but environmentally more benign.

Technical progress in air transport has brought several environmental benefits. Until the late 1940s aeroplanes were powered almost exclusively by internal combustion engines. These were relatively unreliable, extremely noisy and rather inefficient in their use of fuel. Modern aircraft are powered by 'turbofan' jet engines, which are extremely reliable, very quiet and very fuel efficient. In terms of noise and resource (i.e. oil) depletion,

modern technology is environmentally far superior to old technology.

There are numerous examples where the replacement of old techniques, and the corresponding old capital equipment, has had environmental benefits. Indeed, one could speak of the positive environmental externality of technical change.

If the benefits of technical change are to be realised, as mentioned above it is important to substitute away from old capital and towards new capital. In some respects this can be encouraged very effectively by such direct controls as emission limits. For example, in many countries motor cars must undergo periodic inspections, including the quality of their exhaust gases. Failing this test requires the car to be mended or scrapped. It is certainly the case that this periodic checking causes higher rates of car scrapping than would otherwise occur, at some economic cost. However, the overall social benefit obtained is two-fold. First, it reduces the levels of air pollution. Second, it encourages the bringing into use of new capital, which is far more environmentally benign, as well as economically more efficient.

Regarding the rich, developed world, it is often the case that the greatest reduction of negative environmental externalities can be achieved by encouraging the shift from old technologies to new ones. It is certainly the case that the imposition of, say, Pigouvian taxes will encourage the substitution of old techniques by new, more efficient ones. However, a tax in itself is not specifically designed to seek and exploit the environmental benefits of technical change.

7.2 The Case for Environmental Subsidies on Capital Goods

The positive environmental externality of technical change is to some extent encouraged by the use of subsidies on new capital equipment. Of course, it could be argued that a tax on pollution would also encourage the shift towards new capital, so that a subsidy on new capital would be no more effective than a tax in this context. However, this neglects the argument that very of ten individuals have discount rates higher than is socially desirable. Now high discount rates discourage investment in new capital, so the use of a subsidy on new capital equipment may be more effective than a tax on pollution, as it deals with both the public good and intertemporal aspects simultaneously.

A further argument for the subsidisation of new capital that has been made relates to the often low price elasticities of fuel consumption by households (Jackson and Jacobs 1991). The imposition of, say, a carbon tax would have a limited effect on household behaviour, while there is evidence that subsidies on home insulation and efficient heating systems generate appreciable reductions in fuel use at small social cost.

Also in favour of the use of environmental subsidies is that producers in poorer countries often have limited access to finance to allow replacement of technique-specific capital equipment, and substitute the use of environmentally superior techniques. Subsidies can be used to circumvent this lack of an appropriate financial system.

One of the most common subsidies is the provision of government funded toxic and hazardous waste management facilities. Since these are shared by several pollution sources, such as agro-processing plants, there is a problem in getting firms to agree to build such a plant, requiring government intervention. Several of Thailand's export-oriented industrial estates have been fitted with central waste treatment plants.

7.3 Technical Change and Economic Development

The process of economic development can be characterised as the shift from low capital intensive production, giving low per capita incomes, to high capital intensive production, with correspondingly high per capita incomes.

The process of economic development also has implications for resource use and environmental damage. Regarding resource use, there is ample evidence that as countries industrialise they first become more energy intensive in their production, and later become less energy intensive (Proops 1984). It seems likely that countries also become less material intensive over time, at least compared with their 'information intensiveness'.

7.4 Economic Development and Resource Use

The process of becoming more energy (and pollution) intensive is easy to understand; Third World countries begin as primarily agricultural, with sunlight as the primary source of fuel, as embodied in biomass. Industrialisation requires that modern techniques be brought into use, which depend on fossil fuels, often as transformed into electricity. However, it is also known that industrialisation gives way to 'de-industrialisation', as economies move to service and 'information' based production, which requires much less energy per unit of value produced, and generate correspondingly less pollution.

This pattern of an inverted 'U' shape for the energy/GNP ratio is so well established that one can argue with some confidence that the development process almost invariably leads to initially rapidly rising resource use, followed by less rapid use, and even decline. As a by-product of resource use is the generation of pollution, a rapid worsening of pollution levels, followed by a less rapid rise, can also be anticipated.

The consequences of this finding for global environmental issues are profound, particularly for carbon dioxide emissions. If global carbon dioxide emissions are to be stabilised and then

reduced, this cannot be achieved by Third World nations in the short- to medium-run. The process of economic development outlined above suggests that the raising of incomes in these countries is incompatible with steady, even less reducing, fuel use and consequent emissions. However, once the industrialisation process has made sufficient progress, and the service/information stage of production is achieved, then reductions in emissions can be hoped for.

7.5 Economic Development and Population Growth

This relationship between the industrialisation process and emissions is amplified by the apparent relationship between population growth rates and economic well-being. It seems that as incomes rise, with corresponding improvements in literacy (particularly among females), there is a reduction in desired family size. Thus one can expect that rising incomes will be accompanied by reducing population growth rates, so there will be a doubly beneficial effect on rates of income growth per capita. This, in turn, will allow increased saving and capital accumulation, so that the virtuous spiral of economic growth and reducing population growth rates will be maintained.

Enhanced economic development will therefore have two effects. In the short- to medium-run, it will mean rapidly increasing use of resources and emission of pollutants. However, in the longer run it will mean an earlier transition to a service/information oriented economy and a population which is smaller than if development is not enhanced. Clearly, both the shift away from heavy industry and the lower population, will mean that the long-run level of resource use and emissions is likely to be lower than if there is no enhancement of the development process. Thus global social welfare is likely to be increased if the development process is enhanced.

7.6 Enhancing Economic Development

Historically, rich countries have tried to enhance the development of Third World countries with aid and some relief from trade constraints (e.g. the Multi-Fibre Agreement). Unfortunately, there is evidence that much of the aid has not been used effectively, while the trade concessions have usually been minor.

However, in view of the pressing nature of many of the global environmental problems now faced, it might be the time to press the rich countries to make available substantial development assistance, particularly by reducing the trade distortion of agricultural protection. This development assistance would not only generate social welfare in the presently poor countries, but will generate social welfare for all through the eventual downward effect that this accelerated development will have on resource use and pollution.

7.7 Economic Development and Access to New Capital

There is one final way that enhanced economic development is likely to have a beneficial effect with regard to the global environment. As poor countries become richer, they will be able to finance the acquisition of more advanced, productive and environmentally more benign capital goods. Indeed, further enhancement to development and long-run environmental quality could be by the subsidisation of modern but appropriate capital goods for supply to poor countries.

The long-run global environmental effects of the economic activity of the poor two-thirds of the world are liable to be far more significant than the improvements available through taxation and regulation to the rich one-third. Internalising environmental externalities are important in showing how improvements in the short-run can be made. However, for the long-run, global policy attention needs to be on technical change and development, and how these can be harnessed and stimulated, to allow social welfare to be improved globally, through improved income and improved environmental quality.

8 International Institutional Incentives for Environmentally Sound Techniques

Both Chapter 6 and 7 sought to show the disadvantages of using trade restrictions as a way of forcing countries to switch to more environmentally benign techniques of production.

As an alternative to such 'controlling' trade instruments, this chapter will examine how the international community can work together to create 'enabling' incentives for changing techniques. The advantage of this approach is that it ensures allocative efficiency, by using a market-based approach, but that also by creating a positive incentive it should minimise competitive effects. As long as the incentive is not financed by trade tariffs, developing countries will gain from the financial incentive, without suffering any loss of export revenue. This should make it acceptable to governments of developing countries, which resent intrusions on sovereignty or increased tariff barriers. While this concept was touched on in Sections 6.5.4 and 6.5.5, this chapter will review what institutions are needed to take this further at a practical level.

As earlier chapters have demonstrated, technology change is central to the issue of internalising environmental externalities. Whether this is done by market instruments or command and control is a question of means; the central question of ends is that technology changes so that the environmental damage is reduced per unit of commodity production.

8.1 The Costs of Switching to More Environmentally Sound Techniques

The costs of switching to cleaner techniques can be divided into two parts:

1. The cost of installing the technique (known as the 'capital' or 'fixed' cost). 2. The cost of operating the newly installed technique (known as the 'operating' or 'variable' cost).

8.1.1 Fixed Costs of Technology Switching

For fixed costs, it is clear that changing technology will entail an adjustment cost, such as the cost of researching and developing new techniques, the physical cost of new machinery, and the cost of training in the new clean technology. To overcome this cost, there is a need for a financial incentive to encourage producers voluntarily to make the switch to the new technique. This subsidy is at present being provided by some governments (cf Section 5.8.1), but his is a drain on the domestic government budgets.

Thus there is a role for international sources of financing to help overcome these fixed costs, through what we call 'environmental benefit fees' (EBFs). These can be justified at the level of principle, since countries will need to share the costs of protecting global public goods, from which the whole world derives benefits (e.g. the international seas, biodiversity and cultural diversity, the climate). The need for the international community to fund the so-called 'incremental cost of technology switching' has already been recognised in the Montreal Protocol (on CFCs) and the Global Environment Facility. In addition, as discussed in Section 6.4, many industrialised countries have benefited by importing unsustainably produced commodities from developing countries. This suggests that a nation which could be regarded as 'importing sustainability' should seek to compensate the exporting nation for its loss. Essentially, the exporter risks non-sustainability for the benefit of the importing nation. (Pearce et al. 1989). Thus, environmental benefit fees (EBFs) are in line with the 'polluter pays' principle. International transfers for technology change can also be justified on a practical level since without them, many commodity producers will not be able to afford to shift to the new, more environmentally benign, techniques.

To understand the forms these EBFs should take, we need to understand the basic market structure of commodity production. Commodity production is generally characterised by a dualistic market structure, with both large-scale, capital intensive suppliers, and small-scale, labour intensive suppliers. This is a reflection of the lop-sided nature of economic development, with modern capital goods and widespread poverty existing side-by-side. The dualistic pattern can be observed in most sectors.

The dualistic structure can be very useful in determining what kind of subsidies need to be provided to shift to clean technology.

Mining production is divided between small-scale prospectors and huge modern mines. The small and medium scale mining sector accounts for 25% of total production in many developing countries. Fisheries are similarly divided between artisinal or municipal fisheries and large, commercial fleets. For example, Thailand has one of the world's largest fleets, with 20,000 modern vessels. At the same time, over 175,000 fishermen (75% of the total) operate at a small scale, and between them take only 30% of the total Thai catch. Finally, agricultural products are grown by both plantations and small-holders. In El Salvador 85% of the coffee farms are less than 5 hectares, and produce only 20% of the country's yield.

Clearly, the large-scale modern sector may need some low-interest loans, but much of the development and installation of new techniques can be done in-house. By contrast, the small-scale artisinal sector of agricultural small-holders, fishermen and placer miners will face severe credit constraints and will require financial assistance and training to enable them to switch to the new techniques. While some sustainable agricultural techniques may have been developed through a slow process of trial and error, there is also a clear role for outside institutions in funding the research into appropriate, sustainable technology.

8.1.2 Variable Costs of Technology Switching

For variable or operating costs, it is necessary to determine whether the costs of operating the new technology will be higher than under the old technology. The evidence on this point is mixed, and will need more research. In the mining sector and commodity processing sectors, technical changes that increase overall efficiency are often both environmentally and economically beneficial. This is because many technologies for recycling and waste recovery reduce the raw materials requirement, as well as leading to the production of profitable by-products. The new technology may also lead to higher productivity. In addition, the training required for the new technology can also lead to a general increase in managerial efficiency.

In cases where the running costs of the new technique are the same as, or lower than, the old technique, clearly no financial assistance is needed once the technique is in place. However, there are also some cases where it is estimated that running costs will always be higher with more environmentally benign production.

The extra costs of sustainable, extensive coffee production over environmentally damaging, intensive coffee production are roughly US$600 per hectare per annum. This would mean an increase of about 34% in the price of coffee at 1992 prices (Bach 1992). For timber producers, more sustainable harvesting raises the ratio between fixed and variable cost. While fixed costs (for e.g.roads, machinery) remain largely constant, the amount of timber that can

The REFIMET mine in Chile has developed a successful process to clean arsenic-rich concentrates. The process is so successful that, in addition to processing Chilean ores, REFIMET imports concentrates from the Philippines and Greece. An increasing proportion of this by-product, arsenic trioxide, is being exported to the USA at a profit (Warhurst 1993). Recovered agro-processing wastes can often be used in similarly profitable ways. A technique has been developed to use coconut water for the production of 'nato de coco', which is used in desserts. Waste coconut water has been used for the production of yeast and alcohol (ESCAP 1992). In the growing of agricultural commodities,
switching from pesticides to integrated pest management can significantly lower cost, as it did in Indonesia.

be harvested per hectare falls. This higher variable cost leaves the concessionaire more exposed to risks, such as price instability and interest and exchange rate fluctuations.

For environmentally benign technologies, where the running costs are higher than for the old technique, these higher recurrent costs will need to be covered. One way to achieve this is in the form of an environmental premium. For such a scheme to be operated, it must be possible to verify that a particular commodity is produced with a 'clean' technology, which will require monitoring and certification. This will be necessary to ensure that any environmental premium actually goes towards the operating costs of the clean technology. This process of certification is often known as 'Eco-labelling'.

Rough estimates are that the inspection and certification of a particular commodity will add 1% to the price (FOB) of the commodity. Thus inspecting a 50,000 ha. forestry concession will cost US$30,000 (SGS, London, UK).

This environmental premium will then be charged to commodity retailers, who may or may not then pass it on to consumers. Often, the price of the commodity is a small part of the total retail price of a commodity (generally less than 25%). Many vertically integrated commodity producers (e.g. tea producers which also control the tea processing and marketing) will be able to absorb the environmental premium with little or no price rise for consumers.

PG Tips and Brooke Bond, both vertically integrated tea producers, are planning to shift to sustainable production, without any increase in the retail price. Several brands of coffees are now being sold where the producers receive higher than world market prices, but the retail price remains competitive with other coffee brands. These schemes include Max Havelaar in the Netherlands, and Cafedirect in the UK.

Problems may arise if commodity producers are afraid that charging an environmental premium will lose them market share. This is why producers often wait for the retailers to take the lead. Retailers face greater incentives to introduce sustainable techniques of production, since they often fear that if they do not make the switch to a product which can be marketed as 'sustainable', they will lose market share in these environmentally aware times.

However, if retailers do not take the lead, commodity producers have little incentive to change technique, so that although society will gain by the switch to sustainable technology, individual producers will not want to make the shift, for fear of losing market share and profits. This is an instance of the Prisoners' Dilemma, referred to in Section 6.2, since what is in the interests of individual producers is not in society's interest, and there is no socially beneficial switch to clean technology. As mentioned above, this is known as 'free-riding' in the economics literature. To overcome this problem there is a role for some coordinating authority to overcome the free-rider problem and to ensure that all producers switch to the cleaner technology at the same time. The coordinating authority would have several roles:

1. Set up a roster of sustainable technologies for each type of commodity production.

2. Determine the additional cost of these technologies compared to the old technologies. (If there is no additional cost, then there is no need for further assistance.)

3. Set up a monitoring and verification scheme.

4. Help with technical training to aid the use of the new techniques.

5. Help with marketing and links between retailers and consumers, so that they understand why they are paying the environmental premia.

In Section 6.5.6 it was mentioned that commodity agreements may have a role here. These agreements have already created a negotiating forum for producers and consumers, so there should be little difficulty in using the existing institutions to aid the move towards environmentally sustainable techniques of commodity production. The international Tropical Timber Agreement has had some success in coordinating a move towards more sustainable timber production. However, for commodities as a whole there is a need for the more focussed approach outlined above to be implemented.

8.2 Institutionalising the Role of the International Community

The previous sections have outlined two possible roles for the international community in internalising environmental externalities associated with commodity production:

1. Providing short-term subsidies (environmental benefit fees) towards the fixed costs of changing techniques, particularly to the small scale producers who have limited access to sources of investment funds.

2. Instituting a system of environmental premia, to cover the extra variable costs associated with some sustainable techniques.

3. Providing a coordinating authority to overcome free-riding in the establishment of new techniques which attract environmental premia.

All three of these roles may have some relevance to UNCTAD. Clearly, UNCTAD's role in coordinating international trade is already established. In addition, there are funds available for the fixed cost environmental benefit fees, through such sources as the Common Fund for Commodities, which had a budget of about US$100 million in mid-1991. However, while this suggests that the international community should be involved in internalising environmental externalities, this requires two important caveats:

1. Many domestic governments are already taking a lead in internalising environmental externalities, so their experience should not be overlooked, or their efforts duplicated.

2. As we saw in Chapter 3, reducing policy failure is a first necessary step if environmentally benign technologies are to be encouraged. If an agro-processing plant is subsidised for all its inputs, then no amount of environmental benefit fees will encourage to switch to more economically efficient and environmentally beneficial technology.

9 Conclusions and Directions for Future Work

The aim of this study has been to offer a conceptual overview of environmental externalities, their internalisation through various policy measures, and, particularly, the role of international agreements with respect to environmental externalities associated with commodity production.

Our main conclusions are as follows:

1. Environmental externalities are ubiquitous. Three main categories of externality have been identified: public good, open access and intertemporal. These may operate at the global, transnational or local levels.

2. Before steps are taken to internalise these externalities, one should first seek to correct government policies which are making worse the problems of environmental degradation, such as inappropriate subsidisation, etc.

3. Various methods of internalising externalities are available, ranging from command and control to market based instruments. Each methods has its pros and cons.

4. Many environmental externalities are local, in the sense that they affect only the peoples of the country where the externality is generated. There is little or no reason for international action to try to deal with such local externalities. In particular, the argument that different environmental standards affects 'competitiveness' internationally is both specious and likely to be an excuse for protectionism by rich countries against poorer ones.

5. It is tempting to try to internalise environmental externalities associated with commodity production through import or export taxes or quotas. However, this is likely to be inappropriate for several reasons. As noted in 4., it is certainly inappropriate for dealing with local externalities, affecting only the producing country, as it infringes on their sovereignty. Even for transnational and global externalities, the use of commodity trade controls is inappropriate, as the externality derives from the technique of production, rather than the commodity being produced. Finally, the imposition of commodity trade constraints will further threaten the move towards globally freer trade, to the disbenefit of all.

6. For the poorer countries of the world, the most effective way to encourage them to use less environmentally damaging techniques f commodity production is through enhancing their economic development. The best way this can be done is through reducing trade barriers to their exports, including commodity exports, rather than introducing further barriers.

7. Shorter-run assistance could be given to developing countries through making available environmental subsidies (or environmental benefit fees) for new capital investment, from the richer countries. These would allow the accumulation of new capital equipment and skills, so that new, less environmentally damaging, techniques of commodity production can be brought into use more quickly.

8. If operating costs of new techniques are higher than for the old techniques, eco-labelling and certification of environmental sustainability of production will allow the charging of environmental premia for appropriate commodities, encouraging the spread of sustainable production methods.

9. There is a need for international coordination of the provision of environmental benefit fees and for eco-labelling schemes.

9.1 Directions for Future Work

We recommend that, rather than concentrating attention on International Commodity-Related Environmental Agreements, which we regard to be both peripheral and potentially damaging, attention

should be given to techniques of commodity production, in various regions. We propose the following scheme of work. Local environmental externalities should not be the subject of international policy or international intervention. Attempts to impose restraints on trade on the basis of differing environmental standards in different countries should be opposed vigorously. The consequence of such trade restraints would be the further impoverishment of the already poorer countries. Global and transnational environmental externalities associated with commodity production should be identified. Ideally, a database of such externalities should be established, by commodity, type of externality and location. (N.B. Problems of local environmental externalities are best dealt with by domestic governments, which are in a position to judge the appropriate type and level of action to be taken.) Any policy failure associated with commodity production needs to be identified, and means to reduce this policy failure established.

Best practice techniques need to be identified, for the production of various commodities. These techniques would be not only economically effective, but also environmentally more sustainable.

The operating costs of new and old techniques need to be examined. If the operating costs are lower, or the same, for the new, environmentally benign, techniques, only support to new capital investment will be necessary.

Incentive structures and subsidies need to explored for the introduction of these best practices in other regions.

The use of eco-labelling and the charging of environmental premia should be encouraged, where appropriate, under the guidance of a reputable international body.

ANNEX I

The Theory and Application of Monetary Valuation

A1.1 Total Economic Value (TEV)

To determine the economic cost of an externality we need to measure the total economic value of environmental goods and services. This involves considering both use and non-use values (Pearce 1993). Direct use values are the benefits from resource extraction and conversion. Although they do not present any theoretical problems, they are not easy to measure in practical economic terms. In the case of tropical rainforests, the value of on-timber forest products such as nuts and medicinal plants should be measured in addition to the simple value of timber.

Indirect use values correspond to the assimilative capacity and other ecological functions of the nature. Damages from soil erosion such as water siltation are used as a proxy for the value of soil fertility.

Option values are the future direct and indirect use values of environmental assets, of which no use is made currently. Since the current level of knowledge is insufficient, the assets should be conserved until our scientific and technical understanding improve. In the tropical rainforest, many species which are not even identified may have benefits for human beings.

Non-use values have two components: existence and bequest values. The former, as the term implies, is the value placed by individuals on knowing that an environmental asset exists. This value is unrelated to current or possible future use. Bequest value, on the other hand, measures the benefits accruing to any individual from the knowledge that others might benefit from a resource in future. Such values exists for species, habitats and ecosystems.

Total economic value (TEV) can be expressed as: TEV = Direct Use Value + Indirect Use Value + Option Value + Existence Value + Bequest Value While the components of total economic value are additive, care has to be taken in practice not to add competing values. There are trade-offs between different types of use value and between direct and indirect values. For example the value of timber from clear felling cannot be added to value of nuts since there would be none left after timber is taken.

A1.2 Monetary Valuation

TEV reflects in theory the preferences of people for an environmental good or against an environmental bad such as air pollution. But because few of these goods are actually traded in the real world, we need to use monetary valuation methods to determine a price for these goods. Thus the techniques seek to determine the value individuals place on the environment. In other

words, the aim is to derive the preferences by individuals for the environmental goods and not to find the actual worth of the environment. The advantage of having monetary values is the ability to compare the previously unpriced environmental values with the benefits from the loss of these assets.

The main monetary valuation techniques used are: 1. Indirect valuation which seeks to set up a relationship between the level of damage and its economic impact: i. avertive expenditures; ii. production functions; iii. clean-up (replacement) costs;

2. Direct valuation seeks to measure revealed preferences either as reflected in market transactions or directly: i. hedonic price methods; ii. travel cost method; iii. contingent valuation method.

A1.2.1 Indirect Valuation

(i) Aversion Expenditures

The method is based on the assumption that expenditures made in order to prevent a decline in environmental quality are a proxy for the demand for a better environmental quality. Such expenditures include noise insulation, water filters, water treatment and so on. Although it is theoretically correct, there are practical difficulties with this approach. First of all, the method expects risk avertive behaviour from households. However this will not occur if individuals have high discounts rates. Secondly, there are problems associated with the availability of information. People may not be aware of a possible decline in the quality of the environment and therefore, do not undertake any aversion expenditure. In this case the aversion expenditure method would underestimate the true demand for the environment.

(ii) Production Functions

The production function is the most extensively used method in developing countries. This technique values environmental damage indirectly using a two stage procedure:

1. The first stage is to establish the physical and ecological links between pollution or degradation and its effects. By doing so, the technique measures the direct cost of environmental damage.
2. The next stage is to value the final impact in monetary terms, for example by using market prices.

For our purposes, water pollution due to mining can be linked to damages to human health and fisheries. Similarly this technique is used to value changing crop yields or damages from sea level rise due to global warming. Production function estimates require both scientific and economic data as the technique emphasises the link between pollution discharge or resource depletion and its effects. The valuation procedure is relatively straightforward. For example, given the damage to fisheries from salination, the market value of the fish would be used to calculate the economic loss from

salination. The economic value of lost fish production per year would be the decline in physical productivity (in tonnes per year) multiplied by the net profit per unit caught ($/tonnes). The latter is found by subtracting the capital and operating costs of production from the market price. However problems arises with deciding the scientific relationship between salination and damage to the fishery. The method can also be used for project evaluation. For example, the benefits of a soil conservation project can be estimated by looking at the cost of soil loss with and without the project. A comparison of these values with the cost of undertaking the project would provide sufficient data for evaluation.

(iii) Replacement Costs

Once damage is done, the cost of restoration or rehabilitation to achieve the pre-damage situation would appear to be a measure of damage. This measure is called replacement (clean-up) costs approach and is a special type of dose-response technique. Strictly, the costs of restoration are not surrogate for damage. If they were, the benefits of restoration (the reduced damage)would always be equal to the cost of restoration - producing a benefit-cost ratio of unity. Restoration, clean-up and replacement costs therefore need to be used with caution if they are intended as measures of damage. However, in many contexts it may be difficult to find more direct measures of damage. Provided there is evidence that society would normally restore the pre-damage situation then costs of restoration are a reasonable proxy for damage. Indeed, they are then minimum estimates since society may value the restoration at more than what it costs to achieve it. Restoration costs are most likely to be relevant where social action can be expected and where restoration is feasible. For example, it is not feasible to secure zero emissions from an aluminium smelter, but zero emissions would characterise the pre-damage context in this case. Hence it is preferable to seek a direct measure of damage.

A1.2.2 Direct Valuation

(i) Hedonic Price Methods

With hedonic pricing an attempt is made to estimate an implicit price for environmental attributes by looking at real markets in which those characteristics are effectively traded. Hedonic property prices measure the level of internalisation of environmental pollution in the property price. Thus, clean air is effectively traded in the property market since purchasers of houses and land consider these environmental dimensions as the characteristics of property. However, the method is confined to the cases where property owners are aware of environmental variables and act because of them. If we can isolate the fall in price due to pollution, this will provide a guide to the value people place on the environment.

The most common approach for this is to use the econometric technique of multiple regression in which data for a number of independent variables are used to explain the variation of a dependent variable. Property prices would be the dependent variable and property characteristics such as number of rooms would be the independent variables. Environmental quality such as the level of air pollution from a nearby cement factory, for example, would be one of the independent variables and the coefficient on this would indicate a first approximation of the effect on property prices of air pollution. The method requires a detailed data set for house prices. In most developing countries, housing markets are not well established. Therefore, gathering data is likely to create a major problem.

Strictly, hedonic price technique requires a two stage process. The coefficient obtained by the multiple regression projects only one point on the demand curve for environmental quality. But to meet the aim of valuation, i.e., to estimate the demand curve for environmental quality, what people would be willing to pay for given levels of environmental quality needs to be known. The ability to pay would depend on various factors including income. Therefore, the second stage requires that the resulting schedule of house price changes be regressed on these factors. The result would then be an estimation of the complete demand curve for environmental quality.

Hedonic wages assumes that risk is traded in the labour market. High risk jobs may well have risk premia in the wages to compensate for the risk. The application is limited to valuation of morbidity and mortality risks in occupations such as mining and construction. The method assumes workers are perfectly aware of the occupational risk and have political power to reflect this risk on wages. Despite these assumptions, the findings of the method have been used to value health impacts of pollution and resource depletion. Hedonic wage method, as with hedonic property prices, uses multiple regression to relate wages/salaries to factors influencing them and isolate the risk premium. These factors include level of education, years of experience in the occupation and the level of risk faced by the worker.

(ii) Travel Cost Method

Travel Cost Method (TCM) uses the information on the money and time people spend getting to a recreational site as a proxy for the demand for that site. The recreation site can be a rainforest nature reserve or a game reserve as well as an inner city park. Such a site provides many benefits to its users but in most cases, no or very small entry fee is charged. This does not mean that its loss would not impose a welfare loss on society. TCM aims to estimate this value. The variables of this demand model include total time and cost for the round trip, and alternative sites. Then, individual results are grouped according to income and preference for recreation. The method has also been used in a slightly different context, in which fuel wood and water gathering

have been the main emphasis. In the cases where rural workers are not paid in monetary terms, the market value of the work they could have done instead of gathering is taken as the opportunity cost of time. Although TCM has a theoretical setting, it is rather complex to implement. Especially when multi-purpose trips are concerned, regression analysis may not be very successful. However, TCM is worth to be applied if not for any other reason for comparison with CVM results. Such a comparison would increase the accuracy of both methods.

(iii) The Contingent Valuation Method Contingent valuation method (CVM) or market creation method has been applied to see willingness to pay to guarantee an improvement in the quality of the environment, or willingness to accept compensation to forgo this improvement. In this method, varying WTP/WTA values (willingness to pay/willingness to accept) for given levels of environmental quality set the estimated demand curve. CVM ask people directly what values they place on certain non-market goods, such as water quality and biodiversity, if markets did exist. The characteristics of the good being valued are brought to the respondent's attention, extra information may also be provided and then the respondent is asked to make a market-like decision. The questions ask either the absolute amount the respondent would pay or suggest a prefixed amount.

According to economic theory, responses to CVM questions, i.e. WTP and WTA, should not differ significantly. However, empirical studies show that WTA tends to be much higher than WTP. This difference may be due to an endowment effect in which losses are valued more markedly than gains. Like all other valuation methods, CVM has some drawbacks. The drawbacks are called biases in the literature as their existence cause people to state values that are different from their true WTP or WTA. The following is an account of the most important biases.

Strategic bias arises if respondents understate their true WTP to avoid actual payment, and overstating their true WTA to get more compensation. However, there has been very little supportive evidence from empirical studies to suggest that strategic bias is important (Mitchell and Carson 1989).

Hypothetical or framing bias results from having to state a value for a good which is not traded in an actual market. Information bias results from the type and amount of information held by the respondent before the survey. The payment vehicle (the form in which people would pay/receive their WTP/WTA) can create another type of bias. People may develop certain attitudes against taxes, entrance fees or higher prices in actual markets.

Income bias results from the restrictions imposed on the respondent's WTP/WTA by the level of his or her income. Although the technique originated in developed countries, the above biases are less likely to create problems in developing countries. This has been illustrated by the success of CVM for measuring demand for

a reliable water supply (Whittington et al. 1990). The studies in the developed world try to cover mainly disamenity which often elicit emotive responses and hence are hard to explain. Developing country experience, however, has been of more practical matters. People were aware of the costs of, for example, depleted water sources and the distinction between alternative supply routes. This knowledge decreases the possibility of information and hypothetical biases occurring.

ANNEX 2

Social Welfare, the Environment and National Income Accounts

In this annex we briefly outline the relationship between considerations of social welfare, the environment and national income accounts. We purposely set the discussion in a social welfare framework, as this allows one to see that Gross Domestic Product (GDP) is only a partial measure of social welfare, which can be supplemented with, inter alia, considerations of environmental effects.

A2.1 Social Welfare

As noted in Section 2, it is generally accepted that the role of government is to improve the social welfare of its citizens. However, any government seeking to improve its citizens' welfare must first find a means of measuring this welfare, at least approximately. Now the welfare of a society has many dimensions, and among the factors often mentioned as contributing to welfare are such items as: consumption levels; investment; wealth; leisure; income distribution; health; longevity; law and order; social cohesion; environmental quality (Anderson 1991).

The first three are clearly related to strictly 'economic' matters, while the others deal with wider matters. Now, as we shall see, the economic criteria can be used to construct, very simply, a crude but useful measure of social welfare, viz. Gross Domestic Product (GDP). Before we examine this measure in more detail, it should be noted that GDP reflects only a limited part of overall social welfare.

A2.2 GDP as a Measure of Social Welfare

Gross Domestic Product is defined as the market value of goods and services supplied to 'Final Demand' in a given time period. By final demand is meant the ultimate use of that good, at least in that time period. We generally divide final demand into four categories: consumption; investment; government expenditure; net exports (i.e. exports - imports). How do these categories relate to social welfare?

For consumption it is clear; consumption by individuals gives individual well-being and, ignoring the effects of gluttony and distribution, the more consumption there is, the more social welf are there is.

Investment gives the possibility of enhanced production and consumption in later periods, so its effect on social welfare is also clear, but at a later date. The rationale for adding together these two temporally separated contributions to social welfare is that investment can be considered to give rise to welfare in the present through, in effect, the pleasurable anticipation of extra future consumption.

Government expenditure gives social welfare through the provision of certain goods and services directly by the state. Often these take the form of 'public goods', such as national defence, law and order, etc. They may also take the form of 'private goods' provided free, or with a subsidy, such as education and health care. Clearly, such goods generate social welfare.

Finally, net exports are an element of GDP, as this surplus allows future increased imports, and hence future increased consumption.

So GDP as a measure of welfare seems reasonable as a first very rough approximation. It has the added advantage of being a number that is relatively easy to calculate (either in terms of sales of goods or purchase of factors), and so is often the only yardstick used for comparing social welfare between countries (as GDP per capita) or improvements within a country (as percentage annual rate of GDP increase).

But, as noted above, GDP can encompass only part of social welfare, as it would be properly defined. As a result, economists have made extensive efforts to modify and expand the ubiquitous GDP measure, to give a more general measure of social welfare, such as 'Net Economic Welfare' (Nordhaus and Tobin 1972).

A particular element of such an adjustment would be the inclusion of social welfare contributions made by environmental factors, and there is now considerable research into how GDP can be adjusted to give a 'Green' GDP (Ahmad et al. 1989, Lutz 1993).

A2.3 The Effects of the Environment on Social Welfare

Interpreting the term 'environment' broadly, one can offer four categories of the environment that affect social welfare.

First, the availability of natural resources, be they renewable (e.g. forests, fish) or non-renewable (e.g. oil, copper ore).

Second, the use of natural functions for social activity (e.g. forests and rivers for leisure purposes).

Third, the provision of natural services which would otherwise have to be provided by humans (e.g. the natural self-cleansing abilities of rivers).

Fourth, the effects of negative environmental externalities in reducing human welfare (e.g. pollution).

A2.3.1 Resource Rents

Regarding the first category, natural resource availability, in principle this contribution to social welfare should be easily measurable, as long as the resource is being used in a rational way

within a market framework. If it is so being used, then the market price of the resource will be made of two elements. First, part of the price will be the extraction cost. Second, the remainder of the price will be the 'resource rent'. This resource rent is the charge the extractor should make to reflect the scarcity of the resource. For a non-renewable resource, as the extraction continues, then in the absence of changing tastes, technologies and new discoveries, the resource will become scarcer, so its resource rent will increase. This will therefore cause the price of the resource to increase, reflecting the increasing marginal contribution of the resource to human welfare. This is known as the 'Hotelling Rule' (Hotelling 1931). Such market-based use of resources will, of course, be reflected in GDP.

However, some resources are not exploited within the framework of a market. For example, in many Third World countries forest resources are regarded as being available to all. Similarly, prior to modern conventions, sea fish were available to all with the equipment and desire to catch them (Swanson 1991). Such 'open access' to resources means that the social welfare they generate may not be captured by a price, and so this contribution will not be included in GDP.

A2.3.2 Natural Services and Access

Regarding the second category, the contribution to social welfare of the facilities that can be derived from nature without, in some way, destroying it (e.g. enjoyment of landscape), this may or may not be included in GDP. Again, the issue here is access. If a park is available for the enjoyment of all, with no fee charged, then there can be no market assessment of the welfare it generates to include in GDP. On the other hand, if the park is fenced in, and access is only allowed to those who pay, then the welfare the park generates will be measured by the payments received, which will also be an element of GDP.

A2.3.3 Environmental Services

We now turn to the third category, the rendering of natural services which would otherwise need to be provided by humans. Many of these services have the nature of public goods, as discussed above. For example, a city may be on a lake, which acts as both a source of drinking and irrigation water, and a sink for human and industrial wastes. (Mexico City is in just this situation.)

Now lakes have the ability, through their natural ecological processes, to 'metabolise' many waste materials, rendering them harmless to humans. So as long as the noxious emissions to the lake are at a level below the 'carrying capacity' of the lake, then the lake will continue to supply good quality water for other purposes, as well as acting as a waste disposal system. However, if the rate of input of noxious wastes becomes too high, then the lake may begin to become fouled by the accumulation of the wastes, and cease to render good quality water. At this stage it would become

necessary to install waste treatment facilities so that the emissions to the lake were less impure; alternatively it would be necessary to purify the lake water before its use. Either way, a service previously rendered by the lake must now be undertaken by human activity.

Clearly, the natural services rendered by nature (e.g. the lake discussed above) make a contribution to social welfare, but this contribution would not occur in the conventional GDP. On the other hand, as soon as the service has to provided by humans, the welfare it provides is matched by an element of GDP.

A2.3.3 Pollution

Regarding the fourth category, there is little to say except that pollution clearly reduces social welfare, through increased ill-health, reduced benefit from views, etc. These are clearly reductions in social welfare, that should, in principle, be matched by reductions in GDP.

A2.4 GDP, Environmental Effects and Social Welfare

From the discussion so far we can draw several conclusions:

a. Social welfare maximisation can be assumed to be the aim of governments.
b. To be able to maximise social welfare, one needs to be able to measure it.

c. GDP is a simple first approximation to social welfare.

d. GDP does not capture the contributions to social welfare which are not marketed, such as many environmental services, or the effects of pollution.

As GDP as presently defined is clearly inadequate as a measure of social welfare, two questions arise. First, how can GDP and national accounting procedures be modified to encompass the above environmental issues? Second, what do these adjusted measures of GDP tell us about how social welfare has in fact been altering?

A2.4.1 Modifying GDP to Account for Environmental Effects

The simplest issue to deal with is resource rents. These occur, in the terminology, as part of 'value-added', and the sum of value-added is equal to GDP. So if, because of open access, resource rents have not been fully recorded, then if an estimate of the size of these non-recorded rents is made, it needs to be added directly to GDP. Thus the non-marketed nature of some resource use will lead to a direct, and perhaps very substantial, underestimating of GDP.

The services rendered by nature, in whatever form, should also be represented as elements of value-added. However, unlike the case of resource use, where information on resource rent levels may be available, natural services may never be marketed, so there will be no price information to act as a guide. In this case one needs first to value the environmental service, which is no mean task. Details of such valuation techniques are given in Annex 1.

The effects of environmental externalities, such as pollution and over-grazing, are to reduce social welfare. However, as these externalities are, by definition, non-marketed, this reduction in social welfare will not be reflected in a negative component in GDP. The appropriate place to include these externalities is a negative elements in final demand, as they impact on consumers. However, as for environmental services, there is a considerable problem of evaluating the size of these effects, before they can be included in GDP adjustments.

A2.4.2 'Defensive' Expenditures

There is one final issue that should be mentioned with regard to the modification of GDP to account for environmental effects, and this is 'defensive expenditure'. There is a growing literature which suggests that expenditure on 'cleaning-up' pollution should be subtracted from GDP, as this does not reflect social welfare gains. While we have sympathy with the intent of this argument, we find it logically flawed, for two reasons.

The first reason is that this reduction of GDP would be equivalent to reducing the value-added in the economy; i.e. reducing the value of the labour, capital, natural resource, etc. available for production. However, this valuation should be independent of the use to which these factors are put, so the fact that some are used to clean-up pollution should be irrelevant to their valuation.

Second, if the factors were used for another purpose, e.g. manufacturing furniture, this would be an element of final demand, and hence of GDP. That these factors are, as a matter of fact, used to clean-up pollution reflects that this activity also generates social welfare, and therefore should be an element of final demand and GDP. Our sympathy with the intent behind this (we feel flawed) argument is that for many purposes even a modified 'green' GDP would not be a good measure of social welfare, because it would still not take account of the dynamics of economic accumulation and consumption. However, this is rather a technical issue, and is discussed in more detail elsewhere (Proops 1993).

A2.4.3 The Time Path of 'Corrected' GDP

One of the main uses of GDP is to see whether, and by how much, social welfare is changing over time. Particular importance is given to GDP growth rates as an indicator of economic 'health'.

Now if adjustments are made to account for the increase in GDP deriving from resource rents from non-marketed resources and environmental services, and the decrease in GDP deriving from negative externalities (e.g. pollution), then GDP may either increase or decrease in absolute size from its non-adjusted level.

However, the absolute level of GDP is relatively uninteresting compared with its rate of growth. Here a study by Daly and Cobb (1990) suggests that much of the GDP growth seen for the US economy over the past forty years disappears when GDP is adjusted for environmental effects. One might anticipate that if similar adjustments could be made for many Third World countries, significantly negative rates of 'corrected' GDP growth might be seen, reflecting the rapid rise in pollution and the reduction in the quality of soils, as well as rapid resource depletion.

References

Ahmad, Y.J., S. El Sarafy and E. Lutz (eds.) (1989) Environmental Accounting for Sustainable Development. The World Bank, Washington, D.C.

Anderson, V. (1991) Alternative Economic Indicator. Routledge, London.

Pearce, D.W., and G. Atkinson (1993) "Measuring sustainable development". In: D. Bromley (ed.), Handbook of Environmental Economics. Blackwell, London (forthcoming).

Axelrod, R. (1984) The Evolution of Cooperation. Penguin, London.

Bach, C. (1992) "Production related commodity agreements: a proposal". Royal Veterinary and Agricultural University, Denmark.

Baum, J. (1991) "Drifting downstream: Taiwan's fishermen face bleak future". Far Eastern Economic Review (29th August) 39-41.

Baumol, W.J. (1977) Economic Theory and Operations Analysis. Prentice-Hall, New York.

Bourman, S. (1992) "What's in a label? The killing of dolphins in the Eastern Tropical Pacific and the case for an international legal solution". Natural Resources Journal 32:425-447.

Coase, R. (1960) "The problem of social cost". Journal of Law and Economics 3:1-44.

Conway, G.R. and J.N. Pretty (1991) Unwelcome Harvest: Agriculture and Pollution. Earthscan, London.

Coote, B. (1992) The Trade Trap: Poverty and the Global Commodity Markets. Oxfam, London.

Crozier, R. (1992) "Chile's pollution legacy". Mining Journal (24th August).

Daly, H.E., and J.B. Cobb (1989) For the Common Good. Greenprint, London.

Economic and Social Commission on Asia and the Pacific (ESCAP) (1992) State of the Environment in Asia and the Pacific 1990. United Nations, Bangkok.

Friedland, J. (1993) "Meany greenies: Japan faces soaring cost of imported timmber". Far Eastern Economic Review 156:43-44

Gammage, S. (1990) "Agricultural pricing and resource degradation". In Environmental Economics in the Developing World. Report to the US Agency for International Development, prepared by LEEC, London.

General Agreement on Tariffs and Trade (GATT) (1991) United States - Restrictions on Imports of Tuna. Report of the Panel, DS21/R, September 3.

Hardin, G. (1968) "The tragedy of the commons". Science v.162:1243-48.

Hartwick, J.M. (1978) "Investing returns from depleting renewable resource stocks and intergenerational equity". Economics Letters 1:85-88.

Hotelling, H. (1931) "The economics of exhaustible resources". Journal of Political Economy 39:137-175.

Jackson, T., and M. Jacobs (1991) "Carbon taxes and the assumptions of environmental economics". In: T. Barker (ed.), Green Futures for Economic Growth. Cambridge Econometrics, Cambridge.

Kox, H.L.M. (1993) "International agreements to deal with environmental externalities of primary commodity exports". Dept. of Economics and Econometrics, Free University of Amsterdam (mimeo).

Krupnick, A. and I. Sebastian (1990) "Issues in urban air pollution: review of the Beijing case". Environment Working Paper No. 31. Environment Department, World Bank, Washington, D.C.

London Economics (1992) The Potential for Using Market Instruments for Pollution Control in Developing Countries. London.

Lord, M.J. (1991) Imperfect Competition and International Commodity Trade. Clarendon Press, Oxford.

Lutz, E. (1993) Toward Improved Accounting for the Environment. The World Bank, Washington, D.C.

Mitchell, R.C. and R.T. Carson (1989) Using Surveys to Value Public Goods: The Contingent Valuation Method. Resources for the Future, Washington, D.C.

Nectoux, F., and Y. Koruda (1989) "Timber from the South Seas; an analysis of Japan's tropical timber trade and its environmental impact". World-Wide Fund for Nature, Switzerland.

Neher, P., R. Arnason and N. Mollett (1989) "Fee fishing". In: P. Neher, R. Arnason and N. Mollett, Rights Based Fishing. Kluwer, Dordrecht.

Nordhaus, W., and J. Tobin (1972) "Is growth obsolete?" In: D.W. Orr and M.S. Soros (eds), The Global Predicament. University of North Carolina Press, Chapel Hill.

Pearce, D.W. (1993) Valuation and the Natural World. Earthscan, London.

Pearce, D.W., and R.K. Turner (1990) Economics of Natural Resources and the Environment. Harvester Wheatsheaf, London.

Pezzey, J. (1989) Economic Analysis of Sustainable Growth and Sustainable Development. Environment Department Working Paper No. 15, World Bank, Washington D.C.

Pigou, A.C. (1920) The Economics of Welfare. Macmillan, London.

Poore, D. (1989) No Timber Without Trees: Sustainability in the Tropical Forest. Earthscan, London.

Proops, J.L.R. (1984) "Modelling the energy-output ratio". Energy Economics 6:47-51.

Proops, J.L.R. (1993) "A proposed alternative approach to integrating the environment into the national accounts". In: E. Lutz (ed.) Toward Improved Accounting for the Environment. The World Bank, Washington, D.C.

Proops, J.L.R. and G. Atkinson (1993) "A sustainability criterion for closed and open economies", mimeo.

Proops, J.L.R., M. Faber and G. Wagenhals (1993) Reducing CO2 Emissions. Springer-Verlag, Heidelberg.

Repetto, R. (1989) "Economic incentives for sustainable production". In: G. Schramm and J.J. Warford (eds.), Environmental Management and Economic Development. World Bank, Washington D.C.

Segura, O. (1993) Environmental Impact of Coffee Production and Processing in El Salvador and COsts Rica. Prepared for UNCTAD.

Shoven, J. and J. Whaley (1984) "Applied general equilibrium models of taxation and international trade: an introduction and survey". Journal of Economic Literature 22:1007-1051.

Siddiqui, D. (1989) "Licensing versus leasing systems for governemnt owned fisheries [jalmahals] in Bangladesh". In: M. Agiiero, S. Hug. A. Rahman and M. Ahmed (eds.), Inland Fisheries Management in Bangladesh, ICLARM, Manila.

Swanson, T. (1991) "The regulation of oceanic resources". In: D. Helm (ed.), Economic Policy Towards the Environment. Blackwell, Oxford.

Taylor, R. (1993) "Positive incentives, sustainable commodity production and the OECD". Prepared for the OECD.

Thompson, H (1991) "The economic causes and consequences of the Bougainville crisis". Resources Policy (March) 69-85.

Tobias, M (ed.) (1988) Deep Ecology. Avant Books, San Marcos, Cal.

UNCTAD (1992) Commodity Yearbook. United Nations, New York.

Vatikiotis, M. (1993) "Tables turned: Sabah timber-export ban riles Kuala Lumpur". Far Eastern Economic Review 156:66-67.

Veenendaal, J., and J. Opschoor (1986) "Botswana's beef exports to the EEC: economic development at the expense of a deteriorating environment". Free University, Amsterdam.

Warhurst, A. (1993) "Environmental degradation from mining and mineral processing in developing countries: corporate responses and national policies". OECD Development Centre.

Waugh, G. (1989) "Development, economics and fishing rights". In: P. Neher, R. Arnason and N. Mollett, Rights Based Fishing. Kluwer, Dordrecht.

Wesney, D. (1989) "Applied fisheries management plans: individual transferable quotas and input control". In: P. Neher, R. Arnason and N. Mollett, Rights Based Fishing. Kluwer, Dordrecht.

Wheeler, D. and P. Martin (1991) Prices, policies and the international diffusion of technology: the case of wood pulp production. Symposium on International Trade and the Environment, The World Bank, Washington, D.C.

Whittington, D. X. Mu and J. Briscoe (1990) "Modelling village water deamnd behaviour: a discrete choice approach". Water Resources Research 26:521-529.

World Commission on Environment and Development (WCED) (1987) Our Common Future. Oxford University Press, Oxford.

World Bank (1992) Development and the Environment. World Bank, Washington, D.C.

World Development Report (WDR) (1989) World Bank, Washington D.C.

World Resources Institute (WRI) (1992) World Resources 1992-3. Oxford University Press, Oxford.