INTERNATIONAL TRADE AND THE ENVIRONMENT

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Effects of changes in production and trade flows on the economy and the environment

Programming study of NRLO, RAWOO and RMNO

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rawoo

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Forword

This report is the first part of a joint programming study International Trade and the Environment initiated by

National Council of Agricultural Research (NRLO)
Advisory Council for Scientific Research in Development Problems (RAWOO)
Advisory Council for Research on Nature and Environment (RMNO)

This part of the study provides the analytical framework for studying interactions between trade and environment and it discusses major policy issues in this field. The second part of the study will be carried out in the period December 1992 July 1993 and will formulate proposals for research projects.

The research was guided by a Steering Committee consisting of

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The councils are grateful for the work done by the research team and the Steering Committee.

After the full study is finished the three councils shall review the study and its recommendations and publish an official advisory statement.

We hope that this first part of the study will contribute to public and scientific discussion in this field.

Ir. A. de Zeeuw	Prof.Dr. D.B.W.M. van Dusseldorp	Prof.Dr. J.B. Opschoor
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SUMMARY

Economy and environment interact in different and often complicated ways. An important field in which the interrelationship between economy and the environment attracts increasing attention is international trade. When adequate environmental policies are absent, changes in international trade have negative effects on the environment if they increase the general level of economic activity or if they shift activities to areas with lower environmental carrying capacities. On the other hand, positive effects on the environment occur if changes in trade enhance resource use efficiency, or shift economic activities to areas with larger environmental carrying capacities. In addition, trade-induced changes in income and its distribution may affect opportunities for environmental management. *A priori*, it is uncertain which effect will prevail in a specific situation.

Whatever the effects of changes in international trade on the environment, trade-restricting measures are usually not the most obvious policy instruments to counteract possible damage. First-best policy instruments address environmental consequences of production or consumption directly, by internalising environmental considerations in production and consumption decisions. Trade instruments are usually poor substitutes for environmental policies. Even if trade measures are perceived as first-best, as in the case of import restrictions for health reasons, the danger is always present that they will be captured by protectionists' interests.

To address *national* environmental problems, international harmonization of environmental standards is generally not needed. Differences in national priorities and in capacities to cope with environmental and natural resource degradation justify variations in environmental standards across countries. It is, however, desirable to harmonize principles and measures of environmental policy. Tensions between trade and the environment may be reduced by global adherence to the polluter pays principle (PPP). Costs and benefits of measures to address *international* or global environmental problems will often differ between countries. For tackling these problems, positive incentives (financial assistance, transfer of environment-friendly technology) may be needed to achieve cooperation of countries for which national benefits are low. Adherence to the PPP will generally lead to the non-cooperation of these countries. Negative incentives such as

discriminatory trade restrictions are not the best way to promote cooperation.

A sector where changes in trade and environmental policies will have far-reaching consequences is agriculture. Compared to other activities, environmental effects are highly sector-specific and partly policy-induced. In low-income countries, agricultural production often leads to degradation of renewable resources like land, nutrients and water. At higher levels of income, farm inputs (labour and land) are increasingly being replaced by non-farm inputs (capital and variable inputs) which are produced by the industrial sector. The intensity of the resulting environmental effects differs considerably between different (groups of) countries. As international trade in agricultural products includes many perishable and bulk products, their transportation may cause considerable environmental externalities.

An important policy issue is the impact of agricultural trade liberalisation on the environment. Recent work by Anderson and Tyers shows that trade liberalisation would cause the expected international prices for agricultural products to be somewhat higher, the volume of trade to increase, total production to stay at about the same level, and welfare gains to be sufficiently large to fully compensate those who confront losses. However, large trade-induced regional shifts in agricultural production would occur, implying production increases in the developing world and declines in industrial countries. Changes in cropping production from high-priced to low-priced countries would substantially reduce the use of chemicals in world food production. Relocation of meat and milk production from intensive grain-feeding enterprises in densely populated rich countries to pasture-based enterprises in relatively sparsely populated poorer countries is another factor associated with lower use of chemicals such as growth hormones and medicines for animals. The greater use of these less-intensive production methods would reduce not only air, soil and water contamination by farmers, but also the chemical intake by the world's food consumers on average.

To illustrate in more detail the analytical and policy questions regarding international trade and the environment, the study concludes with four cases of commodities whose production and trade involves important environmental externalities: tropical timber, grain and grain substitutes, energy resources, and hazardous wastes.

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1. INTRODUCTION

1.1 Background and approach

Changes in production, resource allocation, income and international trade have important and often complicated consequences for the environment. Economy and environment interact in different ways depending on the nature of goods, and at different levels depending on the nature of externalities. Moreover, environmental effects often display complicated time patterns and may have important spill-over effects into other areas.

An important field in which the interrelationship between economy and the environment attracts increasing attention is trade liberalisation, in particular in connection with the current Uruguay Round of GATT negotiations. Although trade liberalization in no way aims at solving environmental problems (and usually would not be the appropriate instrument), it undoubtedly has important ecological effects. In particular in agriculture, a gradual abolishment of protectionist policies may result in a more rational trading system characterized by a better use of resources (including environmental ones), a reduction of environmentally harmful inputs, and the disappearance of agricultural surpluses due to protectionist policies. Others will argue, however, that more liberalization will only increase pressure on environmental resources, in particular in developing countries.

In many ways, the proposals for reform of the EC agricultural policy (MacSharry Plan) face the same questions: what are the environmental consequences of policy-induced changes in agricultural production and trade, both inside and outside the EC.

The present study pays attention to the general effects on the economy and the environment of changes in production and trade flows. Such changes can be induced by a variety of factors, e.g. changes in international trade agreements, national environmental policy or the Common Agricultural Policy. In view of the current proposals for agricultural reform, the study focuses to a large extent, though not exclusively, on international trade in agricultural products. Where necessary and relevant, however, other sectors of the economy are considered as well.

Research for this study was carried out by Dr. N.B.M. Heerink (Department of Development Economics) and Ir. J.F.M. Helming (Department of Agricultural Economics) of Wageningen Agricultural University (WAU), and by

Ir. O.J. Kuik (Institute for Environmental Studies (IVM)) of the Free University Amsterdam (VUA). The research work was co-ordinated by Prof.dr. A. Kuyvenhoven (WAU) and Dr. H. Verbruggen (IVM). The assistance and comments of the Steering Committee, chaired by Prof.dr. H. Linnemann (VUA), and of dr.ir. C.L.J. van der Meer (NRLO) and dr.ir. A.J. Oskam (WAU) are gratefully acknowledged.

1.2 Overview of the study

Analytical framework

To examine the various issues of international trade and the environment systematically, an analytical framework underlying the study is developed first in chapter 2. It starts with a review of the concept of sustainable development, a notion which is at the heart of any attempt to integrate economy and environment. Several issues are elaborated upon including the notion of full resource cost in the case of environmental degradation, risk and depletion. The consequences of alternative concepts of sustainable development and of several principles that are developed in the context of sustainable development on trade possibilities and restrictions are indicated.

A number of theoretical and policy questions regarding international trade and the environment are raised next. The major reason for trade between countries is that it is a natural and profitable response to price discrepancies that would exist without is. Such discrepancies are largely attributable to international differences in technology and factor endowments. When competition is perfect and markets are complete, free trade is best. In many cases these conditions do not hold, and the question arises under what conditions is there justification for trade restrictions (tariffs and other forms for protection)? Three points can be made here. First, the theorem of second-best states that, in the presence of missing or distorted markets, the usual conditions for efficiency may not hold. Apart from the fact that free trade is not superior in all conditions, the second point is that most trade theorists would argue that trade measures do not address the problems (market distortions) at the right level: trade measures are typically regarded as second-best, and therefore undesirable, solutions. Third, even if trade instruments are perceived as first-best,

the danger is always present that they will be captured by protectionists' interests.

International trade may influence environmental quality in several ways: by changing production patterns, by imports of products which cause risks to the environment or health, by transport externalities, and through enhancing economic growth, which can have positive or negative influences on the environment. In the assessment of impacts it is important to compare the actual situation with the situation resulting from changes in trade. It is also important to assess all stages of the life cycle of a product: from exploitation of the primary resources, to intermediate products, final products, and waste generation. All these stages may cause different environmental problems, and they may occur in different regions or countries, linked through interregional or international trade. Trade itself (the physical transport) is also a cause of environmental pollution and degradation. To analyse the impact of specific trade measures, a classification of environmental effects and a schematic representation of the relationships with production, consumption, and international trade is given.

In economic theory, environmental problems are typically considered as a type of market imperfection. Policy instruments to correct these distortions can be grouped into: direct regulation (permits and standards), economic instruments (charges, subsidies, deposit-refund, etc.), property rights approaches, and a broad category of pressure and persuasion, including voluntary agreements (convenants) between government and industry. The objective of these instruments is to internalize environmental costs so as to ensure that the full environmental and resource costs of a traded product (in production, transport, use, waste) are paid by the final consumer of the product.

A guiding principle in environmental policy is the Polluter Pays Principle (PPP), which has been adopted by the OECD in 1972. It is also a guiding principle for EC environmental policy since the adoption of the Single European Act in 1986. An important goal of the PPP is to limit distortions in international trade. As regards global and transborder environmental effects of nontradable products, differences in environmental priorities (related to per capita income levels) may justify the application of the so-called Victim Pays Principle (VPP).

How do environmental policy and international trade interact? It is important to distinguish between domestic and international environmental policies (unilateral or multilateral). Domestic environmental policies may be influenced by trade in two ways. (1) If the policy is meant to reduce environmental effects of domestic production, the competitiveness issue is often raised. Domestic producers may feel that they are discriminated against foreign competitors who face less strict environmental standards; they demand a "level playing field". (2) If the policy is meant to reduce environmental effects of domestic consumption, imports may face restriction. Foreign exporters may feel discriminated and challenge the trade restriction (Danish beer bottle dispute, US-EC hormones-in-beef dispute).

Environmental policy in one country may also wish to influence environmental pollution or degradation in other countries, because of physical transborder spillovers (acid rain) or otherwise (tropical forest degradation). In fact, environmental policy makers may consider to use trade instruments (with respect to the product causing the problem or an unrelated product) to influence other country's environmental policies. This is a particularly sensitive area.

Finally, many international or multilateral environmental agreements have included trade provisions. These trade provisions may regulate or ban trade (e.g. in endangered species) and usually discriminate against non-signatories. The present GATT disputes concerning environmental implications of trade rules illustrate that these rules do not totally exclude trade measures based on environmental considerations.

Trade and environment in agriculture

A sector where changes in trade and environmental policies will have far-reaching consequences is agriculture. World prices for agricultural products are highly distorted as a result of domestic policies in industrial and developing countries. Large parts of both the developed and developing world face important environmental problems resulting from current agricultural practices, albeit for different reasons. Chapter 3 reviews these issues.

Recent developments in the pattern of technological change in agriculture are outlined first. Considering resource endowments and access to modern technology as major explanatory factors, the economic rationale for these developments is briefly discussed. Because of the emphasis on

international trade in this study, the impact of current agricultural policies on trade receives ample attention. Protection of agriculture in the industrialized countries has led to high agricultural prices which, in combination with rapid technical progress, have stimulated production - in many cases beyond the point of self-sufficiency. Widespread protection of manufacturing has in many developing countries resulted in low relative prices for farmers and limited public investment in agriculture. Under these circumstances, agricultural production has remained far below its potential.

Based on recent work by Anderson and Tyers, the impact of agricultural trade liberalization on the domestic markets of developed and developing countries and on the international market is analyzed. Large trade-induced regional shifts in agricultural production would occur, of which the environmental consequences are reviewed in chapter 4. The final section of chapter 3, dealing with environmental effects of agricultural production in general, provides the basis for this analysis.

Agriculture has specific environmental effects which differ from the effects of non-agricultural products. In particular, agricultural production in low-income countries often leads to degradation of renewable resources like land, nutrients and water. At higher levels of income, farm inputs (labour and land) are increasingly being replaced by non-farm inputs (capital and variable inputs) which are produced by the industrial sector. The intensity of the resulting environmental effects differs considerably between different (groups of) countries. As international trade in agricultural products includes many perishable and bulk products, their transportation may cause considerable environmental externalities.

Policy questions

A number of major policy questions concerning trade and environment is examined in chapter 4. Adoption of (theoretically sound) environmental policies will generally lead to changes in trade flows, as the correction of previous market failures will change comparative advantages between countries. The introduction of environmental policies also raises a number of questions regarding a country's competitiveness, harmonization of environmental standards and measures, and the potential role of trade measures. For analytical purposes, domestic environmental effects are distinguished from transborder or global environmental effects.

What are the consequences of national environmental policies for international trade? There is general agreement that international harmonization of national environmental standards is neither necessary nor desirable. Comparative advantage is based on the existence of differences between countries, of which the environment makes up one element. In this way, differences in standards can well be an additional source of gainful trade.

At the same time it should be emphasized that harmonization of principles and measures governing environmental policy is highly desirable (Polluter Pays Principle as the basis for national policies and the Victim Pays Principle to secure co-operation in international policy-making). When introduced unilaterally, national environmental policies inevitably shift comparative advantages away from the damage-intensive good, with adverse consequences for competitiveness, production and income in the short run at least.

To achieve inter-governmental co-operation on international environmental policies, positive incentives (financial assistance, transfer of environmentally-friendly technology) are more effective than discriminatory trade restrictions or sanctions unrelated to the environmental problem at hand. A possible exception is the use of trade measures to enforce international co-operation on environmental issues.

Another important policy issue is the impact of trade liberalization on the environment. As discussed in chapter 2, free trade maximizes national and global welfare provided environmental externalities are corrected through appropriate policies (and a number of standard assumptions on the functioning of markets are satisfied). These corrective policy measures should be such that the social costs of exporting are taken into account by producers. However, for various reasons governments often adopt policies that intervene with free trade. Moreover, until now corrective environmental policies have only seldomly been undertaken. The last section of chapter 4 therefore examines the potential impact of trade liberalization on the environment. Because of the importance of agriculture in the current GATT negotiations, the emphasis is on trade in agricultural products.

Case studies

Four cases of commodities whose production and international trade involves important environmental externalities are presented in chapter 5. The case studies are primarily meant to illustrate the various theoretical and policy questions with regard to international trade and the environment discussed in the previous chapters. Rather than an in-depth analysis of particular commodities, the four examples emphasize the relation to the analytical framework provided in this study and the trade and environmental policy dilemma's involved.

Tropical timber and grain and grain substitutes are selected in view of the study's focus on international trade in primary (agricultural) products. Both cases illustrate how trade distortions (tariff escalation and export subsidies in developed countries and heavy protection in a number of developing countries) not only reduce welfare, but in many instances are harmful to the environment as well. Provided that adequate environmental policies are being followed, both developmental and environmental goals can be served by trade liberalisation. With regard to tropical timber - where the impact of international trade on deforestation appears to be modest - the arguments presented in favour of international compensation payments and against heavy reliance on trade measures accord well with the theoretical arguments presented in chapters 2 and 4.

The other two cases, energy resources and hazardous wastes, illustrate several other aspects of the links between production, trade and environment. The analytical framework developed in chapter 2 established that, without proper environmental policies in countries involved in trade with negative side-effects, the welfare gains from trade may be smaller than conventional analysis would suggest. However, the two cases illustrate the high cost and detrimental effect on the environment of simply restricting trade. More efficient solutions, which achieve environmental objectives at lower cost, include policies to improve access to clean energy resources and technology, to minimize (hazardous) waste generation, and to encourage environmentally sound waste disposal management, in particular in developing countries.

Conclusions from the present study and recommendations for further work are listed in the final chapter. In the appendix, some background information regarding trade flows and protection is presented in the form of a number of graphs.

2. ANALYTICAL FRAMEWORK

This chapter presents an analytical framework in which the issue of international trade and the environment can be studied. It starts with a review of the concept of sustainable development which is at the heart of any attempt to integrate economy and the environment. It then continues with some brief remarks on the theory of international trade and protection. Elements of this theory may be fruitfully applied to the present issue. Consequently, paragraph 2.2.2 outlines some fundamental linkages between trade and the environment. Paragraphs 2.2.3 and 2.2.4 review the basics of environmental policy and its relations with international trade. The final paragraph deals with the present international trade rules as they relate to environmental protection.

2.1 Sustainable development

Sustainable development has become a key concept in the environmental debate since the Brundtland report (WCED, 1987). RMNO has addressed the issue on several occasions (Soeteman, 1988; De Wit, 1990; De Boer, 1992). Sustainable development has been defined as:

> *"a process of change in which the exploitation of resources, the direction of investments, the orientation of technological development and institutional changes are made consistent with future as well as present needs." (WCED, 1987).*

The concept of sustainable development has placed the environmental resource base in the centre of attention in analyzing economic development. There is an increasing awareness that environmental constraints may jeopardize economic development. In the first place, it is now recognized that the welfare of people does not only depend on their consumption of marketed goods, but also on the quality of the environment they live in. Increased consumption which is offset by increased costs imposed by depletion and degradation of environmental resources is not necessarily welfare improving and may therefore add little to economic development in a broader sense. Second, present environmental damage can undermine future productivity. Soils that are degraded, aquifers that are depleted and

ecosystems that are lost in the name of raising incomes today, can jeopardize the prospects for earning income tomorrow (World Bank, 1992).

In a public lecture, Brundtland has formulated the following requirements for sustainable development. First, it requires the elimination of poverty and deprivation. Second, it requires the conservation and enhancement of the resource base which alone can ensure that the elimination of poverty is permanent. Third, it requires a broadening of the concept of development so that it covers not only economic growth but also distributional and other social aspects. Fourth, and *most* important, it requires the unification of economics and ecology in decision-making at all levels (Brundtland, Sir Peter Scott Lecture, Bristol, 8 October 1986: quoted in Pearce *et al.*, 1989).

One of the most important questions regarding the operationalization of the concept of sustainable development is the question to which extent substitution is possible between alternative environmental resources and between environmental and man-made resources. Different assumptions lead to different optimal resource use patterns over time. Broadly speaking, the two extreme positions are: (1) there is no substitution possible between environmental and man-made resources (strong sustainability), and (2) substitution between environmental and man-made resources is, in the long-term, unlimited (weak sustainability). Evidently, these two positions lead to different policy recommendations.

Recognizing and accepting the broad and essentially multi-objective nature of sustainable development, Pearce *et al.* (1989) nevertheless emphasize that the 'constancy of the natural capital stock' is a *necessary* condition for sustainable development. Thus, Pearce *et al.* are rather critical to the possibility of substitution between natural and man-made capital. Substitution within the natural capital stock is possible within certain limits. Pearce *et al.* (1990) have suggested a so-called 'portfolio' approach in a project planning context. A project which is contemplated should not be considered on its own, but as a part of a group of projects or a project portfolio. This portfolio should include at least one project that compensates for the environmental degradation generated by other projects in the portfolio to ensure overall sustainability of natural systems. For example, if investments in mechanized agriculture or fire-cured tobacco estates lead to problems with, respectively, land degradation

and fuelwood depletion, then these effects should be compensated by soil conservation and reforestation projects.

Opschoor has introduced the concept of the environmental utilisation space (based on Siebert, 1982). The environment has a limited capacity to supply resources and absorb wastes, although this capacity may be enhanced by scientific and technological advance. Sustainability implies that:

1) society's use of the environment should not impair the present and future functioning of resource regeneration systems, waste absorbtion systems and the systems supporting flows of other environmental services and goods, and
2) use of nonrenewable resources should be compensated for by at least equivalent increases in supplies of renewable or reproducible substitutes.

The environmental utilisation space - or environmental utilisation possibilities frontier - can then be defined as the locus of sustainable patterns of economic development in terms of their claims on the environment (see e.g. Klaassen and Opschoor, 1991).

However, more interpretations are possible. They are determined to a great deal by 1) the extent in which (future) possibilities to substitute environmental and man-made resources are feasible, 2) the assessment of what constitutes present and future needs, and 3) the relative weights of man-made and environmental goods and services in the perception of social welfare. Empirically, the weights attached to the availability of environmental services and the ability to maintain its productivity and quality, is closely related to the level of economic development. If it is accepted that the scale factor is a major characteristic of sustainable development, its actual interpretation will often be income-dependent and location-specific (see Van Pelt, Kuyvenhoven and Nijkamp, 1990, 1991).

Whichever interpretation one chooses, sustainable use of environmental resources is an important element of sustainable development. Evidently, sustainable resource use should be achieved in the most cost-effective way. Specifically, it means that sustainable use of environmental resources should be achieved with minimum negative effects on other social objectives of sustainable development, such as growth of real income per capita, equitable income distribution, social and cultural objectives, and so forth. In section 2.2.3 various approaches to integrate environmental and economic decision-making are discussed.

Even by concentrating on sustainable resource use as a precondition of sustainable development, many questions stay open. Which environmental resources should be taken into account: only those with direct (potential) economic importance or a wider selection?; at which spatial levels and at which levels of aggregation?; how should non-renewable resources be taken into account?; is substitution possible between different environmental resources?; should we take into account that technology and knowledge may increase the substitution possibilities?; how should we account for uncertainty and plain lack of knowledge about long-term ecological processes?; should environmental stocks (individual or aggregated) be maintained at every point in time or are they allowed to fluctuate temporarily? And perhaps the most important question: is sustainable development feasible and how should we go about attaining it? (see e.g. Opschoor, 1987; Van den Bergh, 1991; Kuik and Verbruggen, 1991; Klaassen and Opschoor, 1991).

Answers to these questions determine the specific conditions of sustainable development. Even if sustainable development is reduced to 'the constancy of the natural capital stock', the implications for concrete, day-to-day policy decisions are still far from unambiguous. Economic analysis may contribute to this translation of the abstract to the specific by constructing environmental-economic scenarios with respect to specific policy interventions, conditional on specific assumptions regarding some of the questions above (Van den Bergh and Nijkamp, 1991).

One of the questions which have been raised in recent years is how sustainable development and policies to foster it interfere with the process of trade liberalization which is pursued by most nations in the General Agreement on Tariffs and Trade (GATT) and other multilateral or bilateral trade agreements. What are the links between international trade and sustainable development?

Environmental resource use is influenced by consumption and production decisions in an economy. These decisions are, in turn, *inter alia* influenced by consumption and production decisions in foreign economies through international trade. To study questions of environmental resource use in the real world, these economic linkages between countries should be taken into account. Nijkamp and Verbruggen (1990) identify the following issues with respect to international trade:

1. Because of international trade, environmental effects of extraction, production, consumption and waste disposal are shattered over different national states. This complicates the possibilities of integrated product-chain management. Source and effect become spatially separated and the effects in one part of the chain may therefore become 'invisible' to other parts.
2. There may be tensions between on the one hand the pursuit of a free and competitive world economy through the abolition of tariffs and non-tariff trade restrictions, and on the other hand national environmental policies which increasingly employ standards, charges, subsidies, and licences.
3. Many developing countries rely heavily on the export of primary resources. In general they have limited means, or have a low priority, to introduce effective environmental policies to ensure the sustainable exploitation of those resources. Because of their inability, or their low priority, to internalize negative environmental costs in their product prices, the result is over-exploitation of their environmental resources.

International trade and sustainable development are interlinked, albeit in an indirect and often complex way. The main research (and policy) questions on this subject are:

1. before addressing the links between trade and sustainable development, it should be made clear which interpretation of sustainable development is chosen and how this interpretation can be made operational, that is, how it can be measured.
2. after this has been established, the question is whether and/or when international trade affects the possibilities (positive or negative) for sustainable development on a global, regional and local scale.
3. if so, what are the main elements and mechanisms of their interaction, and
4. if the interactions lead to tensions, what policy instruments should be used at what levels to make international trade and sustainable development compatible?

2.2 International trade and the environment

2.2.1 Theory of international trade

The reasons for trade

The fundamental reason for trade between countries is the existence of differences between countries: differences in resource endowments, conditions of production and differences in consumption preferences. In the absence of trade, the opportunity costs of producing goods may vary between countries because of these differences. Marginal opportunity costs measure the quantity of one good that has to be given up to produce an additional unit of another good. In a two-country two-good example (say, the United Kingdom and Australia, both producing mutton and steel) the country with the lowest marginal opportunity costs of producing a good enjoys a comparative advantage in the production of that good and will export the good under free trade. For example, if Australia has to give up less steel production than the United Kingdom to produce one additional unit of mutton, Australia has a comparative advantage in producing mutton and will therefore export mutton under free trade. In this two-country two-good example, the United Kingdom must have a comparative advantage in steel production, and will export steel.

Why do opportunity costs differ between countries? The well-known Heckscher-Ohlin theorem states that if consumption preferences are identical in two countries, relative production costs will be determined by the relative factor endowments of the two countries given that goods are produced using factors of production in different proportions or intensities. For example, if land is relatively abundant in Australia and labour is relatively abundant in the United Kingdom, Australia will specialize in land-intensive goods such as mutton and the United Kingdom will specialize in labour-intensive goods such as steel. Australia will export mutton and import steel and the United Kingdom will do the opposite.

The Heckscher-Ohlin theorem provides a static framework for analyzing trade patterns. More recent approaches to the theory of international trade have stressed the dynamic aspects of trade. Dynamic aspects relate to changes in factor endowments, changes in demand patterns and one of the most important aspects: changes in technology. Technological change constantly introduces new products and improves production methods.

Clearly, technological change is not spread equally among all countries. "Technology gaps" may therefore be an important source of comparative advantage and consequently of international trade patterns.[1]

Although the theory of international trade has been advanced and extended in recent years, especially to take into account conditions of imperfect competition and increasing returns to scale (see below), the concept of comparative advantage has remained the cornerstone in the theory of international trade, and will be used as such in this report.

The theory of protection

Protection is the intervention of governments in markets of internationally traded goods and services in order to provide an artificial comparative advantage to a domestic industry vis-à-vis foreign competition (Gray and Walter, 1987). Protection discriminates between goods and services of different origins. The traditional theory of protection is cast in static partial- or general-equilibrium analysis; it shows a loss of global efficiency in resource allocation in the presence of trade discrimination.

Government intervention of this type can take many forms, ranging from import tariffs to a host of so-called nontariff measures or barriers (NTMs or NTBs), including quotas, subsidies, voluntary export restraints (VERs), orderly marketing arrangements (OMAs) and administrative measures, such as licensing, government-procurement rules, technical standards, customs practices, and so forth. Some studies have listed as many as 200 different NTBs (see e.g. Cassing, 1987).

Figure 2.1 shows a partial-equilibrium diagram of the effects of a tariff or a quota on the domestic market. The foreign supply curve (S_F), the domestic supply curve (S_D), and the domestic demand curve (D_D), determine a free-trade equilibrium with price A, consumption T, domestic production S, and imports ST.

A tariff shifts the foreign supply curve from S_F to S_F', thereby raising the market-clearing price to B. Consumption falls to R, domestic production increases to P, and imports decline from ST to PR units. Consumers consume less and have to pay more. Their total loss (loss of consumer surplus) measures areas a,b,c and d. Domestic suppliers gain by the area a, the raise in producers' surplus. Government collects the tariff

[1] For reasons and consequences of technological change, see for example Dosi et al. (1990).

revenues, the area c. The difference between the gains and losses, the areas b and d, represent net losses (deadweight losses) to society.

The effect of a quota, restricting imports to PR, is similar, except that area c does not go to the government, but is collected by the owner of the quota. Differences between tariffs and quota show up if one of the curves changes. Suppose that demand increases from D_D to D_D'. In the case of a tariff, the market-clearing price would remain constant at B and imports would rise to PU. In the case of a quota, imports stay fixed at PR, forcing the price to rise to C, which would add to society's losses.

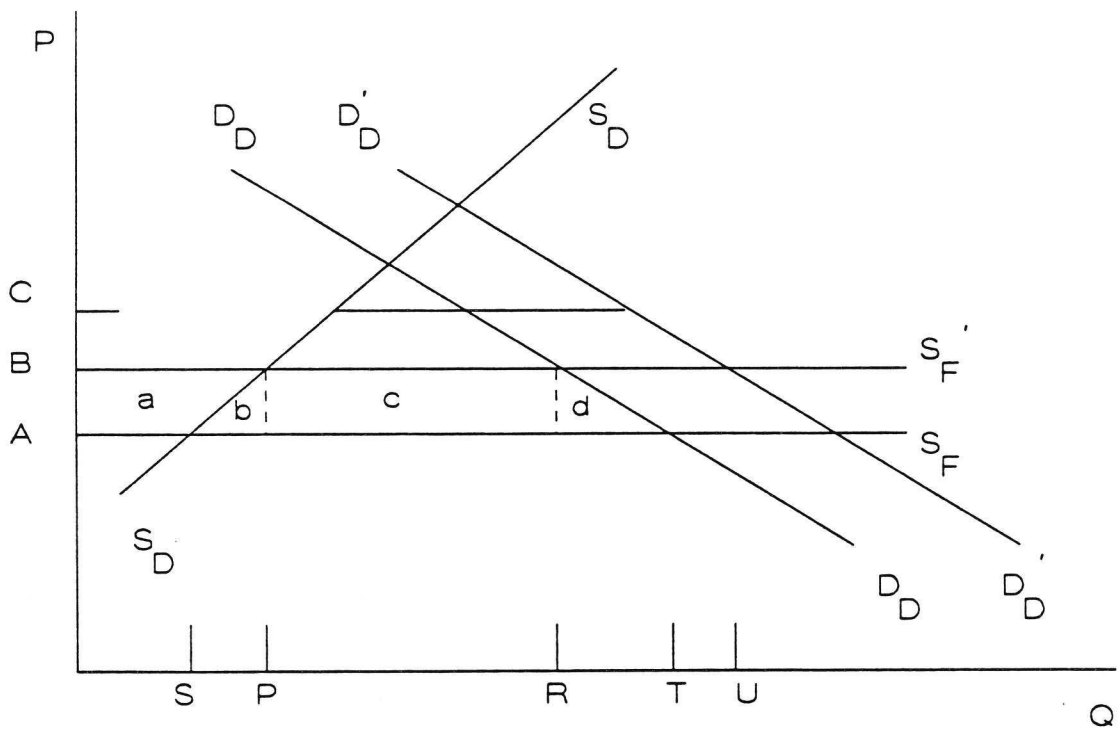

Figure 2.1 The costs of protection

Additional economic losses of protection include the administrative costs of a tariff policy and the costs due to lobbying activities of protection-

seeking domestic firms.[2] From the point of view of the individual industry, lobbying for protection may well pay-off. In figure 2.1, area a depicts the potential increase in net revenue for the domestic industry due to the imposition of tariffs (in the case of quotas even larger revenues may be obtained). If the expected revenue exceeds the costs of lobbying, lobbying is profitable from the industry's perspective. However, resources spent on lobbying do not add to the national product, so they are wasteful from society's point of view. It should also be realized that positive rents in one sector may be accompanied by negative rents in another, for example if the other industry uses outputs from the protected industry, or if both industries compete for the same factors of production.

The political economy of protection has devoted much attention to such rent-seeking distortions. In general the argument goes that politicians may well be tempted to grant protection to lobbying industries as the benefits accrue to few, while the costs are spread over many and are therefore less visible and have less political force.

There may also be reasons for protection that are perceived of being in the national interest. One classical example is that of national defence, whereby free trade may result in a too low a level of the domestic defence industry. The same argument often goes for agriculture, whereby free trade is feared to result in an inadequate level of self-sufficiency in food production. Other reasons for protection may be connected with income distribution, regional development, and so forth. Politicians may be inclined to trade-off allocative efficiency for these other benefits.

Another set of arguments relates to essentially dynamic processes and focuses on adjustment costs. In a comparative static framework such as depicted in figure 2.1, adjustment costs are neglected. In a dynamic framework however, adjustment costs are real. Protection may be perceived as a means to smooth adjustment costs, both to developing industries ("infant industries"), as to declining industries. Again, agriculture provides an example of an industry where adjustment costs can be quite high (see e.g. Keyzer, 1991).

Recognizing these arguments, economists have usually argued that border protection is not a very efficient tool to solve the above-mentioned problems. They have argued that targeted subsidies (although also trade

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[2] Bhagwati (1988) calls these activities "directly unproductive profit-seeking" (DUP) activities.

disturbing) are less costly instruments. Border protection is not regarded as a first-best, or even second-best policy instrument.

Trade policy can only be first-best (from a national perspective, never from a global perspective) if a country can improve its terms-of-trade at the expense of its trading partners. To be able to affect its term-of-trade by using tariffs, a country should have some monopoly power in trade and could therefore gain by restricting trade, just as a monopolist can increase its profits by restricting its sales. An extensive literature exists on the so-called optimum tariff. However, this policy is not without its dangers. The observation that 'any number can play this game', or the fear of retaliation by other countries has made an optimal tariff policy less attractive in practice.

A more recent justification for trade policy has to do with what is called 'strategic' trade policy, in the case of competition between (a few) oligopolistic firms in different countries. In this case, government intervention can shift production and associated excess profits to one's own country by altering the terms of competition among firms in different countries, that is, by using trade instruments. However, Bhagwati (1991) points out that the precise intervention that will improve welfare depends critically on the nature of the strategic interaction between the firms. The information requirements for policy interventions seem very high. In addition, strategic theory usually neglects the possibility of retaliation by foreign competitors.

A final argument for using trade instruments, or rather, threatening to use trade instruments, is to use them as a means to discourage unfair trade policies by trading partners. Countervailing duties and antidumping measures fall into this category. As such, a 'tit for tat' strategy may induce trading partners to cooperative behaviour. However, in practice it is very difficult to distinguish between 'fair' and 'unfair' practices. Several authors have expressed the fear that due to such difficulties, countervailing measures may be used as a pretext for purely protectionist purposes (Gray and Walter, 1987; Bhagwati, 1988).

In sum, government intervention in markets of internationally traded goods and services in order to influence comparative advantages between countries usually results in a loss of global efficiency in resource allocation, and often in a loss of national welfare as well. Even if there are good reasons to interfere with the free working of market forces, trade

instruments are often considered to be second-best or worse. Even if trade instruments are perceived as first-best, the danger is always present that they will be captured by protectionists' interests.

2.2.2 Trade and environment

International trade and the environment are interlinked in several ways. With the increasing economic interdependence between countries and the increasing attention for international and global types of environmental issues and solutions, the linkages become stronger and are increasingly perceived as potentially troublesome, either from the point of view of trade policy or from the point of view of environmental policy. The linkages between trade and environmental policies will be dealt with in paragraphs 2.2.3 and 2.2.4. This paragraph sets out the fundamental linkages between trade and the environment in the absence of measures to internalize external costs in the prices of the traded goods. Four fundamental linkages are distinguished. They concern consumption, production, transport and income effects, respectively.

First, a country's environment may suffer if products are imported which cause particular environmental damage or risks (e.g. trade in hazardous wastes, pesticide-residues in foodstuffs). In this case, the environmental effect is linked to the consumption of the product.

Second, trading countries specialize in those industries in which they have a comparative advantage. If these industries use relatively dirty production processes or deplete resources, the environments of the exporting countries will suffer. Alternatively, if a country's comparative advantage is in relatively clean industries, the environment will be less affected or might even gain. In this case, the environmental effects are linked to production. Such interactions with international trade have long been recognized. For instance, Siebert (1977) has constructed a case in which a country would be worse off under free trade than under autarky due to strongly negative external environmental effects in production.

Third, trade needs transport. Transport uses energy and needs a physical infrastructure. In general, international trade involves larger distances than national trade. Moreover, international transport does not fall within the jurisdiction of one government. This complicates the issue

of government intervention to internalize external costs. Due to differences in taxation, energy prices in international transport are often lower than energy prices in national transport.

Finally, international trade enhances economic growth of the trading partners. The relationship between economic growth and the environment is complex. On the one hand growth may alleviate poverty-related environmental pressures and increase the possibilities of a transition to sustainable production methods. On the other hand, without changes in technological and institutional patterns, growth will mean a mere perpetuation of present economic patterns and hence increase environmental pressures (WCED, 1987).

To make an assessment of environmental impacts of (changes in) trade patterns, these fundamental linkages should be taken into account. Moreover, it is of particular importance to assess the situation "without" the (change in) trade. In other words, what would have happened if the (change in) trade had not occurred? For example, the EC demand for cassava from Thailand may have led to negative ecological impacts in the North-eastern part of Thailand. To make a total assessment of the impacts of changes in cassava trade it is very important to compare the economic and ecological developments between the actual case "with" and the hypothetical case "without" the change in trade.[3]

It may also be important to assess the total life cycle of a product: from exploitation of the primary resources, to intermediate products, final products, and waste disposal. All these stages may cause different environmental problems, and they may occur in different regions or countries, linked through interregional or international trade. Trade itself (the physical transport) may also be a cause of environmental pollution and degradation.

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[3] Bhagwati (1988) remarks in this respect that economists always worry about getting their counterfactual scenarios right. He cites an apocryphal story about an economist who, when asked "How is your wife?", replied: "Compared to what?".

A simple two-country economic-environmental model

A model of the fundamental linkages between the economy and the environment is depicted in Figure 2.2. This figure, which has been adapted from Hafkamp (1983), shows a two-layer projection of reality on both an economic and an environmental layer. The layers contain economic and environmental sub-models.

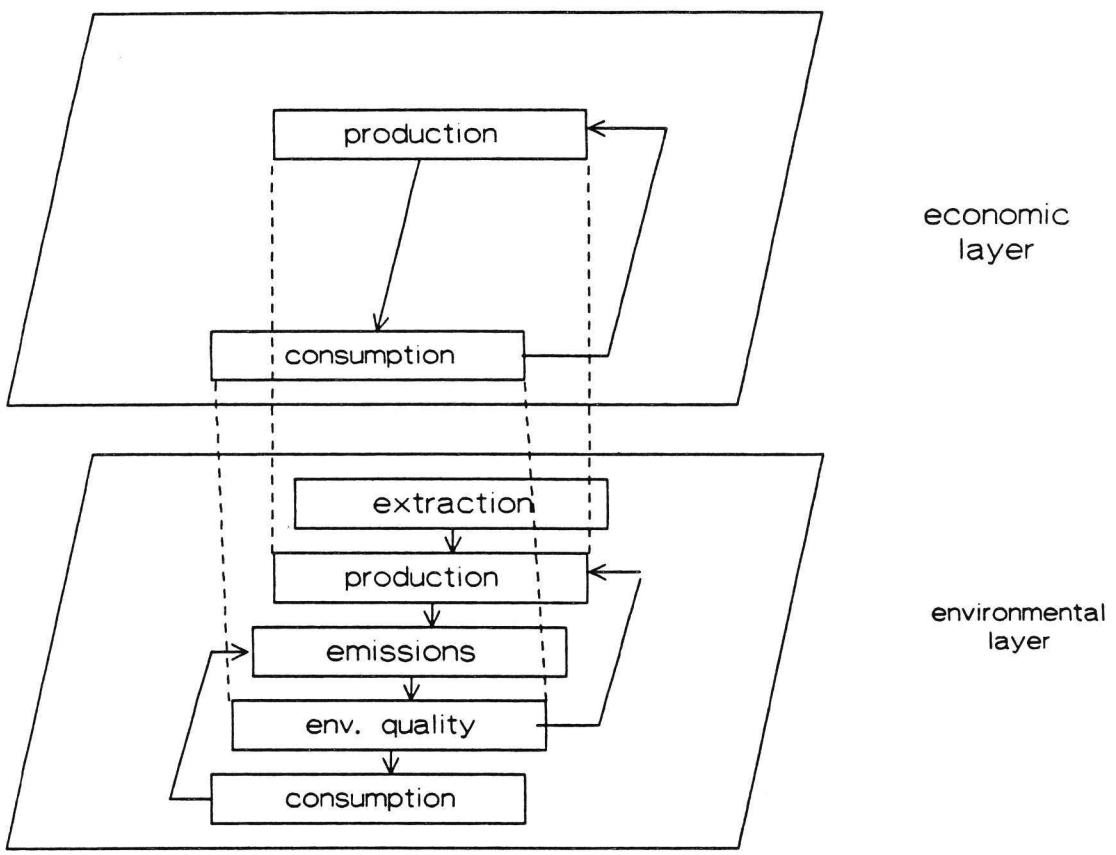

Figure 2.2 Two-layer projection of an economic-environmental system

For reasons of simplicity, the economic sub-model exhibits only production and consumption. The goods that are produced in firms are sold to the consumers. Consumers supply labour and capital to the firms. In economic models, flows and stocks are usually expressed in monetary units.

The environmental sub-model includes three extra variables: extraction, emissions and environmental quality. These variables are indicators

of the state of the natural resource base on which the economic activities ultimately rest.

The environmental sub-model shows that for the production of goods raw materials are extracted and are used in production. Pollutants are emitted as a side effect of extraction, production and consumption (including waste disposal). The emissions cause environmental damage, which influences consumers and firms. In environmental models, flows and stocks are expressed in physical units.

The fundamental difference between the economic and the environmental model is that the economic model is circular and the environmental model is essentially linear in nature. Non-renewable resources are extracted, transformed and consequently dispersed through the environment. In this respect, a connection with the second thermodynamic law of increasing entropy is often made. The regeneration of renewable resources may be threatened by over-exploitation and by environmental degradation.

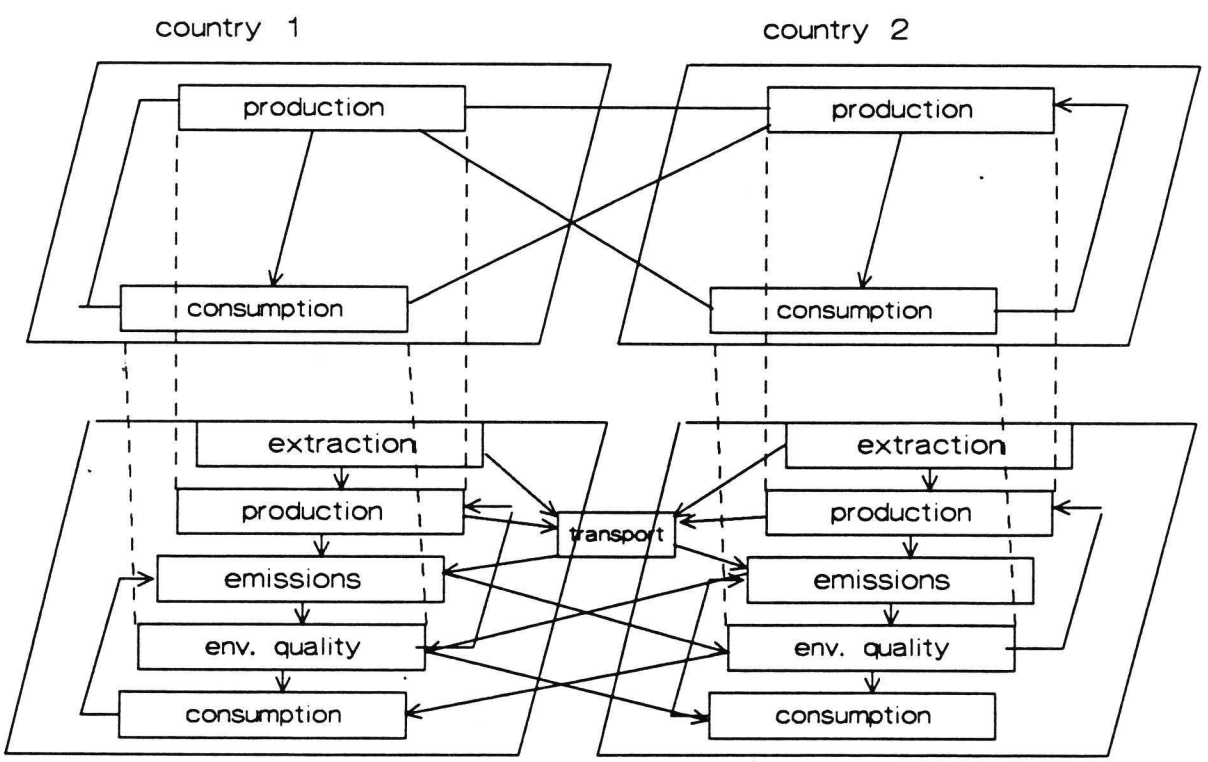

Figure 2.3 Two-layer projection of a two-country economic-environmental system

How does trade fit into this picture? Figure 2.3 depicts a two-country economic-environmental model. The economic sub-model exhibits two countries (one country may be thought of as the rest of the world). A transport sector is added which forms the link between the two countries. The goods that are produced can be sold to domestic and foreign consumers and to foreign producers as raw material or as an intermediate good.

The environmental sub-model shows that for the production of goods raw materials are extracted and are used in domestic production or, via transport, in foreign production. Firms can transport intermediate goods to each other. Goods are either sold to domestic consumers or, via transport, to foreign consumers. Pollutants are emitted as a side effect of production, transport and consumption (including waste disposal). The emissions cause environmental damage, domestic and/or abroad (transborder/global), which influences consumers and firms. The environmental sub-model assumes that consumers are not only affected by the environmental quality in their own country but also by the environmental quality abroad (by what is sometimes called 'psychological spillovers').

2.2.3 Theory of environmental policy

Environmental-economic theory has stressed the link between the lack of property rights to environmental resources and unsustainable resource use. Without clearly defined and protected property rights, no markets can arise to efficiently exchange the entitlements to the resources: from a welfare theoretical point of view, environmental problems are first and foremost a question of 'missing markets'. In a sustainable development context, the missing markets include the markets between present and future generations which are, of course, impossible to establish.

The relationship between externalities and property rights was firmly established by Coase (1960) in his seminal paper. Coase has shown that where there is costless bargaining between the generator and the victim of an externality, the outcome will be optimal whoever holds the property right. But of course, bargaining is not always costless, and this leads to the question under what circumstances it is efficient to create a market and when it is more efficient to address the externality differently.

Consider the example of a traffic light. A traffic light is obviously not a very efficient way to handle right of way situations. The red light may stop a business man who is in a terrible rush to make a billion-dollar contract. The green light may give right of way to a pensioner who is just making a pleasure trip without any hurry. If costless negotiation could take place, the business man might easily bribe the pensioner into giving him right of way. This would provide an optimal outcome. However, it is obvious that the transaction itself would cost the business man more time than waiting for the red light. In this case, transaction costs prohibit the creation of a market, and the traffic light is not such a bad instrument anyway.

From an economic point of view, market creation is probably the most efficient way to correct wasteful environmental resource use. However, excessive transaction costs may prohibit market creation. Alternative environmental policy instruments can be grouped into direct regulation (e.g. permits and standards), economic instruments (charges, subsidies, deposit-refund, etc), and a broad category of pressure/persuasion, including voluntary agreements (convenants) between governments and industries (Opschoor and Vos, 1989). The objective of these instruments is to internalize environmental costs so as to ensure that the full environmental resource costs of a product (in production, transport, use, waste) are taken into account in production and/or consumption. A problem in this context is: whose costs should be taken into account? Is it only costs of the present generation or also to the costs of future generations (and who will determine those)? and, is it only the costs to the domestic population or also the costs of foreigners?

A guiding principle in environmental policy is the Polluter Pays Principle (PPP), which has been adopted by the OECD in 1972. The OECD definition is:

> "*the principle means that the polluter should bear the expenses of carrying out the [] measures decided by public authorities to ensure that the environment is in an acceptable state. In other words, the cost of these measures should be reflected in the cost of goods and services which cause pollution in production and/or consumption. Such measures should not be accompanied by subsidies that would create significant distortions in*

> *international trade and investment" (quoted in: Baldock and Bennett, 1992).*

An important goal of the PPP is to limit distortions in international trade:

> *"the importance and merits of the Polluter Pays Principle [are] not only as an efficiency principle for the implementation of national environmental policies, but also as a principle which promotes the international harmonisation of these policies" (quoted in: Baldock and Bennett, 1992).*

The PPP is also a guiding principle for the environmental policy of the EC since the adoption of the Single European Act in 1986. However, its actual use has been limited, especially in the agricultural sector (Baldock and Bennett, 1992).

Several authors have stressed the importance of all nations party to the GATT to accept the PPP as a guiding principle in their environmental policies (Arden-Clarke, 1991; Verbruggen, 1991). Global adherence to the PPP would diminish tensions between trade and environment.

However, a few observations have to be made on this subject. First, the PPP does not in any way prescribe the intensity or extent of any national environmental policy. Second, the PPP assumes that it is possible to identify all polluters, that is, that some observed environmental damage can be traced back to a specific polluter who then may be held responsible. Experience has shown that this may be quite difficult in cases of historical or diffuse pollution, for instance in agriculture. Finally, the PPP may be not be feasible in cases of transborder or global environmental problems. In these cases, international agreements should be sought in which alternative financial arrangements - side payments - could well be justifiable. For example, Baumol and Oates (1988) constructed a case with two countries and a transborder environmental spill-over in which the global optimum solution would be that the victim should pay (a solution which is sometimes called the Victim Pays Principle).

2.2.4. Environmental policy and international trade

How do environmental policy and international trade interact? As a starting point one can distinguish between, on the one hand, (1) environmental problems associated with production (pollution as a result of a production process or depletion of natural resources) and (2) problems associated with consumption (pollution as a result of the consumption or the waste disposal of a product), and on the other hand, (1) domestic environmental problems and (2) environmental problems which spill over to other nations or to the global environment. The four alternatives are depicted in Table 2.1.

Table 2.1: Four types of environmental problems

	domestic	transborder/global
process/production	11	12
product/consumption	21	22

Policies to address domestic environmental problems (11 and 21) may interact with trade in two ways:

11] If the policy is meant to reduce environmental effects of domestic production, the competitiveness issue is often raised. Domestic producers may feel that they are being discriminated against foreign competitors who face less strict environmental standards; they may demand a "level playing field" (GATT, 1992).

21] If the policy is meant to reduce domestic environmental effects of consumption, imports may face restrictions. Foreign exporters may feel discriminated and may challenge the trade restriction (e.g. Danish beer bottle dispute, US-EC hormones-in-beef dispute).

However, although environmental policy changes comparative advantages between countries, it should be realized that it essentially restores previous market failures regarding environmental externalities. In principle, environmental policies do not cause distortions, they correct distortions. However, industries may face adjustment costs as discussed in 2.2.1. Some government intervention to smooth these costs may be in order,

but such intervention need not necessarily be in the form of border protection.

Can trade instruments be used as substitutes for domestic environmental policies? The answer owes much to the theory of protection, discussed in section 2.2.1. International trade *per se* is not a direct cause of environmental problems[4]: some distortion must be present - for instance the absence of an appropriate environmental policy - in order for international trade to create or worsen environmental problems (Anderson and Blackhurst, 1992). The first-best policy is to restore the market failure at its source by environmental policy at the national level, that is, by internalising environmental considerations in production and/or consumption decisions. For example, the manure problem in the Netherlands has been caused primarily by lack of environmental policies restricting the use of environmental resources as a waste deposit. Restricting the imports of feedstuffs from foreign countries (e.g. tapioca from Thailand) is, at best, a second-best instrument, both with regard to efficiency and effectiveness. Similar to the arguments for protection in section 2.2.1 there may be reasons to interfere with the free working of market forces because of environmental side-effects. However, trade policy instruments are usually not first-best instruments. To counteract domestic environmental problems, trade instruments can therefore never substitute for environmental policies, they can only complement such policies. Clear rules for such usage of trade instruments should be established to prevent the capture of such instruments for protectionists' purposes.

Many environmental problems have transborder or global repercussions, relating to pollution caused by production processes (12) or to polluting substances contained in products (22), or both. In this case international agreements with regard to production processes and product standards should be sought. If all countries participated in all international environmental agreements, there would be no trade distortions and no need for any trade measures. However, participation is often less than universal. Trade measures can then be used as "sticks" or "carrots" to encourage participation. Many international or multilateral environmental agreements have included trade provisions (17 up to mid-1991: GATT, 1992). These trade

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[4] Disregarding the environmental effects of (international) transportation.

provisions may regulate or ban trade (e.g. in certain types of endangered species) and usually discriminate against non-signatories of the agreement.

Environmental policy in one country may also wish to influence environmental pollution or degradation in other countries unilaterally, because of physical transborder spillovers (e.g. acid rain) or because of so-called 'psychological spillovers'. In fact, environmental policy makers may consider to use trade instruments (with respect to the product causing the problem or some unrelated product) to influence other country's environmental policies. This is a particularly sensitive area. The General Agreement on Tariffs and Trade (GATT) does not allow such action (see below) and also the provisional Earth Charter (Article 12) discourages unilateral action of this kind.

In reality, the distinction between 'domestic' and 'global/transborder' types of environmental problems (see Table 2) is not very clear-cut and may well change over time. Parallels may be drawn with the issue of human rights, an issue in which national sovereignty is increasingly being challenged by international rules.

In principle, tensions between trade and environmental policies could be relieved if all trading countries would harmonize environmental policies, for example by complying to the Polluter Pays Principle. However, even if this would be agreed in principle, (large) differences in the intensities of policies and the types of instruments used between countries are likely to remain. The need for, and the priority given to environmental policy may differ substantially due to natural, socio-economic, and cultural differences. The playing field will never be flat: it may be very difficult to assess whether any remaining bumps and holes reflect genuine environmental tradeoffs - and therefore reflect true comparative advantages - or just reflect economic shortsightedness. It is important to find and agree upon common environmental baselines in the international context. However, the same arguments hold for differences in socio-economic policies of the worlds' nations. These differences have at times put the relatively open post-war trading system under pressure, but somehow a *modus vivendi* has been established within the GATT.

In sum, environmental policy and international trade interact on many counts. In principle, environmental policies correct previous market distortions ragarding environmental externalities. In analyzing the linkages between environmental policy and international trade, a useful

distinction can be made between, on the one hand, environmental problems related to production and consumption, and on the other hand, domestic and transborder/global environmental problems. Tensions between environmental policies and international trade exist, and may grow in importance as environmental policy develops. The international community should develop clear rules and disciplines to make trade and environmental policies compatible and mutually reinforcing.

2.2.5 International trade rules and environment

The world's trading rules are laid down in the General Agreement on Tariffs and Trade. The goal of this Agreement, presently subscribed by 105 countries, is to liberalize trade between nations party to the agreement. It does so by regularly negotiating reductions in tariffs and non-tariff barriers on a product-by-product basis in successive 'Rounds'.

It is of particular interest to realize that the GATT operates on a "fixed rule" regime, rather than on a "fixed quantity" regime: if all members play by well-defined rules the members must expect the chips to fall where they may. The resulting allocation of industries and trade among member countries is derived of and legitimated by the approved process. This is in contrast to the "fixed quantity" regime that is inherent in "orderly market arrangements", "voluntary export restraints", etc. which aim to allocate trade volumes directly (Bhagwati, 1988). In intellectual approaches toward the problem of trade and environment, a distinction can also be made between those who concentrate primarily on the rules, and those who concentrate primarily on the outcomes of international trade. The rules and outcomes are of course interlinked, but essentially in a complex and partly impredictable way.

The rules of the GATT are concerned primarily with preventing discrimination, that is, with limiting the extent to which countries can discriminate between home products and imports, between imports from different countries, and between goods sold in the home market and those exported (GATT, 1992).

In certain cases, measures taken for environmental protection purposes which would otherwise violate GATT obligations may be permitted under Article XX of the GATT. This Article, especially subparagraphs b and g,

permits contracting parties to place health, safety and resource conservation goals ahead of non-discrimination, if certain conditions are met.[5] One of the controversies around clause XX(g), which allows exceptions for trade measures which conserve exhaustible natural resources, is the "extraterritoriality" issue which relates to whether or not Contracting parties can take measures to conserve resources outside their sovereign control (for different views, see for instance Sorsa, 1992 and Arden-Clarke, 1991). The GATT's position on this issue is presented below.

In a recent Secretariat Note, the GATT distinguishes three types of environmental policies which may influence trade, and states its position on these policies as follows (GATT, 1992):

1. protecting the nation's own environment

   GATT rules place essentially no constraints on a country's right to protect its own environment against damage from either domestic production or the consumption of domestically or imported products. Generally speaking, a country can do anything it considers necessary to its own production processes.

2. changing another country's environmental behaviour

   In principle, it is not possible under GATT to make access to one's own market dependent on the domestic environmental policies or practices of the exporting country.

3. trade provisions in multilateral agreements

   In the first place the Note argues that in order to induce individual countries to join any agreement, positive incentives such as offers of financial assistance and transfers of environmentally friendly technology directly related to the problem at hand, as well as more broadly based offers, will be, in the long run, more effective than negative incentives such as discriminatory trade measures. In the second place, the Note states rather matter-of-factly that "as long as participation in an environmental agreement is not universal, trade provisions will be [ ] discriminatory".

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[5] These conditions ensure that the trade measures are necessary for the achievement of the goals: that is, the goals cannot be reached with other measures and the measures are the least trade distorting way of achieving the goals.

3. INTERNATIONAL TRADE IN AGRICULTURAL PRODUCTS AND THE ENVIRONMENT

A sector where changes in trade and environmental policies will have far-reaching consequences is agriculture. World prices for agricultural products are highly distorted as a result of domestic policies in industrial and developing countries. Current agricultural practices lead to large environmental problems in industrial as well as developing countries. The present chapter reviews these issues. First, some recent developments in agriculture will be sketched, and the economic rationale behind these developments be discussed. Second, current agricultural policies and their impact on international trade will be outlined. A distinction will be made between agricultural policies in industrial and developing countries. Finally, attention will be paid to the most important environmental problems connected with agricultural production, and to the environmental effects of transport in agricultural products. Environmental externalities of agricultural production will be dealt with at great length, because international shifts in agricultural production resulting from changes in trade policies will have important environmental consequences. The environmental impact of changes in agricultural trade policies is one of the major policy issues that will be discussed in chapter 4.

3.1 Economics of agricultural production

An important part of agricultural production is directly related to the soil. Land is a scarce, immovable and not reproducible (within the period under consideration) unique natural resource (Breimyer, 1962). Clearly, this distinguishes the agricultural production process, as an economic activity, from the industrial production process. Because nature is an important factor of production, the volume of agricultural production is less controllable and predictable. It depends on difficult to influence natural surroundings (climate, rainfall, groundwater and soil quality). Furthermore, agriculture, as the dominant land use, largely determines the nature of the rural environment and can be held jointly responsible for the protection of environmental amenities such as wildlife, landscape quality, improved public access and, above all, variety.

Agriculture in industrial countries is characterized by an increased demand for livestock products, a decline of prices paid for crops in real terms and increasing opportunity costs of farm labour. These developments affect output by encouraging farmers to produce more livestock products and to substitute cheaper production factors for labour. At the moment, livestock production in the industrialized countries exceeds crop production. The present system of feed supply has made feed grains constantly available at fairly well-stabilized prices. Furthermore, crop and livestock production are locationally wedging apart as a result of improved transport, increased commercial preparation of mixed feeds and the need for, and premium on, specialized knowledge in livestock and crop production. The impact of agricultural market interventions on the process of separating crop and livestock production in industrialized countries has been tremendous. Through agricultural market interventions the farmer was assured at all times of a market for feedstuffs and livestock products.

International comparisons of agricultural productivity show that the pattern of technological development in industrial (and other) countries differs markedly depending on whether a country has a large area of arable land and a small (declining) rural population, or whether it has a relatively large rural population and limited amounts of land. In countries with a high land-labour ratio, for example the United States, agricultural productivity has been increased by using tractors, combines, and other forms of machinery primarily as substitutes for labour. In countries with a low land-labour ratio, such as Japan, the constraints resulting from limited land resource endowments were released by increasing the application of fertilizer, chemicals, and other yield-increasing inputs per unit of land (Hayami and Ruttan, 1985: Ch. 5). These findings largely explain the increased use of purchased inputs in the industrialized countries.[6] By the increased use of purchased inputs industrial countries have been able to improve their output of both crop and livestock products substantially.

In parts of the Third World, agriculture is still characterized by traditional farming practices. These practices have been developed without access either to scientific knowledge or industrially produced inputs. Land and labour productivity is low and unstable. The wide variability of yields

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[6] Purchased inputs are capital (consisting of investments in livestock, machinery and equipment, buildings, and management services) and variable inputs as purchased feed (concentrates, forages, and milk replacer) and other intermediate inputs (fertilizer, pesticides, seed, gasoline and diesel fuel, veterinary services, contract work, electricity, etc.).

is caused to a large extent by the limited control over soil moisture, pests and other cropgrowing variables (see e.g. Stevens and Jabara, 1988: Ch. 4).

In large areas of South and East Asia, some parts of Latin America and the Mediterranean region, and very few regions in Africa, agricultural systems have changed dramatically since the beginning of the 1970s. Agricultural productivity was boosted by the availability of new high-yielding varieties of rice, wheat, and maize, developed at international research institutes (the so-called Green Revolution). Adoption of these new varieties has a large positive impact on the profitability of using chemical fertilizer, pesticides, irrigation water and other complementary inputs. As a result, farmers' use of nonfarm inputs (including hybrid seeds) and investments in irrigation by farmers and governments greatly increased in these countries (Stevens and Jabara, 1988: Ch. 8).

The Green Revolution did not have much impact on agriculture in most of Africa, and parts of Latin America and the Middle East. A number of explanations stand out. Firstly, the successful new technologies have been developed for a number of grains, grown primarily in temperate-zone agriculture. Many major food crops, like cassava, yam, sorghum, and millet, have received only limited attention. Secondly, the profitability of new plant materials essentially depends on the availability of complementary inputs like chemical fertilizer and moisture control. In the semi-arid areas of Africa, Asia and Latin America, complementary moisture control greatly constrains the profitable use of these new technologies. Thirdly, government policies that tended to depress agricultural output prices in many countries in Africa and Latin America have made farmers reluctant to increase their output via new techniques. The next two sections will discuss recent agricultural policies, in industrial as well as less-developed countries, in more detail.

3.2 Agricultural policies in industrial countries and international trade

World trade in most agricultural products (intra-EC trade excluded) is less than 20 percent of world agricultural production (Commission of the European Communities, 1991: Table 3.6.5). For individual countries, the ratio of trade to agricultural production is to a large extent determined

by the size factor. Small countries are more dependent on international trade than large ones, since they are less able to produce the range of agricultural products they need. Hence, their ratio of trade to total production is high and their economies are fairly open. The diversity of agricultural conditions in large countries enables them to satisfy most of their own needs.

The ratio of trade in agricultural products to total agricultural production is also influenced by some special features, described below, stimulating domestic agricultural production with the purpose to achieve self-sufficiency. Nevertheless, following the Heckscher-Ohlin theorem, resource endowments will provide a rough indication of the way in which international trade in agricultural products in the long run operates.

Transportation costs are often disregarded in studies of international trade, although they may have a substantial impact on trade flows. The production costs of unprocessed agricultural products are generally low, because production is based to a large extent on the use of unpriced environmental resources. With a low value per unit weight transportation costs tend to be high compared to production costs, limiting (international) trade in unprocessed bulk products. In a further stage of processing, the ratio of transportation costs to production costs declines and international trade increases.[7] Furthermore, transportation costs can be relatively high because many agricultural products are perishable. Consumption, either as a final consumption good or an intermediate good, is often confined to a limited period of time after harvesting. Storage and transport involved in transferring these products (e.g. by trucks or airplanes) are relatively energy-intensive.

Most industrialized countries have well-developed agricultural policies to stimulate self-sufficiency and income parity for agricultural producers.[8] As shown by Anderson and Tyers (1991), the nominal protection rates of grain, livestock products and sugar, are positively related to a country's per capita income and significantly negatively related to its revealed comparative advantage in agricultural production. Because of these agricultural policies, industrialized countries that protect agriculture

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[7] See e.g. Yeats (1977) for information on transportation costs for exports to the United States by product type and stage of processing.

[8] See also figure A.7 for information on the protection of agriculture in selected developed countries.

export more and import less agricultural products than under a system that would be less protective to agriculture. This occurs at the costs of other sectors of the industrialized economies.

Industrialized countries tend to protect those agricultural products for which there is an import need, where the price elasticity of supply is expected to be low, where the product is relatively cheap to store, and where the marketing channel can be controlled (Koester, 1985). If the price elasticity of supply is small for agricultural products and (related to that) the price elasticity of demand for inputs in agriculture is small, then the effect of agricultural protection on the rest of the economy is small and such a policy could induce an efficient redistribution of income in favour of farmers. However, some qualifications are needed. Agricultural policies have spillover effects to unprotected or less protected agricultural products. Furthermore, long-term price elasticities are much larger than short-term price elasticities, because technological development is partly induced by relative prices and because land, labour and capital respond only very slowly to price changes (see e.g. Hayami and Ruttan, 1985; Binswanger, 1990). Hence, the effects of agricultural policies on the economies of protecting countries and on international trade in agricultural products will often not be small. For example, it has been estimated by Anderson and Tyers that during the period 1980-1982, prices on world grain, livestock and sugar markets were 14 percent below the equilibrium prices that would prevail without agricultural protection in the industrialized countries. Without agricultural protection, world trade volume would be more than 40 percent higher for meat and dairy products (Anderson and Tyers, 1991).

Liberalising trade

Removing barriers to trade in agricultural products in industrialized countries is an important issue in the now extended Uruguay Round of multilateral trade negotiations. Because of the interdependence of consumption, production, resource allocation, and income, all sectors of an economy are linked, and the effects of a gradual lowering of agricultural protectionism will not be limited to the agricultural sector alone. To analyse the effects, an empirical model is required that should ideally include all the above-mentioned linkages. Agriculture's share of GDP in most industrial countries is low, however, and relatively few people find

employment in the agricultural sector. As a result, feedback effects may be small and analyses of the effects of liberalizing trade on world food prices, agricultural production, agricultural trade and welfare can be kept largely separate from modelling all sectors of an economy. Nevertheless, even in industrial countries like Canada, New Zealand, Denmark and the Netherlands, agriculture performs a very important role as a major export industry. Moreover, price changes of agricultural products have a substantial impact on incomes both within and outside the agricultural sector. The changes in expenditure patterns that result from these income changes will affect the sectors in an economy in a different way. When price changes are large, the magnitude of these changes may not be small.

At the moment, a number of models exist that have been designed for analyzing the impact of agricultural trade liberalization on domestic and international markets. Each of these models differs from the others in structure, coverage of commodities and countries, and treatment of policies (see e.g. Blandford, 1990 for a review of up-to-date, multicommodity models of agricultural trade liberalization). Most of the models are partial equilibrium models. These models are designed for examining the impact of changes in policies regarding specific agricultural commodities with the remaining sectors of the economy not changing. As a consequence, these models focus on efficiency gains in the sector analysed, but not on the effects on incomes, relative prices and indirect efficiency effects (Goldin and Knudsen, 1990: p. 14). By contrast, general equilibrium models such as the IIASA-model (Parikh *et al.*, 1988) examine the economy as a whole and the linkages between agricultural and non-agricultural sectors. These models allow the analysis of both efficiency and income effects throughout the economy.

The discussion below will concentrate on a model developed by Anderson and Tyers (1989, 1991, 1992). This model has generated a substantial amount of published information on the impact of trade liberalization.[9] It has been used for evaluating the consequences of recent proposals (made during the Uruguay Round's trade negotiations) for a phased, partial liberalization of agricultural trade. Moreover, the model outcomes have been used for exploring the potential effects of agricultural trade

[9] It would be interesting to include the results of general equilibrium models in the analysis as well. Unfortunately, the available documentation on these models sharply contrasts with, in particular, the published information on the Anderson and Tyers model.

liberalization on the environment (Anderson, 1992a,b). Section 4.3 below will go into the environmental impacts of liberalizing (agricultural) trade. For understanding these impacts, it will be useful to discuss the main economic effects of agricultural trade liberalization first.

In interpreting the results of this and other models on the same subject, Blandford (1990) has noted that existing models tend to overstate the impact of liberalization on protected agricultural sectors. In the long run, policy changes lead to changes in factor prices (particularly land prices) that will still keep much of agriculture in the developed world viable, even with lower domestic prices. Furthermore, once a sector is exposed to increased competition, technological advances, economies of scale, and productivity growth may be stimulated. Because these factors are usually not taken into account, the models probably provide an unduly pessimistic view of the survivability of agriculture in a less protected environment (Blandford, 1990: pp. 429-430). Similar arguments apply to the effect of trade liberalisation in developing countries. Changes in relative prices can have a profound effect on agricultural and non-agricultural incomes. In partial models, the demand effect of changes in non-agricultural income are usually not taken into account.

Anderson and Tyers use a dynamic, multi-commodity simulation model of world markets for the major traded food staples, grains, livestock products and sugar (GLS model) to calculate the effects of liberalizing international trade in agricultural products.[10] Their model differs from several other partial equilibrium models in its use of a dynamic framework, its incorporation of technological change and in exploring the effects of liberalization on price stability. Because a partial rather than a general equilibrium model is used, the true comparative advantage position of a sector cannot be measured. The measured effects are therefore incomplete. It is estimated that a phased 50 per cent reduction in protection in the industrial countries between 1991 and 2000 would cause the expected international prices of most grains, livestock products and sugar to be higher than would otherwise be the case (Anderson and Tyers, 1992). The largest price change is for dairy products (an increase of more than 30 percent by the late 1990s).

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[10] Seven commodity groups are distinguished: wheat, coarse grains, rice, meat of ruminants, meat of non-ruminants, dairy products and sugar. These groups account for about half of world food trade, most of the rest being edible oils and beverages.

The results of other models also indicate that world market prices of the major temperate-zone agricultural commodities would increase if existing protective policies were removed. The general consensus is that dairy product prices would increase most, while the change in the price of grains would be modest. Most of the models suggest that the volume of trade would increase if trade was liberalized. As in the case of price levels, large increases are foreseen in the trade of dairy products (and meat), while increases in the volume of trade in grain would be modest (Blandford, 1990: pp. 414-417).

The outcome of the GLS-model indicates that the effect of partial liberalization on domestic food production is, compared to the reference scenario, less dramatic than is often feared in protectionist countries. Although resource allocation within the agricultural sector in one region and over regions changes, total production would be about the same compared to what it would otherwise have been. Total production in the EC-12 would be no more than 3 percent below the base scenario level by 2000. Production of nonruminant meat in Western Europe would be considerably higher with liberalization because feedgrain prices would be lower. Only for Japan, the estimated production differences are larger. Japan's production in the partial liberalization scenario is on average one eighth below the base scenario's production level by the year 2000 (Anderson and Tyers, 1992: Table 2).

Because of productivity growth, the absolute level of production in industrial countries expands considerably (even in Japan) despite the steady lowering of protection levels. By the year 2000, the volume of the EC's output of GLS products would be one fifth larger than in 1990. The gross value of food production would be affected by not only the output effect but also the effect on prices. For the EC-12 the effect of liberalization, compared to the reference scenario, by the year 2000 is a 24 percent decline of the overall value of food production (Anderson and Tyers, 1992: Tables 3 and 5). Under these circumstances a sharp decline of the total number of farmers is expected, resulting in a limited effect on farm income (Tims, 1990).

Estimates of the economic welfare effects associated with partial liberalization indicate that industrial market economies would be substantially better off. The gains of consumers and taxpayers in these countries are only partly offset by the losses that confront producers. Producers in

the traditional food exporting countries among the industrial countries gain because of higher prices for their exports in the liberalization scenario. Industrial countries as a group would be more than 35 thousand million 1985 US dollars per year better off by the turn of the century, or $ 45 per capita (Anderson and Tyers, 1992). Other studies generally agree on the direction of the welfare effects of freer trade. Industrial countries would gain through a net increase in economic surplus (defined as the net sum of transfers among producers, consumers, and taxpayers). The models show, however, considerable variation in the size of transfers among producers, consumers and taxpayers (Blandford, 1990: pp. 421-426).

The IIASA-model (Parikh *et al.*, 1988) attempts to provide information on the effects of liberalization for the whole economy. This model suggests that the gross domestic product of virtually all industrial countries would increase by a small amount as the result of agricultural trade liberalization. In countries with highly protective policies, such as Japan and the European Community, the gain in the nonagricultural sector would outweigh the losses in agriculture. Consumption of all commodities would increase, and trade would become a much more significant proportion of national income (Blandford, 1990: pp. 426-428).

3.3 Agricultural policies in developing countries and international trade

In contrast to the industrialized countries, many less-developed countries have tended to discriminate against agriculture in recent decades. According to the World Bank (1986), agriculture has been taxed implicitly as well as explicitly in the past. Implicit taxation resulted from macroeconomic policies aimed at promoting industrial activity (by means of tariff protection, quotas, subsidies, public investment, etc.) and from overvalued exchange rates. Explicit taxation of agriculture took the form of export taxes on agricultural products, marketing boards extracting high margins from buying and selling agricultural products, and so on. Figure A.8 gives an indication of the extent to which industrial protection has lowered the relative profitability of agriculture in a number of developing countries. The relative protection coefficients show the extent to which value added in agriculture has been protected relative to value added in industry. Except for Korea, all countries in the sample discriminated

against agriculture. The discrimination was highest in Nigeria and Colombia (relative protection coefficients smaller than 0.5).

One of the outcomes of these policies has been an unfavourable internal terms of trade for agricultural products. Protection of industry has resulted in high prices for consumption goods and agricultural inputs from this sector. Furthermore, regulation of agricultural markets, taxation and overvalued exchange rates have depressed the prices for agricultural products.

The lack of developmental interest in the agricultural sector not only caused a worsening of the internal terms of trade, but also had a negative impact on agricultural development policy (structural policy). Investments in agricultural research, rural infrastructure, education and extension, institution building and other so-called public goods were generally insufficient for establishing a fast-growing, transforming agricultural sector.

The discrimination against agriculture is very much a result of development strategies that promote domestic industries with the intent to produce locally the goods that previously were imported. Such strategies are intended to accelerate the shift of resources out of agriculture by lowering its profitability compared with that of industry. To ensure the economic survival of import-substituting factories, it was necessary to adopt policies that made imported goods more expensive or more difficult to acquire.

Since the beginning of the 1980s, structural adjustment programmes have been adopted in many less-developed countries in order to confront an economic downturn. One of the major goals of most structural adjustment programmes is to stimulate the production and export of agricultural products. To this end, improvement of the internal terms of trade for agricultural products, adjustment of the real exchange rate, and an increase of the productivity and efficiency of agriculture are commonly pursued. The measures that are taken differ from country to country, but common elements in most adjustment programmes are price liberalization (including exchange rate adjustment), reduction of government interference, promotion of the private sector, and removal of quantitative and administrative trade controls.

Empirical models of agricultural production and trade may be used for examining the impact of agricultural policy changes in developing countries

on production, consumption, trade and economic welfare of different world regions or countries. Anderson (1992a,b) used the GLS-model for examining these effects. Contrary to other partial equilibrium models on the same subject (including previous versions of the GLS-model), the model addresses not only direct policy distortions, but indirect discrimination against agriculture (via protection for manufacturing and overvalued exchange rates) as well. Using this model, a reference simulation for 1990 is compared with a simulation of what food markets could have looked like in 1990. In the alternative scenario, food price distortions in industrial as well as developing countries are assumed to be absent. The latter scenario assumes that complete adjustment to the new (long-run) equilibrium occurs instantaneously. Although this assumption is unrealistic, the extreme results are useful because they indicate what world agriculture might have looked like in 1990 if distortions would have been absent for a decade or two prior to that year. The results of the alternative scenario have been used by Anderson (1992a,b) for exploring the effects of agricultural trade liberalization on the environment. Section 4.3 will discuss these environmental effects.

It should be emphasized that the alternative scenario differs considerably from the scenario discussed in the previous paragraph based on the proposal made during the Uruguay Round's negotiations for a phased 50 percent liberalization in industrial countries only between 1991 and 2000.[11] The eventual long-run effect of liberalization is less easy to see from such a dynamic simulation than from the comparative static simulations reported in this section (Anderson, 1992b: p. 158).

The model outcomes of the comparative static simulation indicate that international food prices would almost be the same (minus one percent) on average as forecast in the reference scenario when both industrial and developing countries liberalize. The effect of lowering protected prices in rich countries is offset by the recovery of depressed food prices in poor countries when the discriminatory policies against agriculture are removed. The price effects differ considerably across commodities. Prices of dairy

[11] Anderson (1992a,b) also presents results of a long-run, comparative static simulation with protectionist food policies removed in industrial countries only. The results are comparable to those of the phased partial liberalization scenario discussed in the previous section. Only the magnitude of the changes, in particular the production declines in Japan and the EC, is much stronger in the comparative static simulation.

products rise substantially (84 percent), whereas the prices of nonruminant meat, sugar and coarse grain show modest declines in the second scenario.

As regards production effects, Anderson (1992a,b) considers the effects on three (ecologically important) commodity groups only. These are grains, ruminant meat and sugar. The most striking result is that total world food production hardly changes as a result of the reforms. When industrial as well as developing countries liberalize food trade, world production of grain would decrease by 2.8 percent, whereas production of sugar and beef and sheepmeat would increase by 4.2 and 4.4 percent, respectively. To some extent, the decline in grain production occurs because liberalization of trade in meat and diary products implies that less grain feeding and more grazing of pastures would occur globally. The estimated production changes are even smaller when liberalization would take place in industrial countries only.

Although total world food production hardly changes, large regional shifts in food production would occur. When developing countries as well as industrial countries would liberalize their policies, production of the three commodity groups would decline most in Western Europe and Japan (where the declines range from 25 to 84 percent), whereas production in North America and East Asia (excluding China) would decline as well. These declines are more or less balanced by production increases for all three commodity groups in Latin America, China and Sub-Saharan Africa.

3.4 Environmental effects of agricultural production

Technological and biological developments, presumably to some extent caused by agricultural protection, have steadily enabled farmers in industrial countries to improve the productivity of individual crop and livestock activities. Chemical inputs, new varieties of crops and animal breeds, advisory and veterinary services, product specialization, more continual cultivation and larger scale systems are main contributors. In places, previously infertile, waterlogged, or otherwise marginal lands have been brought into production (Green, 1991). To many observers these improvements of productivity have become increasingly open to question. External effects of the existing production technology and also of the scale and intensity of production have been kept outside productivity analysis. A narrow focus

on increased productivity has obscured the fact that there have been high environmental and social costs to agricultural progress.

As discussed above, environmental externalities are evidence of *market imperfections*. In the context of agriculture, environmental problems reflect the price system's inability to achieve the socially optimal land allocation among various uses/farming systems. Primary concerns in industrial countries are water pollution from applications of pesticides and fertilizers, and air pollution by ammonia, nitrogen oxide, etc. More explicitly, environmental externalities of agricultural production mainly caused by increases in agrichemical input use are (see e.g. Adviescommissie perspectieven voor de agrarische sector in Nederland, 1989):

- Environmental pollution by phosphates; the application of phosphates to the soil exceeds the withdrawal of phosphate by crops. As a result the buffer capacity of the soil has declined. Eventually, the quality of surface water declines as leakage to groundwater increases.
- Environmental pollution by ammonia; deposition of ammonia not only leads to acidification, but also to undesirable fertilization of the soil. It is also an important source of air pollution due to smell.
- Environmental pollution by nitrates; nitrogen in fertilizer or manure is only partly used by crops. Due to leaking to groundwater and washing to surface water, nitrates reduce the quality of drinking water and harms the natural vegetation.
- Environmental pollution by insecticides, pesticides, herbicides, etc.; the use of chemicals in crop production threatens the quality of ground, surface and drinking water. Also, they harm animal organisms and influence the ecological equilibrium.

These environmental problems related to intensive input use are primarily of a domestic nature, although there may exist some physical spillovers to adjacent countries. Intensive use of chemical inputs like pesticides and fungicides may also cause consumption-related externalities when large residues of these chemicals are present in food that is being consumed. When food containing such residues is exported, this may affect the health of people in the importing countries.

Changing farming systems created a demand for resource policies with respect to a wide range of natural resources, including forestry resources, fisheries, minerals, groundwater, and soil. Of equal importance is the loss of wildlife habitat and landscape features due to the restructuring of

agriculture. The concern is with changes in both quantity and quality of the resources over time. For example, intensive modern agricultural production in industrial countries has led in some places to deterioration in soil structure, water and wind erosion and to salinization (Green, 1991). Transport of minerals has led to shortages in some places and surpluses in others. Changes in farm landscapes are widely regarded as detrimental to the scenery of the countryside and its use for public recreation. Countries such as the Netherlands, Germany and Britain have long had arrangements for management agreements wherby farmers are paid to farm in ways which maintain the environmental value of their land.

In developing countries, the use of chemical inputs in agriculture is much lower on average, and so are the problems related to intensive use of these inputs. But there exist large differences between countries and regions. As discussed above, productivity increases during the Green Revolution were partly a result of increased use of chemical inputs. In densely-populated areas in Asia, the use of such inputs has reached levels similar to those of industrial countries. For example, FAO-estimates indicate that fertilizer use in China and the Republic of Korea in 1989/90 was equal to 262 and 425 kilograms per hectare of arable land, respectively. The corresponding figures for Denmark, France, and the Netherlands are 250, 319 and 642 kilograms. In Sub-Saharan Africa, on the other hand, average fertilizer consumption is less than 9 kilograms per hectare of arable land (World Bank, 1992: Table 4).

The most threatening environmental problem in developing countries, however, is the deterioration and loss of arable land. Several types of soil degradation can be distinguished. The importance of each type differs greatly from region to region. The main aspects of soil degradation are erosion, nutrient depletion, and salinization and waterlogging.

Erosion is a key component of soil degradation, characterized by irreversibility and off-site effects. Although erosion is a problem for temporate soils as well (for example in the United States), its impact on aggregate agricultural production is much larger in tropical countries. Tropical soils, rainfall and agricultural practices in the latter countries are more conducive to erosion. For countries such as Mali, Costa Rica, Mexico and Malawi, estimates of economic losses due to gross soil loss range from 0.5 to 1.5 percent of Gross Domestic Product annually (World Bank, 1992: pp. 55-56).

Erosion can have important positive or negative off-site effects, depending on where the eroded soil ends up. On the one hand, it may harm productivity by deposing silt in dams, irrigation systems and rivers and by damaging fisheries. On the other hand, eroded soil may add to agricultural land elsewhere. As such, it represents a geographical shift in agricultural productivity. Off-site effects of erosion can evidently have an international dimension, like for example in the case of Nepal and Bangladesh.

A related problem is that of nutrient depletion. Maintenance of soil fertility requires a balance between nutrient losses (through uptake by crops, livestock raising, erosion, leaching, and so on) and nutrient replacements (through manure, chemical fertilizer, crop residues, and so on). If over a period the balance is negative, this indicates that nutrients are being mined from the soil. As a result, agricultural production takes place at the expense of future generations. When losses exceed nutrient gains, application of chemical fertilizer can help to restore the balance.

Soil nutrient depletion is a major problem in large parts of Sub-Saharan Africa (see e.g. Stoorvogel and Smaling, 1990). African farmers have exhausted their soils for a long time. Traditionally, lack of fertilization was compensated by long fallow periods. Increasing pressure on land due to population growth and farm size increases has eliminated the recovery period, or considerably reduced its length. Soil depletion has been the inevitable outcome of this process (Van der Pol, 1992). In addition, population pressures have increased demand for firewood. The resulting removal of tree cover has important effects on the nitrogen contents of the soil (and on soil erosion by wind and water). As more and more people turn to dung and straw for cooking, the natural cycle of soil replenishment is further disrupted (Pomfret, 1992: p. 205).

Salinization and waterlogging have become growing problems in certain irrigated areas in recent years. Irrigated land is detoriating in many countries, partly as a result of bad management practices. According to Repetto, over 20 million of hectares in India and Pakistan have been lost through waterlogging, and at least 30 million are seriously affected by salinization (Repetto, 1989: p. 76). Salinization is not just a problem of irrigated land. Most of it occurs naturally. Globally, nearly one-third of arable land is affected by elevated salt concentrations (World Bank, 1992:

p. 57). Except for the potential cross-boundary effects of soil erosion, most types of soil degradation typically have domestic effects.

A problem with an entirely different dimension is that of deforestation. Cutting of (tropical) forests can have a number of undesirable ecological effects of a global nature. It may contribute to the loss of genetic diversity of timber species and to the potential extinction of plants and animals. As trees sequester carbon as they grow, deforestation reduces the absorption of carbondioxide from the atmosphere. On the other hand, forests protect and enrich soils, affect local and regional climate and have various other ecological effects on a local scale (World Bank, 1992: pp. 57-58).

The clearance of land for agricultural purposes can be an important source of deforestation. But rarely only one source is responsible. Data from the World Resources Institute, presented by Anderson (1992a), suggest that tree felling for firewood is responsible for about 80 percent of wood use in developing countries. Commercial logging has a minor contribution only. Once cleared for firewood, marginal land is often used for food production purposes (Anderson, 1992a: pp. 164-165). According to the World Bank (1992: p. 58), tree felling for fuel purposes is concentrated around dense human settlements, tropical dry forest, and nonforest wooded areas of Africa and South Asia. Tropical moist forests, on the other hand, are mostly being lost to agricultural settlements (roughly 60 percent of annual clearing), especially in land-scarce countries.

Finally, it should be noted that trade in agricultural products may also involve considerable environmental externalities. Transport of unprocessed agricultural products takes place at relatively high financial as well as environmental costs, because transport of these products is relatively energy-intensive. Similarly, the transportation of more processed agricultural products often causes substantial environmental externalities, such as high CO_2 emissions, because of the perishable nature of these products. Examples are the international transportation by airplane of kiwis, eggs, and flowers. The environmental effects of transport are often overlooked in studies of trade and the environment (see e.g. Anderson, 1992a,b; GATT, 1992). More research is needed on means of transporting agricultural products and CO_2 emissions per type of transport in order to verify the aforementioned assertions.

3.5 Conclusion

This chapter has discussed a number of features of domestic policies, trade and environmental problems specific to the agricultural sector. It has shown the large extent to which the global pattern of agricultural production is determined by domestic policies. Together with a country's specific comparative advantages, these agricultural policies considerably influence trade volume and trade directions. As a result, world market prices for a number of agricultural products are highly distorted compared with domestic prices in many countries.

Agricultural production in developing and developed counties causes a number of specific environmental problems, primarily related to the use of land and industrial inputs, that differ from environmental problems in other sectors of the economy. These problems are predominantly of a domestic nature (erosion, soil mining, water and air pollution, etc.), although there do exist some physical spillovers to adjacent countries (including consumption-related externalities). Agriculture also contributes to global problems like the greenhouse effect (for example through land clearance). Moreover, trade in agricultural products may cause considerable (transport-related) externalities, since it mainly involves bulk products and perishable products. The nature of the relationships between production, trade, and the environment therefore differs considerably as between agriculture and other sectors in an economy. Models of relationships between production, trade and environment should take these intersectoral differences into account in order to provide a solid basis for policy decisions.

4. MAJOR POLICY QUESTIONS

To examine the various issues of international trade and the environment systematically, a theoretical analysis of sustainable development, international trade, and environmental and trade policies was developed in chapter 2. Using the proposed analytical framework, some major policy questions with regard to international trade and the environment will now be examined in more detail.

Environmental policies are discused in the first two sections of this chapter. Adoption of (theoretically sound) environmental policies will generally lead to changes in trade flows, as the correction of previous market failures will change comparative advantages between countries (see section 2.2). The introduction of environmental policies also raises a number of questions regarding a country's competitiveness, international harmonization of environmental standards and measures, and the potential role of trade measures. For analytical purposes, domestic environmental effects will be distinguished from transborder or global environmental effects. Section 4.1 will examine consequences of national environmental policies for international trade, while section 4.2 is devoted to international environmental problems and the related use of trade measures.

Another important policy issue is the impact of trade and trade liberalization on the environment. As discussed in section 2.2 above, free trade maximizes national and global welfare provided environmental externalities are corrected through appropriate policies (and a number of standard assumptions on the functioning of markets are satisfied). These corrective policy measures should be such that the social costs of production for export are taken into account by producers.

However, for various reasons governments often adopt policies that intervene with free trade. Moreover, until now corrective environmental policies have infrequently been undertaken. Section 4.3 therefore examines the potential impacts of trade liberalization on the environment. The emphasis will be on trade in agricultural products because of the importance of agriculture in current GATT-negotiations. For a brief review of current agricultural policies and environmental problems related to agriculture the reader is referred to chapter 3.

4.1 Consequences of national environmental policies for international trade

Domestic environmental problems can in principle be resolved by purely domestic policy choices. These choices are made on the basis of various considerations and priorities. Different countries have different natural resources, different natural conditions, and different environmental assimilative capacities. Furthermore, the priority given to environmental quality differs from country to country. Poor countries generally attach lower priority to environmental quality than rich countries do.

There is general agreement in the literature that, in the case of national environmental problems, international harmonization of environmental standards is neither necessary nor desirable (see e.g. Verbruggen, 1991; GATT, 1992; Subramanian, 1992). Comparative advantage is based on the existence of differences between countries: differences in resource endowments, production conditions (including technology), and consumption preferences. The gains from trade or international specialization derive from this difference. The environment is one element of possible differences between countries.

In the eyes of domestic producers, differences between countries in environmental policies are often regarded as unfair, because they give rise to differences in competitiveness. Lower standards abroad regarding pollution are perceived as detrimental to competitiveness. Political pressures to lower the standards at home or to eradicate any trade created by the differences in standards are the logical culmination of this line of thought. However, when the environmental problems are strictly domestic, the differences in policies are properly regarded as domestic choices reflecting, among other factors, the domestic trade-offs between income and the environment. Seen in this way, the differences in costs of production due to differences in standards can well be an additional source of gainful trade among these nations as are any number of other natural advantages (GATT, 1992: pp. 19-20).

It is also important to recognize that in principle there is no difference between the unfair competition argument regarding environmental standards and arguments that could be advanced for remedial action against lax population policies, large expenditures on education, policies encouraging capital formation or the immigration of skilled labour, or other policies influencing competitive advantage (GATT, 1992: p. 20; Subramanian,

1992: p. 141). Subramanian concludes that where there are no physical spillovers, there ought to be a serious presumption against the use of trade restrictive action - be it in the form of contingent protection action (e.g. countervailing or anti-dumping duty), competitive subsidization, or attempts to harmonize pollution standards (Subramanian, 1992: p. 142).

On the other hand, Verbruggen (1991: p. 690) argues that there may conceivably be cases of national environmental problems in which international harmonization would after all be desirable. He mentions the case of international trade in hazardous wastes as an example.[12] Furthermore, it may not be easy in practice to make a clear distinction between national and international environmental problems. Rather there is a continuum ranging from local environmental problems (e.g. noise) through transfrontier problems (e.g. acid rain) to global problems (e.g. climatic change). Despite these complications, the general principle of non-harmonization of standards regarding national environmental problems is commonly accepted in recent literature.

Although international harmonization of standards should generally not be pursued in the case of domestic environmental problems, harmonization of the form of environmental policy (principles and measures) is highly desirable. As discussed in section 2.2, the importance of the Polluter Pays Principle (PPP) as a guiding principle in national environmental policies has often been stressed. Global adherence to this principle would diminish tensions between trade and the environment.

What will be the impact of environmental regulation on trade? When a country unilaterally introduces environmental policy, comparative advantage in the production of the damage-intensive good moves in favour of its competitors. When the country is small, production will decline and foreign exchange earnings will be reduced. A large country which is a net exporter will enjoy an increase in its terms of trade, because the world price rises. Cost increases will be passed on to the importing countries. In general, however, the introduction of environmental measures will shift resources from regulating to non-regulating countries. The flow is often from industrial countries to low-income countries which then become the home of the world's pollutive industries and a market for restricted

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[12] In section 5.4 below, the case of hazardous wastes will be discussed in more detail.

chemicals and drugs. In the long term this can create problems in the non-regulating country. First, regulating countries may gain from the development of environmentally-friendly technologies and products. Secondly, when resources degrade and productivity decreases in the non-regulating country, competitiveness will ultimately decline. Whether or not such effects will occur, depends of course on the natural conditions and the environmental assimilative capacity in the non-regulating country. Thirdly, when resources degrade and productivity declines elsewhere, the regulating country may eventually re-gain comparative advantage in the long run.

How strong is the impact of environmental regulation on the relocation of productive activities? Empirical studies generally show that cost differences due to differences in environmental regulations are relatively small. A number of studies show that even in the most pollution intensive industries, pollution abatement costs constitute only between one and three percent of total industry costs (see studies cited in Subramanian, 1992: p. 142). There is some evidence of cross-border relocation by firms in response to differences in environmental policies, but the evidence (viewed on a world scale) certainly does not suggest massive investment relocations (GATT, 1992: pp. 20-21). Reduced environmental costs abroad are often counterbalanced by other considerations, such as labour availability and quality, wage rates, supporting infrastructure, tax incentives, market size, transport costs, and country risk. Moreover, investment expenditures induced by environmental policies may increase future competetiveness on the expanding market for environmentally-related goods and services (GATT, 1992: p. 21).

A different issue arises when the consumption of an imported good causes pollution or affects health and safety. It is only reasonable that these goods are subjected to the same taxes or regulations as the domestic versions since the externalities arise from the consumption of the products (rather than their production) and therefore is independent of where they were produced (GATT, 1992: pp. 22-24).[13] Import restrictions are a proper tool to enforce domestic consumption bans or domestic standards. For example, a ban on domestic smoking would also require the prohibition of imported cigarettes, and compliance with domestic emission standards would

[13] Trade disputes over health and safety standards are more likely than disputes over policies dealing with consumption pollution because of the inexact nature of their scientific evidence and other reasons (GATT, 1992: pp. 22-24). The U.S.-E.C. dispute over the use of growth hormones in beef provides a good example.

require a ban on cars not fitted with the apropriate catalytic converter (Subramanian, 1992: p. 150).

A related issue concerns the consumption of an imported good whose production affects the local environmental quality abroad ('psychological spillovers').[14] One recent example is the dispute over imports into the United States of Mexican tuna that did not meet the US dolphin protection standards. The GATT panel found that a contracting party should not be permitted to take trade measures to enforce its own laws regarding animals or natural resources outside its jurisdiction. If it would be accepted, then any country could ban imports of a country merely because the exporting country pursues environmental and health policies different of its own. The panel upheld, however, the United States law regulating labelling of tuna products as "Dolphin Safe" (GATT, 1992: pp. 14-15). The use of labelling requirements constitutes a less controversial approach to these problems, as it allows consumers the freedom to exercise their preference against eco-unfriendly processes or products if they wish so (Subramanian, 1992: p. 150).

4.2 International environmental problems and trade measures

When there exist transborder or global physical spillovers, trade interventions are tempting instruments for dealing with these problems. In principle, however, the choice of the appropriate intervention to correct the market failure is independent of whether the problem is domestic or international. The optimal instrument for a problem is the one among the list of feasible instruments whose base is most closely related to the source of the market failure. Thus, trade-based instruments are generally second-best instruments to correct the environmental failure relative to production- and consumption-based instruments. In very few cases is international trade in commodities the actual cause of an environmental problem (Lloyd, 1992: pp. 67-69).

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[14] In some studies, the impact of domestic consumption on the threatening extinction of species of animals (or plants) that live (grow) abroad is also called a 'psychological spillover' (see e.g. Blackhurst and Subramanian, 1992). Since the extinction of species is essentially a global environmental problem (to be discussed in the next section), this type of psychological spillovers is not considered here.

The difficulty with policies aimed at abating transborder or global environmental problems, however, is the absence of a supranational enforcement authority. National jurisdiction and sovereignity has to be respected. The enforcement of environmental policy stops at a nation's border. Cooperation of other countries can be secured on a voluntary basis only. Intergovernmental cooperation is essential to finding a solution. Both efficiency and equity considerations must be addressed as part of such a solution.

Efficiency issues arise when costs of abatement differ from country to country. These differences should be taken into account in order to minimize the global costs of reducing environmental damage. The contribution of each country to the solution of the problem should vary inversely with the costs of abatement. Equity issues arise because a country's contribution to the globally efficient clean-up effort may not match either its share of the pollution being emitted or its ability to pay. Securing multilateral cooperation will not be easy in such situations (GATT, 1992: p. 27).

Mäler (1990) characterizes international negotiations on environmental problems as a game in which those who gain from cooperation must devise rules so that countries that would otherwise lose have an incentive to agree to play the game. He concludes that there will be many situations where the Victim Pays Principle (VPP), i.e. transfers from the country whose environment has been degraded to the country that degrades the environment, will be necessary in order to achieve an efficient solution. The transfers will give the losing countries an incentive to cooperate. Adherence to the Polluter Pays Principle (PPP) would lead to the non-cooperation of these countries and the collapse of the game.

According to the GATT (1992), positive incentives are the best way to achieve sustained inter-governmental cooperation when such cooperation is not voluntarily forthcoming. Positive incentives can include offers of financial assistance and transfers of environmentally friendly technology directly related to the problem at hand, or (more broadly based) offers to increase foreign aid, to lessen debt problems and to make non-discriminatory reductions in trade barriers. Negative incentives - in particular, the use of discriminatory trade restrictions on products unrelated to the environmental problem at hand - are not an effective way to promote cooperation. Given the justifiable basis for a diversity of environmental

standards among countries, it is important to minimize the risk of solutions being imposed (through their greater economic or political power) by the larger or richer countries. Furthermore, by generating resentment and commercial frictions, negative incentives reduce the prospects for intergovernmental cooperation on future problems (GATT, 1992: pp. 4, 30).

The debate over deforestation and global warming may be used to illustrate some of the issues (GATT, 1992: pp. 27-29). It is generally accepted that reducing CO_2 levels involves both reduced CO_2 emissions and action to slow or reverse deforestation, but opinions differ as to which approach to emphasize. One way of viewing the situation is that growing forests provide carbon absorption services to a world that is dumping increasing amounts of carbon into the atmosphere. Since countries that have a high ratio of (growing) forests to domestic carbon emissions are not paid for exporting carbon absorption services to the rest of the world, they have little incentive to take such services into account when deciding how to use their forests. The result is most likely a faster rate of deforestation than would otherwise occur. Rather than being threatened with restrictions on their exports, it seems logical that these countries are offered compensation for exporting carbon absorption (and biodiversity) services.

It should be noted that resource transfers themselves will affect global environmental quality, since income levels and environmental quality are highly correlated. For example, resource transfers to low-income countries may reduce poverty-induced environmental degradation in these countries (Subramanian, 1992: p. 148).

Although trade measures should generally not be used for correcting market failures that create environmental problems, trade measures can play a role in the promotion and enforcement of international cooperation on environmental issues (see e.g. Verbruggen, 1991; GATT, 1992; Subramanian, 1992). Trade sanctions (involving products that are not related to the problem; mostly increased import restrictions) or trade provisions (applicable to problems directly related to the problem) may be used to induce countries to participate, when it has been established that some countries are truly free-riding, or to enforce and sustain multilateral agreements. Trade provisions are generally such that non-participants are at a disadvantage. Their primary purpose is to prevent the agreement from being undermined by non-participants (Blackhurst and Subramanian, 1992).

What will be the impact of multilateral environmental agreements on international trade flows? It is difficult to draw some general conclusions, since the resulting changes in trade flows clearly depend on the precise contents of the agreement in question and its implementation. When a tax is introduced on a specific environmentally damaging commodity, the profits made by producers of the good will decrease and/or the price paid by users will rise (depending on the prevailing market conditions). The volume of international trade in the environmentally damaging good will generally decline. Other potential elements of multilateral agreements can have either a direct (e.g. trade sanctions or trade provisions) or indirect impact (e.g. side-payments to compensate losing countries) on the pattern of international trade in products related and unrelated to the problem at hand. Quantitative models that decribe the relationships between the most important components of a multilateral agreement and international trade in related and unrelated commodities are needed to assess the resulting impacts.

4.3 Impact of trade liberalization on the environment

The potential impact of trade liberalization on environmental degradation has been highly debated in recent years. On the one hand, environmentalists often claim that if production or consumption of a good has negative environmental effects, then the expansion of world output of that good following trade liberalization would lead to greater environmental degradation (assuming no changes in environmental policies or production methods). In addition, the increase of trade flows will intensify transport-related externalities. On the other hand, it has been claimed by others (predominantly economists) that trade liberalization will often benefit the environment. For example, the GATT (1992) argues that there is no reason to assume that growth of per capita income (boosted by expanding trade) necessarily, or even on average, damages the environment, because increases in per capita income provide more resources to contain environmental damage and make people better aware of the need to devote resources to the environment. Moreover, the better trade opportunities facilitate the implementation of environment-improving processes, and trade in recycled inputs can help countries economize on resource use (GATT, 1992: p. 2). Other

proponents of trade liberalization argue that liberalization reduces pressure on resources, since countries will tend to specialize in those goods that use relatively abundant factors of production (Heckscher-Ohlin model), and that income increases alleviate poverty-related environmental pressures and induce a transition to sustainable production methods.

When environmental policies of trading partners are such that environmental externalities are corrected in an appropriate way, trade liberalization will increase national and global welfare. However, despite their desirability from a welfare-economic point of view, first-best environmental policies may not be adopted for a variety of reasons (see e.g. section 2.2). Instead, governments often rely on second-best or third-best policies or do not address certain environmental problems at all. The discussion on the environmental impact of trade liberalization mainly focuses on situations where appropriate environmental policies are lacking. No simple, unequivocal answer can be given with regard to the impact of trade liberalization in such situations. Besides the arguments mentioned above, an analysis of this question should take into account the effect of income increases on technology and commodity mix, and should distinguish between the different life cycle stages of a product. The income increase and relative price changes that result from trade liberalization are likely to induce changes in production technologies. In the absence of appropriate environmental policies, effects of such technology changes on the environment can be positive or negative. In addition, income increases resulting from trade liberalization will change the composition of consumption and production. Externalities related to consumption and production differ greatly from commodity to commodity. The resulting environmental impact of income increases is therefore difficult to assess.

It is also important to distinguish between the life cycle stages of a product. Imports of manufactures and processed agricultural goods in industrial countries generally face much higher tariff barriers than imports of unprocessed raw materials (see e.g. Balassa, 1968; Yeats, 1977). As a consequence, most processing industries are located in high-income countries. Reduction of tariff barriers is likely to induce a relocation of processing industries towards countries that are rich in natural resources, and to change considerably the pattern of trade in processed and unprocessed products. Evidently, this will have a major impact on the environment of the countries involved.

Empirical models are clearly needed to assess the overall impact of the various direct and indirect effects of trade liberalization on environmental degradation. Empirical estimation of the different counteracting effects is needed to appraise the direction and magnitude of the relationship (see also Lutz, 1992). With respect to agriculture, some recent studies have used the outcome of economic models of agricultural trade liberalization as a benchmark for assessing potential environmental effects (see Anderson, 1992a,b; Lutz, 1992). Using the long-run, comparative static version of the GLS-model (see chapter 3 above), Anderson argues that the international relocation of cropping production from high-priced to low-priced countries would reduce substantially the use of chemicals in world food production. Increased chemical use in countries with relatively low producer prices is more than offset by lower applications of chemicals that result from production declines in high-priced countries. The underlying reason is that empirical data suggest an exponential relationship between the price of farm output and the use of farm chemicals per unit of output (Anderson, 1992b: pp. 162-163). The global reduction in chemical use would occur all the more so because most of the countries where production expansions are concentrated tend to be relatively sparsely populated;[15] the consequent lower price of land in these countries is assumed to result in less farm chemicals per unit of output than in relatively densely populated countries at identical farm output prices (Anderson, 1992b: pp. 163-164).

The relocation of meat and milk production from intensive grain-feeding enterprises in densely populated rich countries to pasture-based enterprises in relatively sparsely populated poorer countries is another factor associated with lower use of chemicals such as growth hormones and medicines for animals. The greater use of these less-intensive production methods would reduce not only air, soil and water contamination by farmers, but also the chemical intake by the world's food consumers on average. Food consumers in densely populated Western Europe and Japan, where price and trade policies and high land prices currently encourage the heaviest use of farm chemicals and the most intensive methods of feeding, would have the most to gain from the effect of such reforms (Anderson, 1992b: p. 164). Increases in transport to urban consumption areas resulting from the shift

[15] A notable exception to this general tendency is China.

in production to sparsely populated countries, and the concomitant worsening of environmental problems, like CO_2 emissions, are not included in Anderson's analysis.

Anderson also considers environmental externalities related to primary factors of production. Although primary production factors are much less responsive to price changes than variable inputs, they do respond over the longer term. A slowdown in the flow of labour to urban areas as a result of higher agricultural prices would reduce urban environmental problems, especially in developing countries where that labour is employed in smokestack industries. Land clearance for agricultural purposes may contribute to deforestation. Available empirical evidence cited by Anderson (1992b: p. 166) indicates, however, that land area is by far the least responsive factor to changes in farm output prices. Moreover, the negative impact of price liberalization is likely to be small compared with the negative impact of inadequate enforcement of forest property rights and of tax incentives and subsidy policies which encourage felling to promote agricultural and mineral development projects. And in any case the negative impact of trade liberalization has to be weighted against the reforestation on former farm land in industrial countries that liberalize agricultural trade and the environmental effects of foregone production in developing countries where resources would otherwise have been employed (Anderson, 1992b: pp. 164-167).

According to Lutz (1992), the responsiveness of production factors in developing countries to agricultural price changes depends on farm size. The response of large farms is very significant, while the response of small farms is comparatively small and inelastic for all factors of production. In developing countries with a commercial farm sector, increased agricultural prices will therefore result in more intensive resource use and associated negative environmental effects of that subsector. Increased absorption of farm labour by the commercial sector could potentially have some off-setting positive effects if the labour otherwise would be farming marginal areas and extending the frontier, but the impact is unlikely to be large (Lutz, 1992: pp. 85-86).

Negative environmental effects in developing countries could also partially be offset via the income effect of higher prices. Higher incomes permit farmers to use production techniques that are more environmentally benign and to make some additional conservation-type investments that

increase long-term productivity. In the view of Lutz, these potentially positive effects are expected to be small,[16] but empirical work should be undertaken to determine these (Lutz, 1992: pp. 86-87).

In his conclusion, Lutz holds that higher world agricultural prices lead to economic benefits for developing countries, but the associated environmental effects are expected to be negative; however, because of positive off-setting effects, this cannot be concluded unambiguously without empirical examination. In Lutz' opinion, Anderson's (1992a,b) conclusions about the results of food trade liberalization are somewhat more positive, and he stresses Anderson's point that a removal of distortions on farm prices could and should be accompanied by the introduction of more optimal environmental policy instruments including the removal of any farm input subsidies, or policies to discourage deforestation (Lutz, 1992: p. 87). As a general proposition, trade liberalization should not only never be cancelled for environmental reasons, but its benefits can be enhanced if appropriate environmental measures are taken at the time of liberalization (Anderson, 1992b: p. 168).

Recalling the discussion of environmental effects of agricultural production in chapter 3, a number of remarks on the outcome of these studies can be made. First, no distinction between environmental effects for different groups of developing countries is made in these studies. In Sub-Saharan Africa and other regions where the Green Revolution did not have much impact thus far, use of chemical inputs is at very low levels. Taking into account the low estimates of (long-term) supply response found in empirical studies for Sub-Saharan Africa and other low-income countries (see e.g. Chhibber, 1989), higher farm output prices are unlikely to cause significant problems due to intensive use of these inputs within one or two decades (or even longer). On the contrary, since farmers are mining their soils in large parts of Africa, increased use of chemical fertilizer may in fact contribute to restoring the nutrient balance in these countries.

Second, higher international prices may induce farmers in developing countries to shift from food crops towards export crops. Such a shift may have important but complicated environmental consequences, because the amount of environmental damage varies markedly by type of crop. For example, increased export production enhances soil nutrient depletion

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[16] Repetto (1989), on the other hand, stresses the negative impact of depressed output prices on farmers' investments in soil conservation in his plea for eliminating market distortions.

(since export disrupts the natural cycle of soil replenishment), but in the case of perennials the continuous soil cover provides obvious ecological advantages compared to annual food crops. In the United States erosiveness is relatively high for cotton and soybeans and relatively low for wheat and rice. Fertilizer and pesticides requirements also differ considerably from crop to crop (Reichelderfer, 1990: Table 1).

Third, increased trade aggravates transport-related environmental externalities. As discussed in chapter 3, environmental effects of transport may be relatively high for a number of agricultural and food products. Empirical models of the environmental effects of agricultural liberalization should be able to distinguish all these effects if they want to provide a realistic description of the most important mechanisms in force.

5. ENVIRONMENTAL EFFECTS OF TRADE IN SELECTED COMMODITIES

Four cases are presented in this chapter of commodities whose production and international trade involves important environmental externalities. The case studies are primarily meant to illustrate the various theoretical and policy questions with regard to international trade and the environment discussed in the previous chapters. Rather than an in-depth analysis of particular commodities, the four cases emphasize the relation to the analytical framework provided in this study and the trade and environmental policy dilemma's involved. Tropical timber (section 5.1) and grain and grain substitutes (section 5.2) are selected in view of the study's focus on international trade in primary (agricultural) products. The other two cases, energy resources (section 5.3) and hazardous wastes (section 5.4), illustrate several other aspects of the links between production, trade and the environment.

5.1 Tropical timber

Tropical timber is an example of a commodity whose production involves global environmental externalities. Moreover, international production and trade patterns are significantly distorted by trade barriers. A lively discussion has been going on recently on proposals to reduce the cutting of tropical forests, including proposals for trade bans and other measures restricting trade in tropical timber. Tropical timber therefore provides an interesting case for comparing recent literature regarding its trade and environmental aspects with the general theoretical analysis of the previous chapters.

Deforestation affects the environment in a number of ways. Tropical forests, in particular tropical moist forests, are very rich in species of plants and animals. Tropical plants contribute important genetic materials for plant breeders and underlie many pharmaceutical products. The removal of tropical forests is likely to result in an important loss of endemic species. Deforestation in tropical areas also contributes to soil degradation through erosion, laterization, and other processes. Large parts of the soils underlying the remaining tropical forest are infertile and easily degraded if the vegetative cover is removed. Because of high temperatures

and rainfalls, nutrients in the soil quickly deplete (Repetto, 1988: p.14). Forests also function as CO_2 sinks, since they sequester carbon as they grow. For this reason, and because a substantial part of the increase of CO_2 results from burning wood and forests, deforestation is an important contributor to the green house effect (see e.g. Mather 1990: pp. 202-204).

Commercial logging is one of the factors responsible for deforestation in tropical countries. Gillis and Repetto (1988) argue that industrial country trade barriers against wood products have been partially responsible for inappropriate investment and patterns of exploitation in Third World forest industries. In order to protect wood manufacturing industries, industrial countries typically have set tariffs much higher on imports of processed wood products than on logs. Faced with the anti-processing effect of these trade barriers, log-exporting countries have banned log exports, reduced or waived export taxes on processed wood, and offered substantial incentives to forest product industries in an effort to stimulate investment in domestic processing capacity. While the net effect of these conflicting trade policy measures has been to restrict world consumption somewhat, severe distortions in investment patterns and losses in economic efficiency have also resulted.

In industrial countries, labour and capital have been retained in declining industries. Many industrial countries are both importers and exporters of forest products, tend to import relatively unprocessed products and to add value to these in industries developed initially on the basis of domestic wood production (Mather 1992: pp. 153-156). In developing countries, the protection provided to wood-processing industries has been so high as to weaken competitive pressure and to undermine incentives to minimize costs. An example of the latter are the low recovery rates from logs in heavily protected timber processing activities. As a result of these inefficiencies in production, demands on natural forest endowments have intensified. In principle, however, domestic processing of logs offers substantial potential savings in shipping and manufacturing costs, since processing considerably reduces the weight of the raw material. Countries with forest resources and low labour costs clearly enjoy comparative advantages in forest-based industries.

On the basis of these considerations, Gillis and Repetto (1988) argue that reduced tariff escalation and non-tariff barriers to processed wood imports from developing countries will result in a gradual transfer of most

tropical wood-processing industries to countries with large forest endowments. Reduced protection and a more competitive environment for wood processing in developing countries can be expected to result in substantial modernization and improved efficiency of existing processing industries. Hence, in this case both developmental and environmental goals can be served by trade liberalization.

This conclusion is, however, subject to a number of qualifications. First, the analysis by Gillis and Repetto is essentially a qualitative one, based on a number of case studies for major timber-exporting developing countries. No quantitative assessments of the impact of trade liberalization on the rate of deforestation are made. Second, although the study considers the impact of processing on shipping costs, the implications of changes in the structure of trade flows on total energy consumption in transport are not examined. Third, opinions differ widely on the extent to which commercial logging actually contributes to the process of deforestation. According to the World Bank (1992: p. 58), tree felling for firewood and land clearance for agricultural purposes are more important contributing factors in developing countries, although tropical moist forests in East Asia have been exploited most for its timber by logging companies. In this context, it is interesting to consider the results of a model for production and trade of tropical timber in Indonesia (Jepma and Blom, 1992). The model outcome indicates that the introduction of import quotas by developed countries or export quotas by developing countries does not or at most hardly affects deforestation processes. However, other policy options, such as reducing population pressure or raising agricultural productivity, seem capable of substantially mitigating the trends towards progressive tropical forest degradation.

Deforestation is a typical example of a global environmental problem. International consensus is recently emerging on the desirability of sustainable use of tropical forests. For example, the International Tropical Timber Agreement (ITTA) is the first international commodity agreement that has included sustainability among its goals. During the 1990 meeting of the International Tropical Timber Organization (ITTO) it was decided that by the year 2000 all traded tropical timber should be produced in a sustainable way.

Important disagreements exist, however, on the measures that have to be taken at the international level to achieve these goals. The Government

of the Netherlands intends to foster timber imports by 1995 from those countries or regions that have adopted forestry policies aimed at conservation and sustainable production. Although the impact of this unilateral measure on deforestation will be small, the Dutch Government obviously intends to promote the desirability of rational forest management. It is recognized, however, that lower prices resulting from import restrictions may cause reactions that conflict with the intended goal. Increased tree felling in order to maintain incomes and foreign exchange earnings at previous levels may be one of the consequences (Ministerie van Landbouw, Natuurbeheer en Visserij, 1991: pp.45-46).

The European Parlement has adopted in 1989 a resolution regarding trade in tropical timber. The purpose of the proposal is to stimulate sustainable management of forests in producer countries. Agreements should be reached through bilateral or multilateral negotiations. Import quota on tropical timber will be an element of such agreements. In addition, imports of tropical wood products from countries that do not participate in forest management and conservation programmes will be banned.

Malaysia is the main proponent of the view of the tropical timber-exporting countries. In their view, industrial countries that have destroyed their own natural heritage now want to control the use of relatively undamaged resources in developing countries. Malaysia recognizes the importance of tropical forests for the preservation of biodiversity and the absorption of CO_2. But tree felling is of vital importance to the country's economy, because land is needed for agricultural purposes and for accommodating the growing population, and because wood exports provide an important source of income. Instead of boycotting tropical timber imports, industrial countries are expected to compensate countries that reduce deforestation for the economic losses involved. In addition, industrial countries can make positive contributions to the deforestation problem by paying higher prices for tropical wood produced in a sustainable way, by closing inefficient farms and polluting industries, and by reforestation of the resulting idle land.

The GATT Secretariat is also opposed to trade restraints on tropical timber for environmental reasons on a number of grounds (GATT, 1992). Total timber exports amount to less than one percent of the trees felled in developing counties, so the impact on deforestation will be very small. Moreover, through lowering the price of tropical timber, a ban would reduce

the incentive to protect existing forests and establish new ones. And because half the world's traded timber comes from tropical countries, attention needs to focus on forest management in developed countries, too. If deforestation is considered undesirable, then countries that reduce the rate of exploitation should be compensated, i.e. paid for the carbon absorption and biodiversity services they provide, instead of being threatened with restrictions on their exports. But perhaps the most effective way to slow down deforestation is to promote employment and income growth in timber-exporting counties, for example through economic policy reform at home and access to markets abroad (GATT, 1992).

In conclusion, studies on the impact of the structure of protection in trade of wood products on the process of deforestation show that both developmental and environmental goals can be served by trade liberalisation. However, many qualifying factors play a role, and future studies may greatly benefit from the use of quantitative models. Such models should incorporate the impact of land clearance, tree felling for firewood and other causes of deforestation. Attention will also have to be paid to the institutional context in which deforestation takes place in terms of property rights, resource management, and the ability to enforce conservation measures. Moreover, an extension of the analysis to environmental problems related to transport in logs and processed wood products is desirable.

As regards the ongoing discussion on the use of trade restraints for reducing deforestation, it can be concluded that the arguments presented in favour of international compensation payments and against the use of trade measures accord well with the theoretical arguments presented in chapters 2 and 4. Moreover, the impact of trade measures on deforestation is likely to be much smaller than the impact of compensation payments (and economic policy reforms), because international trade in timber makes only a minor contribution to deforestation.

5.2 Grain and grain substitutes

Grain includes wheat, rice, barley, corn, rye, oats and other cereals. Grain is an important product in food and feed. Because of a highly adaptive capacity, grain can be produced under very different climatologic

circumstances and cultivation practices. Crop prospects are normally speaking good, although accidental factors may influence the annual production volume. Grain is cultivated in all regions of the world: in developed countries like North America, Europe and Australia and, using much simpler cultivation practices, in less developed countries in Asia and Africa. Important differences in productivity do exist between regions and countries. Most governments in developed countries stimulate production and influence trade in grain by market regulations.[17] By stimulating technological change, production of grain in and export of grain from the developed countries increased sharply. These developments also caused environmental problems.

Grain is easy to store. This increases the possibility to trade and transport grain over great distances. Grain is the most important agricultural product on the world market measured in monetary terms. The ratio of trade to production differs from almost 20 per cent for wheat (highest) to less than 3 per cent for rice (lowest) (Silvis and Van Berkum, 1990).

World grain trade increased rapidly during the seventies. World grain import in 1980 was about 220 million tons, almost twice as much as in 1970 (Van Berkum, 1992). An indication of the increases in world grain import is presented in table 5.1. The (former) Soviet Union increased their grain import demand from 2.8 million (metric) tons in 1970 to 43.7 million (metric) tons in 1981. Income and population growth also caused significant increases in import demand by less developed countries, especially in North Africa and the Middle East. The United States increased their share in world export of grain from an average of 39 per cent in the period 1970-73 to an average of 50 per cent in the period 1978-81. Here, the possibilities to increase production, by bringing formerly unused land into production, were to a great extent available. Other traditional exporters like Canada, Australia and Argentina also increased their export also. Under its Common Agricultural Policy (CAP), providing a stabilized internal market for grain, the EC shifted from a net import into a net export position. By 1990, the EC share in world export of grain was nearly 21 per cent. More detailed analysis at the world, continental and country level about the composition and fluctuations in grain production and trade can be found in Oskam (1991).

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[17] See section 3.2 for reasons of agricultural protection in the developed countries.

Table 5.1: Export and import of grain for selected countries, 1970-1990

(million metric tons)

	1970	1975	1980	1981	1989	1990
Export						
United States	40.4	74.1	112.9	113.4	108.3	92.6
EC-9	17.5	25.9	33.1	37.2	52.0	54.6
Canada	14.9	15.6	21.8	22.8	16.6	23.1
Australia	8.4	11.3	19.5	13.3	13.1	14.8
Argentina	10.2	8.2	9.9	18.4	7.1	10.4
Import						
USSR	2.8	16.7	31.2	43.7	38.8	32.9
Japan	15.6	18.8	24.5	24.4	27.4	27.0
China (incl. Taiwan)	6.4	5.8	17.1	18.4	22.2	19.9
EC-9	34.9	37.6	31.5	30.6	26.5	26.7
World import	110.8	156.4	218.9	233.1	236.1	225.2

Source: Oskam (1991) and FAO (1990)

World trade in grain stabilized after 1980. Trade in grain was affected by increased domestic production, a slow-down of economic growth and the shortage of hard currency in the importing countries (Silvis and Van Berkum, 1990). Also, up to 1985 the price of grain on the world market increased because of the appreciation of the dollar.

Grain price policies of the industrial countries have supported the increased export of grain to the developing countries. The current position of nations on the world grain market is determined by the rapidly increasing productivity in the industrial countries. In the latter, production per hectare increased at a much higher rate than in developing countries (Anderson and Tyers, 1991). Productivity growth in the industrial countries resulted mainly from increased use of chemical and mechanical inputs, of which the EC is a clear example. The transition of the EC from a net importer of grain into a net exporter during the last decade, can be considered a result of intensive use of purchased inputs, enabling farmers to improve production per hectare (Blom, 1990). Intensive use of purchased

inputs have negative environmental externalities (see also section 3.4). As chapter 2 points out, trade-related measures to correct for these environmental externalities may not be as efficient as production- and consumption-related measures.

The impact of the observed grain trade flows on the development of the agricultural sector in developing countries depends on two questions: (1) does it depress the grain market in the developing countries and (2) how do domestic producers respond to changes on the domestic grain market (Van Berkum, 1990). There is no unambiguous answer to these questions. Although consumers in developing countries gain from a low grain price on the world market, incentives to producers in the developing countries to expand grain production are low. This might have negative as well as positive environmental effects.

Grain substitutes

It is not very clear which products are covered by the term "grain substitutes". Winterling and Tangermann (1987) accept the definition of the EC-Commission. This definition covers all products which are supposed to replace grain in compound animal feed; cassave, (wheat) bran, corngluten feed, maize germ meal, citrus pellets, dried grain and molasses. Grain substitute imports in the EC increased from 7.4 million tons in 1970 to an maximum of 18.4 million tons in 1982 (Winterling and Tangermann, 1987).

Ever since 1980 the EC-9 has been a net-exporter of all grains, where it has been a net exporter of wheat ever since 1974. Due to the CAP, the internal price of grain is much higher than world market price. Export subsidies are needed to make export to the world market possible, which puts high pressure on the EC budget. Problems of financing the EC budget started discussions as how to fight surpluses on EC grain markets as early as the end of the seventies (Winterling and Tangermann, 1987). Grain producing countries in the EC, especially France, hold the rising import of grain substitutes responsible for the surpluses on the EC grain market. However, even before the EC grain market had developed into a surplus situation, the EC grain price policy had induced the import of grain substitutes by its high grain price relative to the world market. The competitivenes of grain substitutes on the EC market depends on the ratio of the EC grain price to the world market grain price. Also, grain substitutes would not be competitive when trade restrictions like tariffs and

import quotas would be used to increase the internal price of grain substitutes. However, part of the grain substitutes is not covered by market regulations and can be imported at relatively low world market prices. The increased livestock production in the EC, especially the increased intensive livestock production in the Netherlands, started to use increased shares of the cheap and imported grain substitutes.

The growth of intensive livestock production in the Netherlands, based on imports of grain substitutes, causes animal waste surpluses. Mineral losses from manure have affected environmental quality. The negative external effects of minerals are: accumulation of phosphates in soil, groundwater and surface water, emissions of ammonia, percolation of nitrates to groundwater and emissions of odors (Hoogervorst, 1990). These problems vary between regions according to the concentration of livestock in a region. Trade measures, such as restricting the import of grain substitutes to correct for these environmental problems, are second-best; the first-best policy is to reform the CAP such that the internal grain price equals world market price. European and national environmental policies should be introduced to fight the negative external effects of existing production techniques. Increasing the competitiveness of grain compared to grain substitutes and internalisation of negative environmental effects of intensive livestock production into production costs may have negative concentration effects. Provided that these negative concentration effects outweigh positive concentration effects related to infrastructure and technical know-how, intensive livestock production may shift to traditional grain producing regions.

Thailand presents an interesting case of a country producing grain substitutes. Around 1980 about one million hectares were used for the production of cassave, which was mainly exported to the Netherlands. By producing cassave, minerals are taken from the soil and exported abroad. Fertilizers would be needed to restore the fertility of the soil. It is argued that cassave producers do not use fertilizers because export revenues from cassave are low compared to the price of fertilizers. The fertility of the soil therefore declines, which will have negative consequences for the future production capacity of the soil (Tamminga and Wijnands, 1991). Conflicting with this view is the argument that, despite direct or indirect government interference in trade flows of grain and grain substitutes, existing trade flows are the result of comparative

advantages in production (Blom, 1990, Dijksterhuis, 1990). Thailand has a comparative advantage in the production of cassave. With respect to the sustainability of the production of cassave in Thailand, Dijksterhuis (1990) argues that the production of cassave is fairly sustainable; after 20 years, there is still no significant reduction in soil fertility. The export of cassave accounts for an important share of total export revenues in Thailand. This illustrates that conclusions about the desirability of export of grain substitutes from developing countries cannot be drawn easily. If there are market failures, for example environmental problems, the first-best policy is to restore the market failure at its source, for example by environmental regulation (see section 2.2.1). Additional research will be required to assess the effects of trade restrictions on the environment.

5.3 Energy resources

Several aspects of the international trade in energy resources are presently in discussion; they range from energy trade between the EC and the former Eastern bloc countries, liberalizing the European natural gas trade, the question of energy (coal) producer subsidies, to international trade implications of the imposition of carbon taxes. Alternative trading rules influence the production and use of energy resources in the trading countries. As the production and use of energy resources have important local, regional and global environmental impacts, the environmental effects of trade in the energy sector should receive due attention.

This case is based on a discussion paper by Langlois (1992), prepared for an OECD joint session of trade and environment experts in February 1992. Four issues are discussed: 1) the environmental effects of trade barriers (illustrated by energy-environment issues in the former Soviet bloc), 2) the environmental effects of trade liberalization (illustrated by the European natural gas trade), 3) the environmental effects of energy producer subsidies, 4) the environmental effects of pursuing environmental harmonization in free trade areas (illustrated by the discussion in the EC about carbon taxes).

The discussion of these issues may illustrate some of complexities of the links between international trade and the environment, while it also provides a brief introduction to a highly topical area of research.

Production and use of energy cause environmental side-effects. Given some level of energy consumption in a country, the extent of these effects depend on many factors such as the fuel-mix, the energy extraction and use of technologies, and the availability and use of pollution control technologies. These factors depend in turn on national or regional environmental regulations and standards, the availability of indigenous energy resources and energy use technologies, and on trade restrictions affecting either energy or technology or both.

The former Soviet bloc presents a historic example of trade barriers affecting both energy use and environmental quality. The energy use in Eastern European countries depended on Soviet oil and gas and their own (brown) coal reserves. Because of the limited (state controlled) exports of Soviet oil and gas, the Eastern European satellite countries were not able to reduce their brown coal consumption. In 1989, brown coal consumption accounted for almost a third of the energy-mix. In Western Europe, brown coal accounted for only 3.5 percent of the energy-mix.

The lack of access to Western resources and technology, highly distorting energy subsidies,[18] and a lax or non-existent environmental policy have resulted in serious environmental degradation from both mining and energy use in Eastern Europe. In Czechoslovakia alone, some 35,000 hectares of agricultural land have been lost because of mining operations. Water resources have also been seriously affected. The combustion of fuel - especially brown coal - with virtually no pollution control measures, has resulted in an immense pollution. For example, while the emission of particulates averages about 2.8 million tons in Czechoslovakia (1985), total Western European emissions average 221,000 tons (1988).

This example highlights an important link between international trade and the environment: barriers to trade may effectively arrest the introduction of clean energy resources and technologies. Even if the Eastern European countries had attempted to pursue environmental policies, these would have been much more expensive than if they had had access to foreign energy resources and technologies. Free trade would have allowed, a much

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[18] The World Bank suggests that half of the air pollution in Eastern Europe and the former Soviet Union is attributable to distorted energy prices (World Bank, 1992).

greater choice among fuels and compliance options, thereby reducing the costs of environmental control measures. The distorted energy prices due to energy subsidies have added to the problems tremendously.

The question of liberalization of the EC natural gas trade can be analyzed much along the same lines. If barriers to free trade in natural gas could be abolished, natural gas would become cheaper, and would thus be used more relative to 'dirtier' fuels (e.g. coal). Due to the increased use of a 'clean' fuel, environmental compliance costs would also be lower.

The energy markets in Germany and the United Kingdom are highly distorted because of coal subsidies and official procurement rules for national steel companies and power plants. In Germany, half of the electric power generation is reserved to domestic coal, in the United Kingdom about two-thirds. The effect of these rules on overall pollution is governed by two opposite forces: on the one hand, electricity prices are higher than without such restrictions, thus reducing demand; on the other hand, fuel switching options to assist in meeting environmental standards would be greatly enhanced.

Finally, international trade and competitiveness may be seriously affected with the introduction of carbon taxes. In turn, these potential trade and competitiveness impacts may seriously retard the introduction of such taxes. Regional free trade areas (e.g. the EC or the North American Free Trade Area) which are considering to introduce carbon taxes, face two problems. The first problem relates to trade with countries with no carbon taxes. Should this trade be left unaffected, or should the free trade region tax the carbon content of imported goods at its border? And likewise, remit the tax on the carbon content of exported goods? Is this an economically sound policy and is it administratively feasible? The second problem relates to the harmonization of carbon policy in the different member states of the free trade association. Should policies be harmonized in terms of goals or instruments? Harmonization of goals (equal carbon emission reductions) between member countries will almost certainly require different measures, including different taxes. Harmonization of instruments (equal tax rates) will result in different emission reductions.

Border corrections and harmonization may both be captured by domestic industry to limit competition, in the sense that differences in costs, efficiency, endowments, and overall competitive advantages can be "harmonized" or "corrected". In cases like these, coalitions between environmental

groups and (parts of) industry may result in very costly solutions, to the detriment of social welfare and ultimately also to the detriment of the environment.

In sum, the links between international trade in the energy sector, energy and environmental policies, and environmental quality is highly topical from both a policy and a research point of view. This study has only touched upon some of the issues involved, and much work remains to be done in this field.

5.4 Hazardous wastes

One issue in which many aspects of the links between international trade and sustainable development are present is the international trade in hazardous wastes. The aspects include environmental risks, North-South relations, differences in national waste management policies, etc. This case is based on a study by Hilz and Ehrenfeld (1991) which examines several policy options for the international waste trade, ranging from free trade to a global ban on trade. This section presents the results of Hilz and Ehrenfeld (H-E), and then discusses these results on the light of our analytical framework, developed in chapter 2.

Hilz and Ehrenfeld (H-E) first address the reasons for trade, based on national differences between the demand for, and the supply of waste disposal facilities. The demand for waste disposal facilities is influenced by the amount of waste produced by the economy, and by environmental regulation on the proper disposal of hazardous wastes (sea dumping, landfills, incineration). Supply of waste disposal facilities is influenced by natural conditions (land space, ground water characteristics), environmental standards in hazardous waste management, and public opposition to the siting of facilities. Due to the growth of the economy and tighter regulations, the total amount of hazardous wastes generated in the United States increased from 9 million tons in 1970 to 286 million tons in 1986. The clean-up of old hazardous waste disposal sites has additionally increased the demand for disposal capacity. Tighter environmental standards and growing public opposition to hazardous waste facilities have sharply increased disposal costs: according to the U.S. Environmental Protection Agency a "sixteenfold" increase since the early 1970s. These developments

have led to export of hazardous wastes to countries where disposal costs are lower. Costs of hazardous waste disposal (landfill) in the United States averaged $250 per ton in 1989; by contrast, the average disposal costs in several African countries was approximately $40 per ton (Rabe, 1991). According to H-E, estimates of the total volume of exports of hazardous wastes are rather speculative as national definitions of hazardous wastes differ widely and large volumes may be involved in illegal or covert operations. One source estimated 1988 trade at more than 20 to 30 millions of tons, of which about 5 to 10 percent went to developing countries. However, another source estimated imports to Africa alone at about 24 million tons. Despite this uncertainty, most authorities agree that the number of shipments and the total volume of hazardous and solid wastes have steadily increased in both Western Europe and the United States during the 1980s (Rabe, 1991).

Uncontrolled trade in hazardous wastes has in the recent past led to some awkward international incidents. In 1988 the Nigerian government reacted sharply to the dumping of more than 4,000 tons of Italian hazardous waste in a rented backyard of a small Nigerian village. Nigeria recalled its ambassador from Rome and seized an Italian freighter in order to force the Italian government to take responsibility for the waste (Rabe, 1991). Other Western European countries and the United States have been involved in similar incidents, which have attracted much public attention. Incidents like these have led to policy initiatives to regulate international trade in hazardous wastes. These initiatives range from bilateral and regional agreements to larger international agreements such as the Basel Convention. Some developing countries have called for a ban on trade between developed and developing countries and some have even proposed a global ban on the exports of hazardous wastes (for instance through the Organization of African Unity). This call for a global ban has been hailed by many environmental organizations.

Due to their often poorly developed regulatory and administrative framework for managing hazardous wastes, hazardous waste disposal in developing countries may lead to near-term damage to human health and the environment, and long-tem clean-up costs. However, in face of their debt burden, importing hazardous wastes generates valuable revenue. H-E argue that free trade exploits their urgent needs for foreign exchange at the costs of long-term damage. On the other side, by providing cheap disposal

sites to industrial countries' hazardous wastes, free trade does not contribute to a sustainable hazardous waste policy in the North, that is, a policy which emphasizes the reduction of waste *generation* to the minimum level possible. Bilateral agreements between rich and poor countries do not address these problems fundamentally. An example is the agreement between the United States and Mexico, which, despite its formal procedures and regulations on control and monitoring of waste movements (including notification and consent), does not function properly mainly due to the poor institutional infrastructure for managing wastes in Mexico. Regional initiatives may lack administrative strength and international cohesion to enforce its objectives. Moreover, the exclusion of exporting and importing countries always present loopholes to such schemes. A global ban on trade in hazardous wastes is not considered feasible by H-E. The best way to reduce the environmental risks of the hazardous waste trade is through a global convention, such as the Basel Convention.

The Basel Convention, drafted in 1989, established effective monitoring procedures through requirements for notification and prior consent, a manifest system, and a yearly report of a countries hazardous waste exports. The Convention also directs its Parties to adopt an environmentally sound management of hazardous wastes; it does not spell out, however, the exact meaning of "sound management".

H-E give some recommendations to improve the Basel Convention. Two of these recommendations merit attention. First, H-E argue that the role of national sovereignty in environmental protection should be redefined. In particular, these sovereign rights should be limited in favour of an international agency which could, for instance, inspect waste disposal sites to check if wastes can be disposed of in an environmentally sound manner. The agency should also assist in cases of emergency. Second, H-E recommend that liability for damage to third parties should remain with the waste generator and should not be transferred to the owner of the disposal site. H-E see this as a strict interpretation of the Polluter Pays Principle, and it also reflects the notion that pollution prevention is better than pollution abatement.

Discussion

Our analytical framework in chapter 2 established that without adequate environmental policies in the countries involved in trade with negative

environmental side-effects, the "gains from trade" may be smaller than conventional analysis would suggest, and might even prove to be negative. However, the analytical framework also showed that trade measures, such as a global ban on trade in hazardous wastes, are usually not first-best solutions. Consequently, there must be scope for solutions which are more efficient, i.e. solutions which achieve environmental objectives at lower costs.

These more efficient solutions should, in the first place, include policies to minimize (hazardous) waste generation. Any policy geared at sustainable development should be concerned with the reduction of waste generation. A ban on waste exports would, by denying low-cost opportunities for waste disposal, give some incentives to this objective. A tax on waste generation would accomplish the same. To force waste generators to use high-cost waste disposal sites, just to encourage waste reduction, would amount to taxing waste and giving all revenue to waste disposal site owners. This does not make much sense.

In the second place, efficient solutions should include policies to encourage environmentally sound waste disposal management, especially in developing countries. The *raison d'être* of these policies is not only, and not even in the first place, to provide safe disposal facilities for imported wastes, but also to provide safe disposal sites for the increasing volume of hazardous wastes generated by developing countries themselves. Advocates of trade bans tend to overlook this point. Imports may not be the biggest source of hazardous wastes in the importing country, and certainly not the only threat. Therefore, with or without trade, policies should be geared towards improving waste disposal management globally.

The issue of liabilities, raised by H-E, merits further research. On the one hand it seems to offer opportunities to apply the concept of integrated chain management in the context of international trade. Section 2.1 of this report already mentioned this issue. On the other hand, however, waste disposal site owners should not be entirely relieved of responsibilities. Moreover, it may be questionable whether the juridical concept of liability is a very powerful instrument of environmental policy in many countries.

Trade in hazardous wastes is a global phenomenon, it should therefore be addressed within a global policy framework, i.e. in an international environmental agreement, such as the Basel Convention. The relationship

between international environmental agreements and national sovereignty is a delicate one, but it is clear that in order to achieve effective global environmental policies, national sovereignty has to give way to some extent. The potential tension between global and national responsibilities is likely to be one of the major issues in the development and implementation of a new generation of international environmental agreements.

In sum, trade in hazardous wastes is a subject in which trade and environment are closely intertwined. Research into this subject necessarily touches upon major environmental, economic, social, ethical and political questions. As with most trade and environment issues, the question transcends the issue of trade alone (to trade or not to trade) and should be studie within a wider context.

6. CONCLUSIONS AND RECOMMENDATIONS

In the present study a number of conceptual issues regarding sustainable development, international trade and the environment are analysed. Based on this analysis, major environmental and trade policy questions are examined and the links between them illustrated with several case studies. From the discusssion of theoretical and policy issues, the following conclusions can be drawn and recommendations for further work be formulated.

1. Most of the links between international trade and the environment are indirect. Changes in international trade flows may affect production, consumption, income, resource use, and technological change in the trading countries, which in their turn are likely to influence the environmental quality. Direct effects of international trade concern mainly transport-related environmental effects. An assessment of the overall environmental and welfare effects of a change in trade (e.g. trade liberalization) requires a careful specification of these direct and indirect relationships in empirical models.

2. In the absence of adequate environmental policies, a change in international trade may have negative effects on the environment if it increases levels of economic activity or if it shifts economic activities to areas with lower environmental carrying capacities. On the other hand, it may have positive effects on the environment if it increases resource use efficiency, or if it shifts economic activities to areas with larger environmental carrying capacities. In addition, trade-induced changes in income and income distribution may affect opportunities for environmental management. *A priori*, it is uncertain which effect will prevail in a specific situation.

3. If changes in international trade increase environmental damage, through changes in production; consumption, etc., measures to restrict trade are usually not the first-best policy instruments to counteract this damage. First-best policy instruments address environmental consequences of production or consumption directly, by internalising environmental considerations in production and/or consumption decisions. Trade

instruments are usually poor substitutes for environmental policies. Only in certain cases can they complement such policies.

4. Environmental effects of trade-related activities (transport, storage, infrastructural facilities, etc.) are often neglected in studies on international trade and the environment. Further research into the quantitative significance of trade-related environmental externalities is needed.

5. It is important to assess the entire life cycle of a commodity from raw material to final product, since different types of environmental problems (e.g. resource depletion, pollution, waste disposal) may arise at different stages. Because of international trade, these environmental problems may be located in different countries. Removal of trade barriers, and the anti-processing tendencies often implied in these barriers, will therefore have important effects on the intra-sectoral pattern of trade flows as well as on the location and magnitude of environmental problems related to each processing stage.

6. Domestic or local environmental effects should be distinguished from international (transborder) and global environmental effects. As no supranational enforcement authority exists, international policies should be based on international agreements between sovereign states.

7. As regards national environmental problems, international harmonization of environmental standards is generally not desirable. Differences in national priorities and in capacities to cope with environmental and natural resource degradation justify variations in environmental standards across countries. On the other hand, harmonization of the form of environmental policy (principles and measures) is highly desirable. Tensions between trade and the environment may be reduced by global adherence to the polluter pays principle (PPP).

8. The benefit-cost ratio of measures to address international or global environmental problems may differ between countries. For tackling these problems, positive incentives (e.g. financial assistance, transfers of environment-friendly technology) may be needed to achieve cooperation of

countries for which additional benefits are low. Adherence to the PPP will generally lead to the non-cooperation of these countries. Negative incentives (e.g. discriminatory trade restrictions on unrelated products) may not be the best way to promote cooperation.

9. Agricultural production in developing and developed countries causes a number of specific environmental problems, primarily related to the use of land and industrial inputs, that differ from environmental problems in other sectors of the economy. Models of interrelationships between international trade and the environment should take these differences between sectors into account in order to provide a solid basis for policy decisions.

10. The analysis of interaction between environment and international trade in agricultural products should preferably be undertaken in a general equilibrium framework to account for important feedback effects in terms of factor reallocation and remuneration (e.g. land rent changes and set-aside in industrialised countries, farm income changes in developing countries). These models may be supplemented with partial models containing more detailed analyses of the agricultural sector or specific products. It should, however, be noted that dynamic processes driving economic growth, such as technological and institutional development, are not adequately captured by existing models. Separate studies are needed to analyse the effects of environmental and trade policies on such processes.

11. Current studies on environmental effects of trade liberalization in agricultural products suffer from a number of shortcomings (insufficient product and process differentiation, large geographical aggregates, different assumptions about environmental measures, partial equilibrium approach). For this reason, the generally positive conclusions about the environmental effects of agricultural trade liberalization need some qualifications. Further research is needed to address these shortcomings.

12. Research on environmental effects of trade liberalization should pay particular attention to the effects on soil degradation in developing countries, which is often considered the most threatening environmental

problem in these countries. Empirical work on the magnitude and direction of these effects is very limited.

13. The introduction of national environmental policies results in shifts in actual comparative advantages. The extent to which existing models of international trade can be accomodated to include the effects of such policies should be investigated.

14. International agreements and proposals concerning transborder and global environmental effects differ widely in scope. Appropriate models will have to be developed to describe the relationships between the most important components of a multilateral agreement, international trade in related (and in the case of sanctions: unrelated) commodities, and the resulting environmental impacts. Game theoretical considerations may be helpful in analysing the negotiating process leading up to possible agreements. The analysis of international environmental policies is likely to raise a number of fairly new issues with respect to international trade and the environment. Part of the research in this field will therefore be of a more theoretical nature.

15. Modelling of the linkages between international trade and the environment is not independent of the nature of the policy questions to be analysed. National environmental policies typically affect international trade through changes in production, consumption and, consequently, income. As a first approach, ecological variables and their relationships with economic variables can be added to sectoral or sub-sectoral models. Existing models as developed by various research institutes provide a useful starting point for further work. Problems which arise when linking economic and environmental models include differences in spatial and time dimensions.

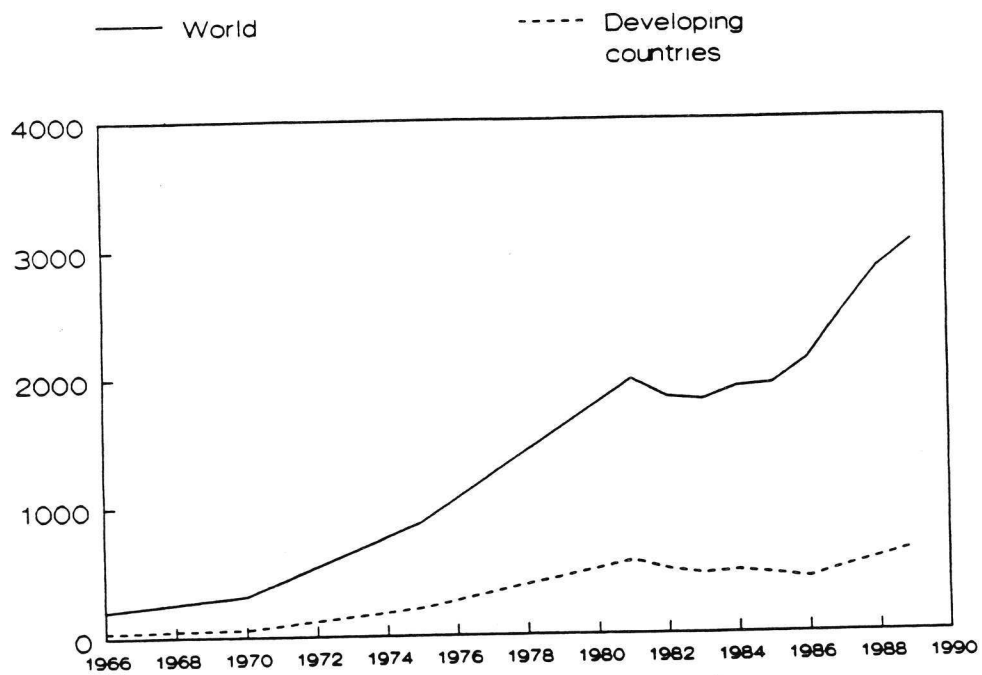
16. Modelling the impact of trade liberalization on environmental and natural resource degradation can start from a number of existing and fairly detailed studies on trade liberalization, in particular in agricultural products. The limitations of the present studies are well-known (conclusions 10 and 11) and constitute an obvious starting point for future research.

17. At present, research on international trade and the environment is being conducted by various research institutes, and duplication of work should be avoided as much as possible. In particular, it is recommended to liaise, where necessary, future work with the current research efforts at the OECD. This applies especially to on-going work in the Agricultural and in the Environment Committee, the Joint Session of the Trade and Environment Experts, and the Economic Department's GREEN model. Furthermore, it is desirable to establish contacts with research institutes in developing countries, in order to discuss their potential contributions to research questions that concern in particular these countries.

APPENDIX

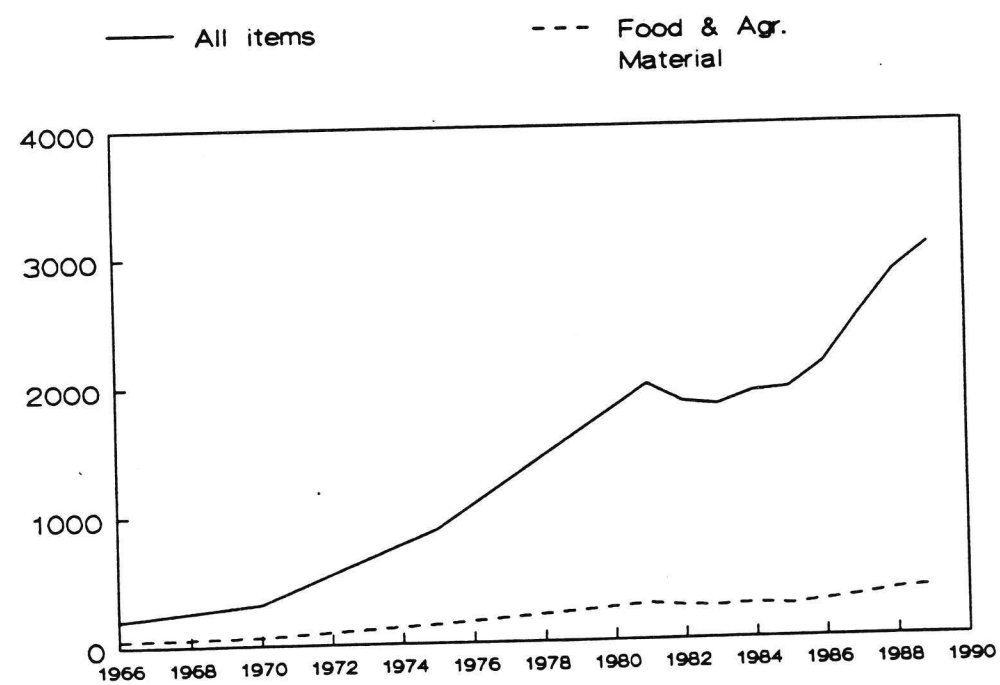
Selected statistics on international trade flows and levels of protection.

Figure A.1 Development of total merchandise world trade in billions of US dollar, 1966-1989, by region.



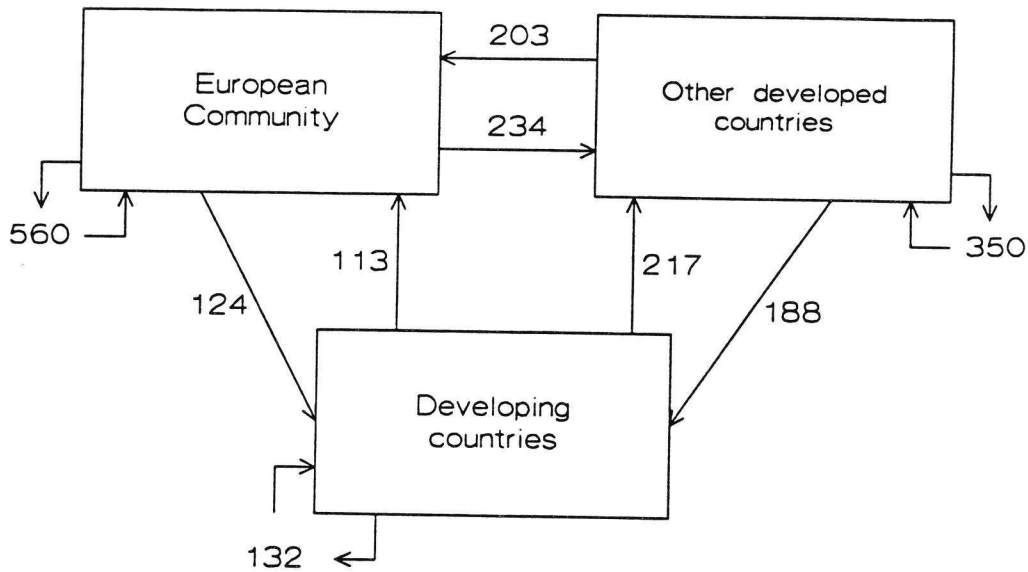
source: UNCTAD

Figure A.2 Development of total merchandise world trade in billions of US dollar, 1966-1989, by commodity.



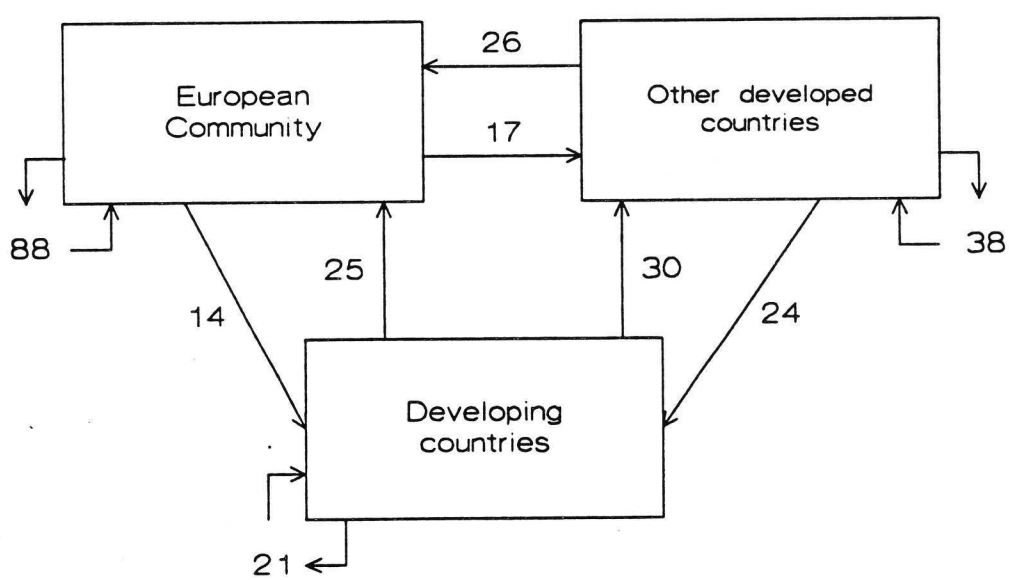
source: UNCTAD

Figure A.3 Total merchandise trade flows between major country groupings in 1987 in billion US dollars.



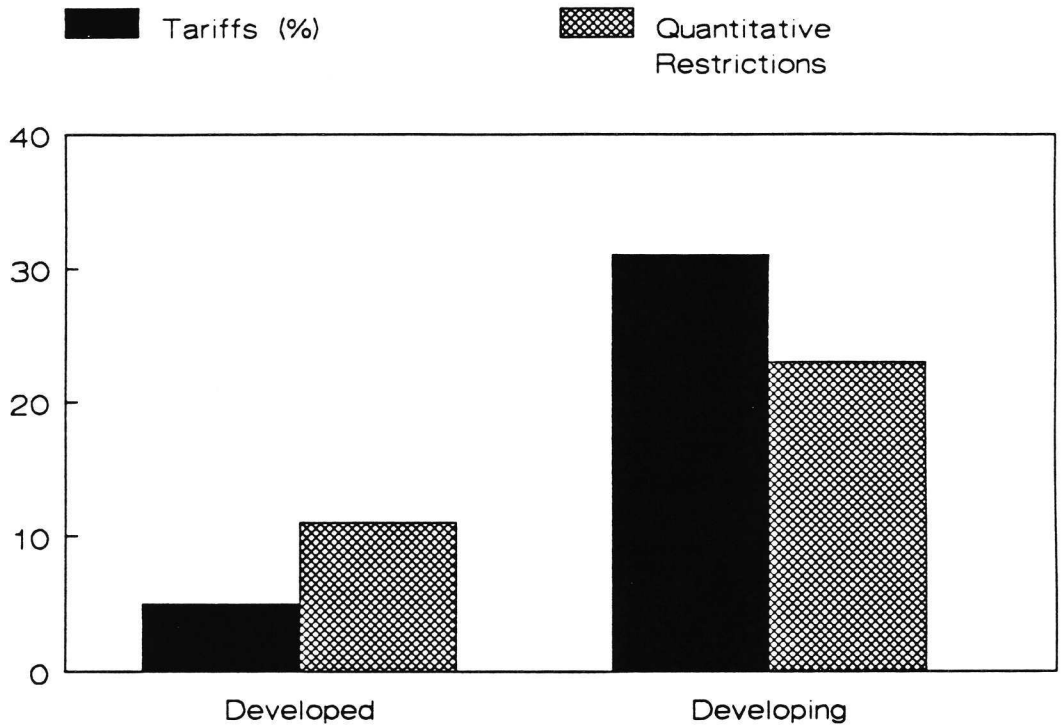
source: UNCTAD, 1989

Figure A.4 Total food and agricultural raw materials trade flows between major country groupings in 1987 in billion US dollars.



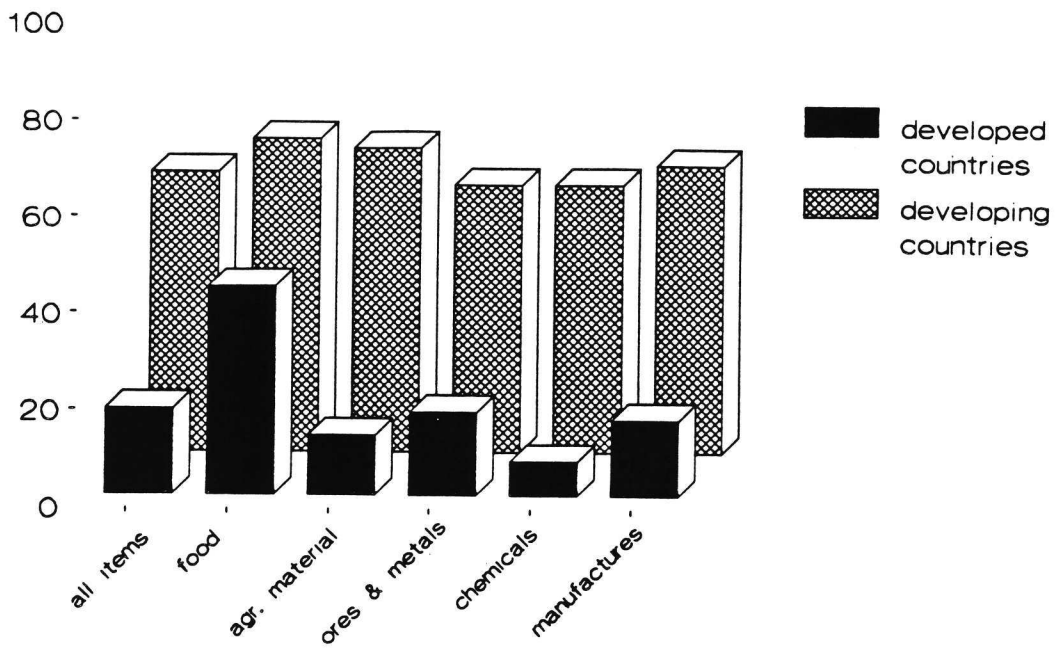
source: UNCTAD, 1989

Figure A.5 Trade protection by tariffs and quantitative restrictions in a selection of developed and developing countries, around 1988.



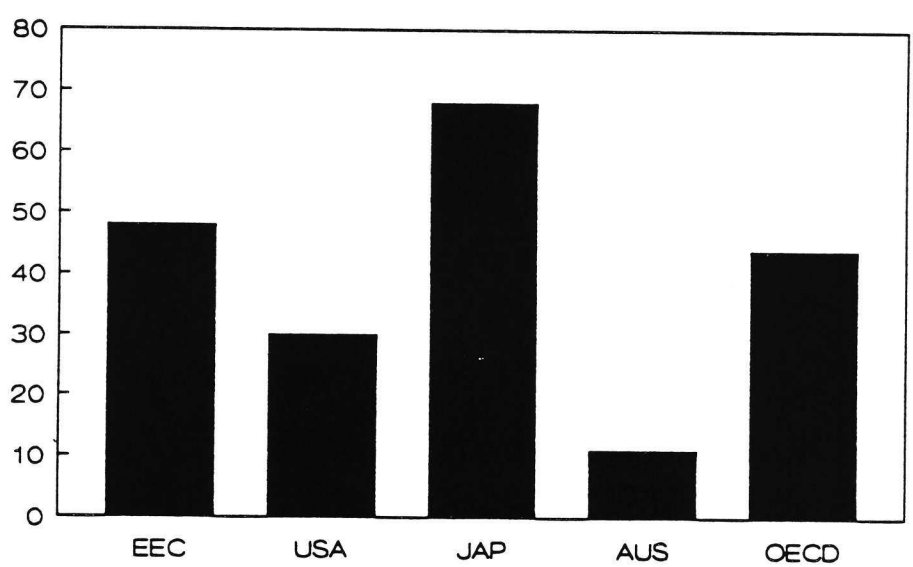
Developed countries: EC and USA
Developing countries: 31 countries
Tariffs: for developed countries: average ad-valorem tariff for all products except fuels; for developing countries: tariffs and import charges as a percentage of the value of all imports.
Quantitative restrictions: unweighed frequencies of application by tariff line per country weighted by import values.
Source: UNCTAD, 1991

Figure A.6 Frequency of nontariff measures for selected items in developed and developing countries (percentage of items affected)



Source: Bhagwati, 1988

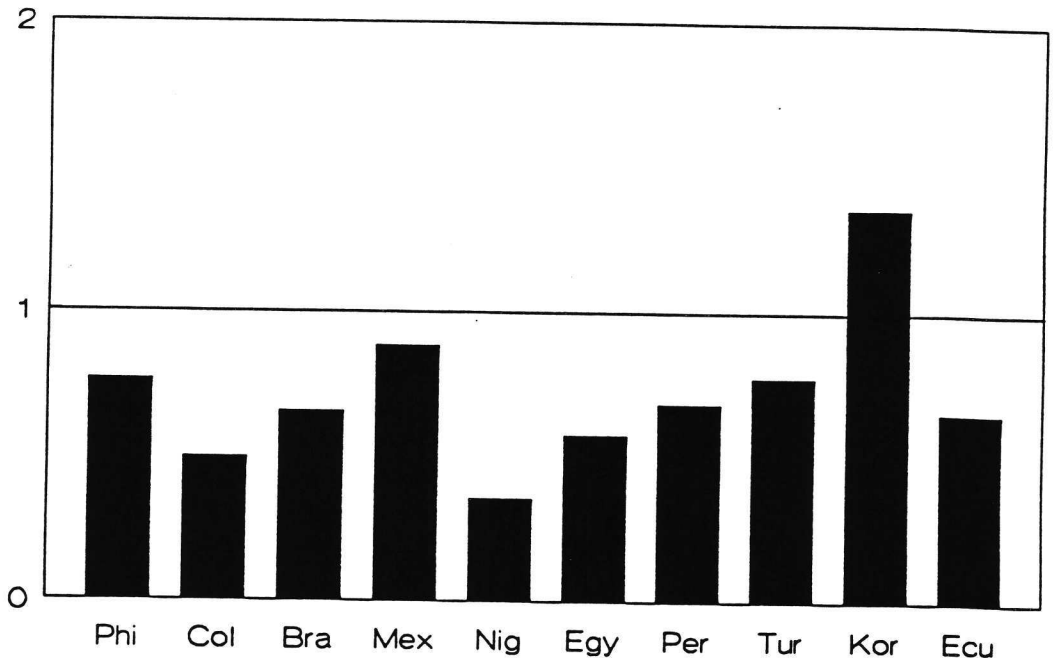
Figure A.7 Protection of agriculture in selected developed countries (producer subsidy equivalents as a percentage of producer price*)



* Producer subsidy equivalent measures the value of the monetary transfers to farmers from consumers and taxpayers resulting from agricultural policy.

Source: OECD, 1991

Figure A.8 Relative protection of agriculture compared with manufacturing in selected developing countries*



Phi: Philippines (1974)Egy: Egypt (1981)
Col: Colombia (1978)Per: Peru (1981)
Bra: Brazil (1980)Tur: Turkey (1981)
Mex: Mexico (1980)Kor: Rep. of Korea (1982)
Nig: Nigeria (1981)Ecu: Ecuador (1983)

* Relative protection is calculated as (1 + EPRa)/(1 + EPRm), where EPRa and EPRm are the effective rates of protection for agriculture and the manufacturing sector, respectively. A ratio of 1.00 indicates that effective protection is equal in both sectors; a ratio less than 1.00 means that protection is in favour of manufacturing.

Source: UNCTAD, 1991

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