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A SURVEY OF THE TRADE AND ENVIRONMENT NEXUS: GLOBAL DIMENSIONS

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INTRODUCTION

Increasing economic openness has given rise to concerns about possible detrimental effects on the environment. Expanded trading opportunities in natural resources and hazardous products and the associated development of potential pollution havens have added to fears about the environment. At the same time, pressures have mounted to use trade instruments to environmental ends. Recent agreements, such as NAFTA and the Uruguay round of the General Agreement on Tariffs and Trade (GATT), have incorporated environmental concerns and illustrate the intensity of the debate on trade and environment.' In addition, the emphasis now given to the concept of sustainable development, combined with more universal interest in outward-oriented development strategies, has linked the issue of longer-term growth with trade and the environment.

The existing literature tends to follow the two directions of interaction, from trade policies to the environment, and from environment policies to trade flows.[2] This paper examines the trade and environment nexus in a rather different way. It looks first at the link between trade and environmental policy instruments (Part I). It then reviews the interaction between environmental regulation and competitiveness (Part II). The linkages between trade liberalisation, growth and the environment are then considered in the context of the debate on sustainable development (Part III). The paper focuses on South issues, which are largely institutional and often arise in production, and North issues where both consumption and production generate substantial trade-environment linkages.[3] In addition to reviewing an extensive policy and theoretical literature, the paper highlights the need for more empirical results in this area and gives indications about directions and priorities for this work (Part IV).

I. LINKAGES BETWEEN TRADE AND ENVIRONMENTAL POLICY INSTRUMENTS

A. Instrument use and cost efficiency

Consider an open economy exchanging goods and services with the rest of the world, where production and consumption of traded commodities generate an

externality, such as pollution. Pollution abatement can be achieved by using various policy instruments, such as emission taxes, output taxes, or export tariffs. To minimise the cost of reducing pollution, the optimal response would be to use policy instruments most directly linked to the source of the externality. In that context, trade instruments, such as bans on exports, are inferior to Pigouvian[4] effluent taxes, abatement subsidies or more complete assignment of property rights.5 Non-targeted instruments, such as border measures, induce large welfare losses by distorting resource allocation beyond the source of the externality. This instrument assignment principle is grounded in recognition of different pollution abatement costs across polluters. For example, addressing a production externality with an output tax which is uniform across polluters is not efficient because it decreases output for all producers independently of their pollution levels (Beghin, Roland-Holst and van der Mensbrugghe, 1994). Tariffs would be even worse than output taxes under these circumstances because they would penalise consumers of the commodity even though consumption has no bearing on the pollution level. The optimal policy would be a targeted uniform tax ***per unit** of **pollution*** as this would directly discourage the emission of pollutants. Markusen (1975*a, b*) and Lloyd (1992) provide reviews of these first-best results.

These clear-cut principles do not necessarily hold when some instruments do not exist, take time to be implemented, or require scarce institutional capacity (Bohm and Russell, 1985). In a second-best world it has been shown that trade policy interventions, alone or combined with environmental taxes, can be welfare-improving. Such results have been established for, ***inter alia,*** small open economies with domestic pollution (Copeland, 1994); waste trade with some illegal disposal (Copeland, 1991); large country cases (Krutilla, 1991); and restrictions on available instruments (Vasavada ***et al.***, 1993). The major drawback of these second-best studies is their lack of generalisation. Although they identify interesting sufficient conditions for implementation of some types of correction, their assumptions are generally too narrow to be of extensive practical use.

In fact, economists maintain the presumption that trade instruments should not be used to reduce pollution, even in a second-best world. Lloyd (1992) cites the general acceptance of the Polluter Pays Principle6 (PPP) as evidence supporting specific (first-best) instruments in the real (second-best) world. The recent and progressive move away from command-and-control measures towards market-based instruments in OECD countries is another testimony to the acceptance of these principles (OECD 1993*a*). The case against broad-based instruments has been sustained by several empirical studies in second-best settings (for example, Lee and Roland-Holst, 1994; Braga, 1992; and Perroni and Wigle, 1992). Since trade instruments usually do not have a direct or strong impact on the pollution source, significant trade distortions, and concomitantly large resource misallocation, result from tariff-based environmental policies.

Targeting and internalisation principles, supported by empirical research in the North, must be applied to the South with some care. In this region, trade policy instruments can induce more rent-seeking activities than other policies, with important income transfer effects that depend upon property rights to natural

resources (Bell **1990;** Binswanger *et al.* **1993;** and Taylor **1993).** Moreover, institutional capacity can be far from the second-best found in industrialised countries: general administrative and monitoring capacity, consistency, delineation and protection of property rights, and the scope of enforceable policy instruments, can be seriously deficient.' Minimising the possibility of rent-seeking behaviour should be a pragmatic guiding principle in the presence of limited institutional capacity. Non-protectionist options are thus to be favoured and externalities are best tackled with incentive-based mechanisms which minimise enforcement infrastructure and costs.

Indeed, several empirical studies show that the targeting principles from the North still apply to the South: tariffs and other trade measures are inferior instruments for achieving domestic environmental objectives. Lee and Roland-Holst **(1994)** demonstrate the inferiority of tariff measures to control the level and composition of industrial pollution in Indonesia. Braga (1992), Gillis **(1988***a, b),* and Barbier **(1994)** analyse the link between timber trade policy and environmental degradation in Indonesia, Brazil, Malaysia, Ghana, and Liberia. Their general finding is that export bans are an inferior way to internalise forest-related environmental problems because they induce higher domestic consumption by decreasing the domestic price for timber (see Box **1).** The same conclusion was reached a decade earlier for the United States (see Sedjo and Wiseman, **1983;** and Parks and Cox, **1985).** The case for more specific policies, such as royalties, is more ambiguous. In forestry, some (Boado, **1988;** and Gillis, **1988***a,* c) argue that royalties increase deforestation by inducing "high-grading", which fosters waste and enlarges disturbed areas.

Do the targeting principles change when the source of pollution is outside national boundaries? Transboundary pollution can be seen as a second-best problem, *i.e.* a constraint on the jurisdiction and the set of instruments available to policy makers. In the absence of international co-operation it may be optimal for a single country to use trade measures to reduce environmental degradation originating abroad. For example, Markusen (1975*a, b)* showed that, in the absence of international co-ordination or co-operation, trade taxes can be used to lower the world price of the polluting good and internalise some welfare costs. Copeland **(1993)** also considers the case of transboundary pollution in production, internalised with a combined import tariff and process standard (on the production method), and these are shown to be equivalent to a tax on the pollution content of the imported good. Nevertheless, these arguments rest on rather specific assumptions and on the absence of retaliation by trading partners.

International co-operation is the most efficient way to address transborder environmental problems. Policies can then be designed as if the world was a single country, equating marginal abatement cost across several countries through the use of, for example, common charges per unit of emissions. The importance of concerted policy interventions to reduce CO_2 is highlighted in Burniaux *et al.* (1992), Dean and Hoeller (1992), Martin *et al.* (1992), and Nordhaus (1991*a, b).* The recognition of the need to coordinate policies to safe-

Box 1. Deforestation and international trade

Causes of deforestation in developing economies

The large-scale exploitation of timber resources poses one of the most significant development-related environmental challenges, but the linkage between this issue and trade is not as obvious as one might presume. The trade-environment-growth link for tropical forest production seems especially important in Indonesia and Brazil. Although tropical deforestation is alarming in these and other developing economies, commercial logging of tropical wood is not an instrumental contributor to national growth (less than **1** per cent of GDP) or trade. Deforestation is often led not by external markets but by itinerant agriculture. Institutional failures and market imperfections (property right delineation and enforcement, uncertainty and monopolistic practices, and logging contract design and government subsidies) are the major sources of deforestation externalities. Domestic consumption claims most of the timber production in developing economies. Trade bans and other export restrictions aimed at increasing domestic value added in wood products have often had negative environmental effects. These trade impediments depress domestic prices of logs and increase the log content of domestic products. It has been estimated that 10 per cent of Indonesian consumption of logs could be saved by removing the export ban. Recent EC and OECD proposals to fix import quotas of tropical wood and wood products would have the same qualitative effect and would foster inefficiency in wood product industries in developing economies (based on Barbier, **1994;** Gillis, **1988a;** and Braga, **1992).**

guard global commons also prompted the Montreal agreement on CFCs and halon reduction in 1990.

The problem with international agreements is that not all countries have the same incentives to join, and such agreements are fraught with free-riding and monitoring problems. For example, Martin ***et*** *a/.* (1992) showed that China and India would have little incentives to participate in an agreement to reduce global warming through uniform carbon taxes as they would have to shoulder the cost to a disproportionate extent. This problem can be taken care of, in principle, through transfers, for instance, by international trade in emission permits (Newbery, 1990; Mailer, 1990; Bohm, 1992 and 1993). Nonetheless, free riding is likely to be a perennial problem with all such international agreements, and the tendency for defection is likely to be enhanced as the different countries may have different views on the importance of pollution abatement.

The threat of trade sanctions can be used to discourage free riding and to enforce co-operation. For example, the Montreal agreement contains **a** clause which permits trade sanctions against non-complying countries. It is, however, questionable whether the threat of trade sanctions is an efficient deterrent to

shirking. A more effective way, notably in a repeated context, may be to provide stronger incentives to cooperate. International transfers, as in the Montreal agreement, may encourage co-operation as they would introduce a cost of non-compliance, although it would be important to ensure that the subsidies which such transfers involve do not have worse effects through distortions to resource allocation than the problem they are intended to mitigate.

B. Instrument use and political economy: rent-seeking

Given the recognition among economists that trade policies are generally inadequate instruments for addressing environmental externalities, the prevalence of their use for environmental ends is puzzling. This paradox raises the perennial question: why do policy makers do what they do? The answer has mainly to do with the political economy of rent-seeking. Every policy decision creates some losers and gainers who are likely to oppose or promote that policy. Rent-seeking interest groups pressure policy makers to adopt policies which benefit them but which may be inefficient for the economy as a whole. In the specific context of environmental problems advocacy groups put high value on environmental goods and may find that international trade negotiations are a useful arena to pursue environmental objectives. They may also regard the welfare losses induced by trade barriers as small relative to the expected environmental gains (Hillman and Ursprung, 1992). Other domestic pressure groups have vested interests in trade impediments. For example, some domestic producers may attempt to level the playing field with South competitors with respect to environmental standards and regulations through trade barriers, while others may promote protectionism in order to escape international competitive discipline. These overlapping interests among pressure groups can give rise to coalitions between environmental and industrial lobbies.

The way in which the trade-environment linkage is influenced by quantitative regulation, such as product and process standards, both *via* distorted trade flows and the political-economy game of interest groups, is discussed by Hoekman and Leidy (1992). Fixed factors prefer output regulation to pollution taxes because factor reward may be less affected under the former. Standards can be manipulated to restrict entry, with new firms facing more stringent standards. A quantity-regulatory approach favours collusive behaviour. Environmentalists tend to be process-oriented because tax-based internalisation is perceived as a license to pollute for the dirtiest firms. If the policy instrument is a product standard (directly related to the final consumption good), domestic producers will pressure for standards that decrease foreign competition. Environmentalists tend to favour maximum abatement, hence stringent standards. Hence product standards are less likely to take account of abatement cost and will tend to be sub-optimal. Process standards can lead to import bans as domestic groups will push for "fair" trade. The emergence of different instruments (standards, taxes, emission permits) in different politico-economic situations is explored by Hahn (1990) who

provides a useful assessment of the literature on the political economy of environmental policies.

A useful taxonomy of trade interventions for environmental ends is provided by Subramanian (1992) and Blackhurst and Subramanian (1992) who differentiate policies that can be used for protectionist purposes from GATT-legitimate uses of trade instruments. GATT recognises a few narrow cases of lawful trade interventions to address environmental problems, using the following explicit criteria: nondiscrimination (most-favoured nation), non-protectionism (the least intrusive on trade), national treatment (nondiscrimination between domestic and competing imports), necessity or minimum trade restrictiveness (the most efficient available) and scope (product, time) (see Box 2; and OECD, 1994*b*; Sorsa 1992*a, b*; and Lloyd, 1992). The OECD guidelines on environmental policies maintain the same philosophy of minimizing trade flow distortions, and emphasizing national treatment, nondiscrimination and transparency. However the actual policy menu adopted by OECD members is diverse and often follows a regulatory approach (Barde, 1994).

Box 2. General Agreement on Tariffs and Trade (GATT) - inconsistent environmental protection

The United States-Canada dispute on the Canadian ban on certain unprocessed fish exports

Fisheries resemble agriculture in the degree of intervention which they have experienced in OECD countries, but here the implications of support policies, which may promote unsustainable production and inefficiency, reach far beyond domestic boundaries. Canada, under its Fisheries Act of 1979, passed two regulations in 1984 banning the export of certain species of herring and salmon in unprocessed form. Canada argued that the regulations were consistent with Article XXg of the GATT (exceptions to GATT rules to protect exhaustible natural resources), because they were part of a comprehensive conservation effort and because they had important conservation effects. The United States brought the dispute to the GATT, and contested the regulations, arguing that the measures provided protection to Canadian processors by depressing the price of unprocessed fish, and that they were not a conservation policy since they applied to harvested fish and not to the stock. In 1988, the GATT panel ruled against Canada. Although the regulations were part of a comprehensive conservation program, they did not aim primarily at the protection of an exhaustible resource. The trade measures were not combined with production measures restricting access to the herring and salmon supplies in general but only in unprocessed form (based on Sorsa, 1992*a*, Annex 1).

One of the key unsettled issues concerning trade and the environment is the harmonization of environmental standards and the effects that this could have both on trade and the environment. Nevertheless, GATT has been trying to foster the adoption of minimum non-protectionist standards as a way to circumvent unilateral manipulation of these standards for protectionist aims. The OECD is following the same pragmatic strategy with its guidelines on harmonization **(OECD 1994*a*).**

The agreement on technical barriers to trade, annexed to the Uruguay agreement, devotes substantial attention to uniform standards, but with a focus on production and process methods affecting characteristics of the final product. "Green" or "eco" labels which provide information that is potentially valuable to consumers are an example of such standards (see Box **3).** In this case market prices should reflect differences in environmental characteristics of final goods that matter to consumers. "Green" producers get rewarded for the environmental characteristics of their products. Eco-packaging and, more generally, the life-cycle management approach to environmental impact of a good reveal the limits of and

Box 3. Eco-labels and their trade impacts

The Dutch eco-labelling schemes for flowers and their effects on the Colombian flower industry

Green preferences represent a new and rapidly growing dimension of trade and environment issues. Such demand driven forces are not GATT actionable and are influenced by commercial advertising and other forms of product information and image management. The Netherlands has a long tradition in horticultural exports such as cut flowers. Dutch dominance on world markets has been recently eroded, however, by the emergence of horticultural production and exports originating in developing economies. The flower industry is chemical-intensive and polluting both in the North and South. Dutch horticulture is also energy-intensive since most production occurs in greenhouses. A proliferation of green labels (for example environmental standards defined by flower auction houses) has been occurring in the Dutch horticultural sector, partly to address growing environmental concerns and partly to differentiate their products from those produced by competitors in the South (for example, Colombia and Morocco). In 1995, the independent environmental foundation "Milieukeur" will award an independent eco-label for cut flowers considering five production stages and eight environmental dimensions that will mimic a cradle-to-grave approach. Importers can apply for the new label, but foreign producers will not be represented on the Milieukeur panels and are not involved in the definition of the label. It is unlikely that the two types of production (natural sunlight versus greenhouse) will be on equal footing and it is likely that some comparative advantage of South producers may be diluted (based on Verbruggen et *al.*, 1994; and Gavaria *et al.*, 1994).

potential conflict with national sovereignty which is central to the GATT (OECD, 1994*b*). Eco-packaging policies defining quantitative standards (bans, recycled content) may be inconsistent with article **XI** that prohibits such restriction. Two caveats about labelling should be noted. First, because of substitution effects, labelling can have the perverse effect of decreasing the price of environment-unfriendly products and thereby stimulate their consumption (Mattoo and Singh, 1994). Second, if eco-standards become compulsory and affect trade, they are more likely to be manipulated to achieve protectionist ends.

The issue of environmental standards has already given rise to intense debate – and much lobbying – in the context of the European Community. Klepper (1992) has reviewed EC members' important environmental standards, their trade implications and related rulings of the European Court of Justice on their legality. He points out the heterogeneity of technologies within industries (from green to dirty according to capital vintage) and the incentive for some firms and for environmental groups to push for some environmental standard to force firms using old capital out of a market. Heterogeneous political interests exist within industry lobby groups. This heterogeneity extends to the more forward-looking unions who tend to be favourable towards environmental policy because they foresee new induced technologies, enhanced productivity, and dynamic comparative advantages of the country. This latter strategy may clash with labour interests in traditional sectors, such as mining, where environmental standards are resisted because of perceived threats to the whole industry.

There is limited evidence of collusion between environmental groups and sectoral interests advocating protection (van Grasstek, 1992, for the United States, and Klepper, 1992, for Germany). Van Grasstek (1992) extensively investigates voting behaviour of US legislators to identify manipulation of trade for environmental objectives. He finds that legislators are parochial but not often protectionist because of the diversity of industries in most states. The overlapping interests of domestic industries and environmentalists in the United States appear to be limited. Environmental protectionism, however, occurs in the financing of environment policies which discriminate against imports and/or impose process standards on imported goods (for example, minimum-size lobsters), or impose trade sanctions for violation of environmental safeguards. There is some indication of legislators enacting "green" protectionist policies when their own state depends on dirty industries. They appeal to consumers and protect their state's producers, thereby reaping a double dividend politically.

II. ENVIRONMENTAL REGULATION AND COMPETITIVENESS

A. Theoretical considerations

Environmental policies can affect production costs and thus influence trade patterns. The early conceptual work on competitiveness and environment

examined the effects of environmental policies on comparative advantage and trade in simple trade models. In these models, surveyed in Siebert (1985), pollution is treated as a production factor and environmental policies, which reflect the value societies attach to a clean environment and their absorptive capacity, determine whether pollution is abundant or scarce. The standard result is that countries with relatively large absorptive capacity tend to have a comparative advantage in pollution-intensive activities. The models further predict that specialisation in "dirty" activities will be located in the South when the environment is taken to be a normal good and thus in relative abundance in poor countries (see Copeland and Taylor, 1993). Tougher environmental policies in the North without a matching tightening in the South will tend to shift the location of world production of pollution-intensive goods to the South.

B. The mixed evidence

Empirical research tends to confirm that developing economies specialise in dirty industries: the global capacity and output of pollution-intensive industries is shifting to the South. Hettige, Lucas and Wheeler (1992) and Lucas, Wheeler and Hettige (1992) find that pollution intensity is higher in low-income countries, which is consistent with specialisation in pollution-intensive activities where absorptive capacity is economically abundant. Birdsall and Wheeler (1992), Low and Yeats (1992), and **OECD** (1993*a*) present similar findings. Studies focusing on pollution intensity of trade between North and South also find that the South exports relatively dirty products and the North exports relatively clean products. For example, in their analysis of the pollution intensity of trade between Indonesia and Japan, Lee and Roland-Holst (1994) find that the pollution content, as measured by a human toxicity index of effluents, of production and trade differs greatly between the two countries. The reference level of the index is normalized to one and represents the toxicity of a unit of aggregate economic activity in the United States. Japan's aggregate output has an index of 0.86, while Indonesia's index is 2.45 showing the specialisation in dirtier activities. The disparity in pollution content of trade is arresting: exports from Indonesia to Japan have an index of 10.64 while Japanese exports to Indonesia have an index equal to 1.62.

However, studies do not find strong evidence that environmental regulations *per se* have influenced competitiveness. On average, the price effects of environmental regulations appear to be limited. According to available estimates, abatement costs in the North appear to be low, between 1 and 3 per cent of total costs (OECD, 1993*a*; Tobey, 1990; and Walter, 1973). The contrast between the findings that the South specialises in dirty industries and that environmental regulations have only modest effects on competitiveness could signal measurement problems. The strong opposition and resistance of developing countries to adopting industrialised countries' environmental norms also suggests that pollution abatement cost estimates may not capture the full costs of some of the regulations.[8]

This could also explain why studies fail to find any support for the "pollution haven" hypothesis. This hypothesis predicts that weak environmental regulation stimulates foreign direct investment in pollution-intensive industries (Pearson, 1987; Richardson and Mutti, 1977). The absence of systematic patterns of foreign direct investment in polluting industries, which is documented in Leonard (1988), is not surprising given the difficulty of estimating the impact of regulations on investment decisions (Lucas, 1993). It may also reflect the fact that weak environmental standards often go in hand with political instability, uncertainty about future regulation, and corruption. The costs associated with the latter may cancel out any possible gains from low environmental costs.

III. TRADE LIBERALISATION, GROWTH AND THE ENVIRONMENT

Copeland and Taylor (1994) investigate how economic growth influences the location of pollution-intensive industries. Growth with trade as opposed to autarky induces three main effects: a scale effect that always increases pollution; a composition effect that reflects international specialisation in more or less dirty activities; and a technical effect that indicates the move towards cleaner technology. In this decomposition, based on the empirical work of Grossman and Krueger (1992), it is assumed that the environment is a normal good and higher income induces tougher environmental standards (higher taxes on pollutive inputs) and adoption of cleaner production methods (the technique effect).

The interface of growth, trade, and the environment, is made more complex because scientific understanding of ecosystems is limited (Solow, 1991). Although some stylised facts exist, the long term relationship between effluents and economic development is neither well understood nor well documented (Hettige, Lucas and Wheeler, 1992; Krueger and Grossman, 1992; and World Bank, 1992). For example, in high-income countries, pollution related to solid waste, groundwater contamination, and global warming is still increasing with economic growth (see Box 4). Grossman (1993) and World Bank (1992) show that not all effluent growth follows an inverted-U shape (rising at early stages of growth, reaching a maximum at average levels of development, and eventually decreasing with higher income). Hettige, Lucas and Wheeler (1992) actually show that effluent intensities per unit of industrial output increase with economic development. The composition effect seems to be more important than the technological one in explaining lower pollution per unit of wealth created in the North. Production of the dirtiest output apparently, has been displaced to lower-income countries *via* international specialisation. Pollution related to transport increases dramatically with greater specialisation, market integration and urbanisation (OECD, 1993*a*). Further, there is nothing automatic about the decline of some effluents with growth, implied by the inverted-U pattern found for some effluents. A complex combination of technical change, income effects, public interest pressure for cleaner environment, and pluralistic political systems leads to lower

Box 4. Effluent patterns and economic growth

Inverted-U shape and other patterns of effluents

Urban air and river water quality indicators reveal considerable diversity in effluent patterns linked to economic growth. Some effluents show patterns with an inverted-U shape: suspended particle matters, sulfur dioxide, airborne lead, carbon monoxide, nitrogen dioxide, fecal coliform and oxygen-depleting substances in rivers. Other pollutant concentrations decrease with economic development, such as lead and cadmium in rivers. Some effluent concentrations increase monotonically with development: total coliform in rivers, greenhouse gases (carbon nitrous oxides), and municipal wastes. Finally, no robust patterns can be identified for several heavy metals (mercury, arsenic, and nickel). The concentration reversal shown by the inverted-U is due mostly to the compositional effect and tighter regulations rather than to new technologies. Aggregate emission data, estimated with US-based sectoral intensities, confirm that intensities per unit of GDP exhibit inverted-U patterns but also reveal that effluents per unit of manufacturing output rise monotonically with income. The inverted-U shape result hinges on changing the composition of aggregate production in OECD countries. There is evidence that pollutant intensity has been growing faster in developing economies since the 1970s when OECD countries adopted tighter regulations (based on Grossman, 1993; Hettige *et al.*, 1992; and World Bank, 1992).

pollution-intensity of output because of cleaner technologies and a change in the composition of output and consumption (O'Connor, 1994). It is not clear that every country will follow the sequence of stages implied by an inverted-U curve. The simplicity of the argument implied by the curve is appealing, but may, like Kuznets' prediction on equity and growth, eventually be revealed to be fallacious.

A. Specialisation and efficiency effects

Trade enhances market discipline which in turn decreases waste and inefficient use of energy resources. Hence trade pressures may contribute to the decline of some effluents induced by growth because of more efficient international specialisation. International market discipline and undistorted price signals increase allocative efficiency and decrease pollution through more economic pricing and use of energy resources (Lucas, Wheeler and Hettige, 1992; Ten Kate and Draaisma, 1994). This is a case of a "win-win" or "no regret" situation, with a better environment and a larger pie (World Bank, 1992). The specialisation effect is sometimes counter-intuitive because a country may have several abundant factors, such as unskilled labour, land, and absorptive capacity. Hence specialisation need not be detrimental to the environment.

Before the debt crisis and the implementation of structural adjustment policies, there was a sharp dividing line in the trade orientation of South countries in terms of development strategy. Many countries followed import substitution policies aimed at reducing trade dependence. A wide array of distorting policies was used, including heavy tariffs, taxing exportables (especially agriculture), subsidising some indispensable imported inputs, and foreign exchange restrictions. These policies contributed to overvalued exchange rates. Infant-industry protection policies and more general protectionism led to inefficient and monopolistic domestic industries. In inward-oriented countries, the state often escaped market discipline and political accountability, and was itself the worst polluter and violator of environmental regulations within the economy (for example, in the public enterprises of the former Soviet countries, the oil sector in Mexico, and forest resources in many countries).

Structural adjustment policies promote unilateral removal of distortions, trade opening and competitive market discipline. However, unilateral trade liberalisation or opening may not lead to overall welfare gains when pollution-intensive exports expand. At the same time the welfare of the importing country increases – a welfare transfer induced by "pollution cost transfer" (Pethig, 1976; and Asako, 1979). Copeland (1994) considers piecemeal trade policy reform in a distorted economy with production externalities. Piecemeal trade reform alone, towards a more uniform structure of protection or towards free trade, has ambiguous welfare effects, depending on pollution intensity of different sectors affected by the reform. In the absence of robust results on trade reform alone, Copeland stresses the need for co-ordination of trade reform and environmental policy. Trade liberalisation accompanied by environmental policies internalising externalities is beneficial. Factor mobility increases the size of the gains from adopting appropriate environmental policies (towards their first-best level). If pollutants are controlled by marketable permits (quotas) trade liberalisation improves welfare because its environmental effects are capped by the quantitative restrictions.

B. Changes in absorptive capacity and technology

A major argument concerning the environment-growth-trade link is that absorptive capacity changes with economic development and in turn affects comparative advantage and consumption decisions that induce new trade patterns. Outward-oriented strategies foster the international division of labour, which may imply specialisation in dirty industries at a low level of development, although the evidence suggests that specialisation occurred in labour-intensive as well as in pollution-intensive activities (Hettige, Lucas and Wheeler, 1992). International trade facilitates transfer and adoption of cleaner technology and allows latecomers to do technological leapfrogging (Hettige, Lucas and Wheeler, 1992; O'Connor, 1994). **A** technical effect ***via*** mobility of factors (a long-term dynamic effect) is the third and last effect in the Grossman-Krueger taxonomy. Specialisation and demands for cleaner environment tend to locate production where the technology is the most advanced and often cleanest. Hence there are two dimen-

sions to the technological change: cleaner technology becomes easily available in a global world, but it is also demanded because of higher valuation of the environment (Copeland and Taylor, **1994).**

Technology and its transfer are central to current analysis of the relationship between economic development and the environment because they are the fundamental means for breaking the link between growth and pollution accumulation. Trade and world market integration facilitate the transboundary transfer of cleaner technologies. New and cleaner technologies allow the pollution intensity of industries to be reduced, so that the pollution content of a unit of output becomes less pollution intensive with growth. When externalities are properly addressed, growth improves welfare but nevertheless pollution accumulates (albeit at a decreasing rate) and in that sense growth increases pollution. New technology eventually becomes the last resort to break the growth and pollution link. Lopez **(1992)** proposes a model capturing many of these features. Two cases are considered: when the environment is a resource in future production and when it is not. In the latter case, output decreases are necessary to decrease pollution. In the former case, pollution can decrease with growth since the environment has an opportunity cost in future production.

***Box* 5.** Clean technology transfer and trade orientation

International diffusion of thermo-mechanical pulping technology in wood pulp production

Although it can be difficult to generalise about technology adoption patterns, it is instructive to examine global experience with a specific technology. Thermo-mechanical pulping is an innovation from the North which is dominant in OECD countries because it is efficient and environment-friendly. It is progressively being adopted in the South. It is also a wood-saving, energy-using technology. Several factors influence decisions to adopt greener technologies. Green consumerism offers a reputational premium to firms which adopt and governments which promote adoption. Rapid economic growth also may influence adoption of cleaner technology by newer and more dynamic firms (leapfrogging). Anticipation of new regulation is another potential adoption factor, motivated by the emergence of new environmental regulations since 1980. In the case of the wood pulp sector, early adoption and diffusion appear to increase with outward-orientation, which promotes rapid transfer and new adoption incentives, and with the scale of the industry, which propagates information and reduces the average cost of adoption. Development levels do not seem to influence the adoption process in part because the cleaner technology is also the cheaper. This specific instance excludes a trade-off between environment and production cost, that is it excludes the potential dirtier but cheaper technology option for the South. (Based on Wheeler and Martin, 1992.)

Wheeler and Martin (1992) analyse international transfers of technology in the wood pulp industry (see Box 5). They show the positive influence of competitive forces on the adoption of cleaner technologies. However, development level and presumably higher valuation of the environment have no effect on adoption (timing of first adoption and diffusion of wood pulp technology). Nonetheless, technology transfer will only happen if there is adoption by price-responsive entrepreneurs. For instance, a switch to cleaner energy technologies by China is possible but would be very expensive under current conditions. Government-targeted help can foster clean technology transfers when such adoption is expensive. A subsidised transfer could improve the global commons, but may be as subject to rent-seeking activities as any other governmental programme. The US Government has such programmes for technology transfers to Mexico (Dunne, 1994).

C. Empirical studies on trade liberalisation and the environment

During the last round of GATT negotiations, several papers analysed the environmental implications of multilateral trade liberalisation, often with a special emphasis on agriculture and natural resource industries (Anderson, 1992; Cook and Tobey, 1992; IFPRI, 1990; Lutz, 1992; OECD, 1994*a*; and Runge, 1994). Actual empirical estimates are scarce in the literature. Most papers have identified the likely channels of environmental impacts for agricultural trade liberalisation but welfare estimates for quantified environmental impacts of reforms do not exist. A consensus view has emerged that the environment in developed economies will benefit from fewer distortions in agricultural markets, because this will reduce the intensification of agriculture, in terms of less pesticides and fertilizers used, land diverted to competing uses, and farmers reducing scale or exiting the industry.

By contrast, South economies would see opposite changes following GATT-induced trade liberalisation. In agriculture, intensification (mechanisation, pesticide and fertilizer use) is expected when liberalisation results in higher output prices, with its implications for water use and pollution, erosion, and agricultural land expansion (see Box 6). Several conjectures await investigation. For example, marginal producers may face higher land prices and exit, or may find expanded employment opportunities because of an increase in labor demand. Scale economies are likely to take place. Since land will become more valuable, it will induce some delineation of property rights that may decrease the commons' problem. However it is also plausible that land-clearing may intensify given output (price) incentives. The net effect on land (better property rights, land expansion, less poverty-driven deforestation) is a priori ambiguous. The lack of knowledge on aggregate land response is an important question to address for agriculture is a major contributor to tropical forest destruction. Summary measures of the impact of agricultural trade liberalisation on the environment are not yet available.

The impact of trade liberalisation on the environment may often be negative, at least in the short term, because use of natural resources, even if the latter are

Box 6. Determinants of land use

Evidence on land use, population growth, price incentives, and poverty

Land use patterns are responsive to economic forces, but it is difficult to generalise about their environmental consequences. Southgate (1991) establishes a positive link between arable land and population growth using data from 24 Latin American countries. Cook and Tobey (1992) find weaker evidence of that link using the USDA-ERS data base of 33 countries (mostly OECD Member countries). Cavallo (1989) suggests that land use is price-inelastic with respect to output price in Argentina. By contrast Abler and Pick (1993) estimate econometrically that land devoted to Mexican horticulture is very responsive to output prices. Cross-section international data, dominated by OECD production, show that agricultural protection is linked to intensification but not to extensification (Cook and Tobey). The absence of extensification may be due to the ability of OECD governments to decouple planted areas and income support as evidenced by high land prices in these countries. Delineation of land rights, which has already occurred in industrialized countries, limits the validity of North-South comparisons when looking at land use. The link between poverty and deforested agricultural land has not yet been formally established, but there is evidence that the scale of swidden forest removal has risen sharply in some areas (for example, Brazil and Indonesia). Moreover, this extensification of subsistence agriculture may by abetted by transport infrastructure for expanded capacity in agriculture and forestry (Barbier, 1994).

correctly priced, increases with the output expansion that comes with the reform (Lee and Roland-Holst, 1994). In theory, increasing pollution does not mean that welfare necessarily decreases since, where optimal environmental policies exist, the higher social cost implied by pollution externalities are internalised and there are offsetting benefits that accrue to consumers. However, the common presumption is that, in the South, optimal environmental policy may not be in place, or may not be enforced or appropriately designed, so that trade liberalisation may give rise to environmental externalities which reduces welfare. In such cases environmental side agreements, as in NAFTA, may seek to deal with any environmental problems that may arise. Regarding NAFTA, Grossman and Krueger (1992) show that Mexico would actually specialise in unskilled labour-intensive activities and that the United States would increase its output in "dirty" capital-intensive industries. Mexico's most polluting industries (utilities) would contract.

In conclusion, trade is certainly not the villain in the larger context of sustainable development. The link between growth and environmental degradation is complex: it is positive for some forms of pollution but follows an inverted-U shape for other types of environmental degradation. World market integration and outward-oriented policies promote technology transfer, specialisation and better

pricing of resources. Such policies can mitigate environmental degradation and actually speed up adoption of cleaner technology. Outward-oriented growth shortens the environmental transition for developing economies by inducing larger income effects on the demand for environmental goods (Baldwin, 1993). Global integration of markets and international mobility of factors will undoubtedly foster more co-ordination of domestic environmental and trade policies.

IV. CONCLUSIONS AND RESEARCH AGENDA

This article first reviewed the link between trade and environmental policy instruments. Trade policies are a blunt and, in most situations, inappropriate instrument to address domestic environmental problems. However, they can play a role in fostering international co-operation when addressing transboundary problems, either as a stick to induce co-operation, or to punish noncomplying parties after an agreement is reached. Next, the paper addressed the competitiveness-pollution haven hypothesis. It was found that the loss of competitiveness induced by environmental regulation was limited, but simultaneously that an international specialisation based on absorptive capacity is taking place. The South specialises in dirty production while the North has changed its output composition towards cleaner goods. Last, the paper investigated the dynamic linkages between trade orientation, growth and the environment. For both conceptual and empirical purposes, three important effects were identified: first, a scale effect (more output means more pollution); second, a composition effect (cleaner goods are produced with economic development); and, third, a technology effect (cleaner technologies become available and are adopted because of tighter regulation). The empirical evidence on the evolution of pollution and pollution content of output is mixed, suggesting that the composition effect is the most important and that the technology effect is limited. It is not clear that global economic activity becomes cleaner with growth.

The current state of knowledge suggests an agenda of research in several directions, although the empirical vacuum dictates immediate priorities. In terms of data, little is known about the co-evolution of effluent emissions directly with growing economic activity. International data on emissions are measured only in selected urban areas and do not adequately measure pollution linked to industrial activity (World Bank, 1992). Virtually all studies dealing with international comparisons of output pollution intensity rely on the US effluent data compiled by Martin *et a/.* (1991). It would be extremely useful to develop these effluent data for several countries and to follow them over time as well. Martin, Wheeler and collaborators are currently developing such a data base for Indonesia.[9] There is no information however on how these effluents respond to prices, income, and other variables. These new data could be incorporated in trade liberalisation analyses to quantify environment-trade linkages. These data can easily be used

in general equilibrium models which can identify the critical environmental "hot spots" following trade integration (Lee and Roland-Holst, 1994; Beghin, Roland-Holst, and van der Mensbrugghe, forthcoming). Beyond these general equilibrium analyses, industry case studies, such as in Antle and Crissman (1994) and Wheeler and Martin (1992) should be replicated, both for individual country interest and to enlarge the body of knowledge on the trade and environment nexus.

There is very little quantitative knowledge on long term intensification and extensification of agriculture following trade liberalisation in developing economies. Estimated demands for pesticides are available only for a few countries (for example, Yang and Carlson, 1994; Naylor, 1994). Land use responses are not well understood either especially for decisions concerning marginal land (Abler and Pick, 1993, is a first example). Knowledge of how land rights will evolve with intensification is speculative at best. Will increased scarcity induce new institutions to make land excludable[10] or will free riding on the commons prevail? The link between intensification and environmental degradation has not been quantified for developing economies. For the time being estimates for industrialised countries' effluent intensities of manufacturing output can be used.

The political economy of environmental protectionism also needs to be studied. The stylised facts of the political economy of environmental policies have not really been established for most developing economies. The OECD experience suggests that it is erroneous to assume monolithic "green" and industry interest groups. Practical understanding of green policy formation could help to avoid protectionism by fostering environmental co-operation and decreasing the uncertainty pervading environmental outcomes. The choice of specific policy instruments for enforcement and monitoring is not much elucidated either. Most models abstract from these matters and focus on the instrument alone (Hahn, 1990). A better understanding of the tendency of firms to prefer standards to taxes may be provided by closer examination of the institutional dynamics of enforcement and monitoring.

The next round of international trade negotiations under World Trade Organization auspices will devote substantial attention to protectionism and trade effects associated with environmental regulations. There is only fragmentary knowledge of these trade effects. Tariff equivalents of many non-tariff barriers, such as standards, labels, phytosanitary and other health regulations addressing consumption externalities, will need to be developed in order to examine trade-environment links.[11]

NOTES

1. Early contributions to this debate date from the 1970s (for example, D'Arge, 1974; Magee and Ford, 1972; Walter, 1973; Baumol, 1971; and Markusen, 1975*a, b*). Contributions to the current debate include Anderson and Blackhurst (1992), and Low (1992*a*).
2. See Cropper and Oates (1992); Dean (1992); and Quijandria (1993) for other surveys.
3. We purposely have a strong dichotomy in environmental perceptions between the North and South though we realise that there is a continuum of consumer and social preferences. Social preferences refer to preferences for non-market goods promoted by environmental interest groups and adopted by policy makers in their policy decisions (see Hahn, 1990, for a similar understanding of preferences). Production externalities refer to the difference between the private and social costs of production; consumption externalities are external costs only arising with consumption, such as post-consumption or packaging waste.
4. Pigouvian taxes refer to taxes that correct for externalities by altering decisions of the economic agents which produce the externality. The tax alters relative prices faced by agents and induces them to modify their decisions. This idea of a government correcting for externalities by levying taxes is attributed to Arthur Pigou – hence the term Pigouvian. If the production of a good induces pollution the ranking of policy options is to first tax the effluent emission directly, next to tax the polluting input; third best would be to use an output tax and last to use a trade tax, say for an exportable commodity.
5. Trade sanctions are legitimate in a few cases in a first-best world: when trade is the source of externalities or in case of emergency trade measures (for example, imported health risk). These legitimate cases are internationally acknowledged: bans of trade in hazardous waste and other endangered species are allowed by the Basel Convention and by the Convention on International Trade in Endangered Species of wild fauna and flora (CITES).
6. The Polluter Pays Principle represents an allocation of property rights on the environment to consumers making polluters (producers) pay the difference between the social and private cost of production. This principle is widely adopted among OECD countries (OECD, 1975).
7. Natural resource-based problems are intricate combinations of property right issues and enforcement problems and designing institutional responses to these problems is a complex task. Bell (1990), and Binswanger ***et al.*** (1993) show that land tenure systems rely on sophisticated and multi-layered institutional structures (titling, cadastre, judicial system, colonial institutional legacy, etc.). This is equally the case with traditional shared resource systems in irrigation, forestry, and fishery (see, for example, Deacon, 1992). Integration of this body of work into the current trade and environ-

ment literature would lead to more robust and implementable rules and institutional standards.

8. Measures of cost of abatement in the South are rare. Khalid and Braden **(1993)** provide some cost estimates of environmental regulation in Malaysian agriculture (palm oil) and related industries. The cost is about 5 per cent of production value in processing and about **40** per cent for producers of fresh fruit bunches.
9. Using data form Martin *et al.* **(1991)** Dessus, Roland-Holst and van der Mensbrugghe **(1994)** obtain econometric estimates of effluent emissions per unit of intermediate inputs and for thirteen effluent types. These emission coefficients can be combined to input/output data to compute the pollution linked to economic activity in other countries.
10. Excludable means that the owner or user of the resource can exclude other potential users of the resource without incurring significant cost.
11. See Espinoza and Smith (forthcoming) for a first attempt.

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