Policy Research

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World Development Report

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Background paper for World Development Report 1992

Trade and the Environment

A Survey of the Literature

Judith M. Dean

At best, trade barriers are a second-best means of reducing environmental damage. Any case for more gradual liberalization of trade should be based on estimates of the costs of maintaining barriers versus the benefits of delayed environmental damage.

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This paper — a product of the Office of the Vice President, Development Economics — is one in a series of background papers prepared for the *World Development Report 1992*. The *Report*, on development and the environment, discusses the possible effects of the expected dramatic growth in the world's population, industrial output, use of energy, and demand for food. Copies of this and other *World Development Report* background papers are available free from the World Bank, 1818 H Street, NW, Washington, DC 20433. Please contact the *World Development Report* office, room T7-101, extension 31393 (August 1992, 27 pages).

The recent revitalization of concern for environmental quality has generated many questions about the interaction between trade and the environment. Most of these questions have to do with the impact of environmental regulation on trade patterns and gains from trade. If a tradeoff is perceived, it is often argued that some intervention becomes appropriate: either a specific trade policy or the establishment of an international environmental standard.

Present GATT policy then becomes an issue of debate. Should GATT revise its rules to accommodate the specific trade measures suggested? How can GATT ensure that the environmental objective is not a disguise for a trade barrier? Should GATT establish some international environmental standard with procedures to ensure compliance?

The importance given to trade liberalization and exchange rate policy reform as part of adjustment for development has raised another set of questions: Is there a direct link between the removal of trade barriers and environmental degradation? If so, how should liberalization strategies incorporate this cost? Should trade policy be used to meet environmental objectives?

Dean surveys the literature on the main questions being debated in both of these areas. Among her conclusions:

- More stringent regulations in one country are thought to result in reduced competitiveness and perhaps industrial flight and the development of pollution havens. The many empirical studies that have tried to test these hypotheses have shown no evidence to support them.

- Countervailing duties or an international environmental standard have no place here. Both concepts ignore the reallocation of resources that must occur if externalities are to be efficiently incorporated into costs. They also ignore the fact that standards should be based on local calculations of marginal costs and benefits. Only if an exporter's standards are below what is locally optimal would a countervailing duty be justified.

- Subsidies are likely to be trade barriers in disguise and should generally not be accommodated. They are not usually an efficient means of achieving an environmental objective and may hinder the efficient allocation of resources away from pollution-intensive industries.

- Imposing a tariff when pollution spills over national boundaries can be no more than a second-best policy. If the tariff is based on damage to the victim country alone, it will not reduce trade in the polluting product enough; if it maximizes the welfare of the victim, it may reduce trade in the product too much.

- There seems to be a case for establishing some international code of product standards, to prevent the use of such standards as nontariff barriers.

Trade and the Environment: A Survey of the Literature*

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Background Paper Prepared for the
World Development Report 1992

I gratefully acknowledge helpful comments from Sudhir Shetty and Andrew Steer. Special thanks go to Lara Akinbami for excellent research assistance.

The World Development Report 1992, "Development and the Environment," discusses the possible effects of the expected dramatic growth in the world's population, industrial output, use of energy, and demand for food. Under current practices, the result could be appalling environmental conditions in both urban and rural areas. The World Development Report presents an alternative, albeit more difficult, path - one that, if taken, would allow future generations to witness improved environmental conditions accompanied by rapid economic development and the virtual eradication of widespread poverty. Choosing this path will require that both industrial and developing countries seize the current moment of opportunity to reform policies, institutions, and aid programs. A two-fold strategy is required.

• First, take advantage of the positive links between economic efficiency, income growth, and protection of the environment. This calls for accelerating programs for reducing poverty, removing distortions that encourage the economically inefficient and environmentally damaging use of natural resources, clarifying property rights, expanding programs for education (especially for girls), family planning services, sanitation and clean water, and agricultural extension, credit and research.

• Second, break the negative links between economic activity and the environment. Certain targeted measures, described in the Report, can bring dramatic improvements in environmental quality at modest cost in investment and economic efficiency. To implement them will require overcoming the power of vested interests, building strong institutions, improving knowledge, encouraging participatory decisionmaking, and building a partnership of cooperation between industrial and developing countries.

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I. INTRODUCTION AND OVERVIEW

The recent revitalization of concern for environmental quality has generated many questions regarding the interaction between trade and the environment. Most of these questions relate to the impact of environmental regulations on trade patterns and gains from trade. If a trade-off is perceived, it is often argued that some intervention becomes appropriate: either a specific trade policy measure or the establishment of an international environmental standard. Present GATT policy then becomes an issue of debate. Should GATT revise its rules to accommodate the specific trade measures suggested? How can GATT ensure that the environmental objective is not a guise for a trade barrier? Should GATT establish some international environmental standard with procedures to ensure compliance?

The importance given to trade liberalization and exchange rate policy reform as part of adjustment for development has raised another set of questions. Is there a direct link between removal of trade barriers and environmental degradation? If so, how should liberalization strategies incorporate this cost? Should trade policy be used to meet environmental objectives?

This paper surveys the existing literature on the major questions being debated in both these areas. The remainder of this section presents an overview of the main points of debate.

Inter-Country Differences in Environmental Regulation of Production Pollution

Will a country with stricter environmental regulations regarding production of a good lose comparative advantage in that good? Will this lead to relocation of "dirty industries"--particularly to developing countries? If so, should an international set of environmental regulations regarding production be established to avoid such a shift in trade patterns? Alternatively, should GATT allow countries to apply countervailing duties to lower cost imports from countries with more lenient restrictions? Should GATT allow subsidization of environmental control costs so that more strictly regulated firms do not lose comparative advantage? Are domestic subsidies to meet environmental objectives allowable, or do they generate an unfair advantage in trade?

Transnational Pollution

Some production generates pollution which crosses national boundaries, e.g., acid rain. Should trade barriers be used to reduce the level of global emissions? Should trade barriers be used as a threat to coerce countries to comply to an internationally agreed upon emissions target? If so, how must GATT revise its rules to accommodate this? Will different abatement strategies imply large changes in trade patterns or the gains from trade?

Product Standards as Non-Tariff Barriers

Will a country with relatively strict standards for product quality/safety be perceived as using that standard as a trade barrier? Should GATT require its signatories to comply to an international standard for products in order to eliminate the possibility of implicit barriers? Would this not imply that countries with relatively strict standards would be forced to lower their standards to a global common denominator?

Trade in Hazardous Substances

Should countries be able to export domestically prohibited goods, or goods which are severely restricted in the home market? Or, should the exporting countries' product standard be imposed on the importing country?

Reform of Trade and Exchange Rate Policy: The Implications for Natural Resource Use and Environmental Degradation

Will devaluation of currency and removal of trade barriers encourage growth in developing country export sectors at the cost of overuse of natural resources? I.e., will such liberalization encourage a type of development which is not sustainable? Will forests be depleted too rapidly? Will soil be depleted due to increased production or shifts to more environmentally damaging crops? If so, should trade policy reforms be revised to incorporate these costs?

II. ENVIRONMENTAL REGULATION AND COMPARATIVE ADVANTAGE

As long as damage to the environment is not internalized appropriately into the costs of production, a non-optimal allocation of resources exists. In an open economy, this means that the pattern of trade is also likely to be non-optimal. How, then, should trade patterns be altered to reflect the opportunity cost of environmental damage?

In theoretical trade literature the environment is most often treated as a "third" factor of production (in addition to the standard labor and capital in the 2x2 model). A country is thought to have an environmental abundance if it has a relatively large assimilative capacity--i.e., a relatively greater ability to tolerate (absorb) pollutants. As Blackhurst (1977) points out, assimilative capacity is influenced not only by the physical ability of water, air, and land to absorb waste, but by the level of pollutants the society is willing to tolerate.

Several studies have analyzed the theoretical impact of environmental policy on standard results in trade. See, for example, Siebert (1977, 1985), Pethig (1976), McGuire (1982), Baumol and Oates (1988), and Blackhurst (1977). Siebert (1985) summarizes the main results of many of these studies regarding the impact of environmental policy on comparative advantage.

Assuming that countries have identical production, pollution and abatement functions for a particular good, then in free trade, one would expect the country with relatively larger assimilative capacity to specialize more in the pollution-intensive good. I.e., it is assumed that in autarky, the country richly endowed with assimilative capacity will have a price advantage in the pollution-intensive good. However, as long as the costs of pollution are not internalized, the price advantage is overstated. There is too much specialization in this good.

Unilateral imposition of environmental regulations by the environmentally rich country will impose environmental control costs (ECC) on its producers, thus eroding their price advantage relative to the foreign country. This will reduce the location disadvantage of the environmentally scarce country. We should, therefore, expect a shift in specialization, where the environmentally scarce country increases production of the pollution-intensive good.

Unilateral regulations not only change the pattern of trade, but increase pollution in the other country--even when no transnational pollution exists ("pollute thy neighbor via trade").

Siebert discusses unilateral policy only. Suppose, however, that both countries adopt optimal environmental regulation, such that production costs now include the true costs of pollution. Then, one would expect world output of the pollution-intensive good to fall. However, one would still expect the environmentally rich country to retain its comparative advantage in the production of the pollution-intensive good. Optimal regulation of pollution in both countries should alter the pattern of trade to reflect the relative assimilative capacities of the trading partners. It is unclear, then, whether unilateral restrictions move the pattern of trade closer to the optimum pattern.

III. THE IMPACT OF INTER-COUNTRY DIFFERENCES IN ENVIRONMENTAL REGULATION OF PRODUCTION POLLUTION

From this brief summary of the theoretical literature, there appears to be grounds for concern that countries with more stringent environmental regulations could experience loss in comparative advantage in affected sectors. It is also clear that some shifting of resources out of the pollution-intensive sector is desirable, to the extent that present trade patterns do not accurately reflect relative assimilative capacities. Part A examines the extent to which trade patterns have been influenced by inter-country differences in regulations. Part B examines the degree to which whole industries have relocated to countries with more lenient regulations. In particular, is there evidence that developing countries are becoming havens for pollution-intensive industries? Finally, part C analyzes the appropriate policy response to these shifts in comparative advantage. Specifically, should the attainment of environmental objectives justify the use of countervailing duties, subsidies, or a harmonized system of international standards?

A. Loss of Competitiveness

Numerous studies have tried to estimate the impact of ECC on industry price and output,

and on the trade balance. See for example: D'Arge (1974), OECD (1978), Magee and Ford (1972), Pasurka (1985), Mutti and Richardson (1976, 1977), Walter (1973), Ugelow (1982), US DOC (1975), Yezer and Philipson (1974), Chapman (1991), Robison (1988), Tobey (1990). The methodologies are quite varied, making comparisons between studies difficult. However, some generalizations can be drawn. First, estimates of total ECC by industry tend to be very low--abatement costs are a very small portion of industry costs on average. Second, reductions in output caused by ECC are also small and insignificant on average, although they can be significant for some individual sectors. Third, there is little evidence of any significant impact of ECC on the pattern of trade. This section will briefly review several early studies, and then turn to two more recent works, Robison (1988) and Tobey (1990).

In one of the earliest studies, Walter (1973) investigates the pollution content of US trade. If export goods are relatively pollution-intensive compared to import goods, then US environmental regulations are likely to discourage the export sector. Walter calculates direct ECC and overall ECC (direct and indirect) for 83 goods and services in the US. ECC is defined to include: current R&D expenditure for compliance, depreciation on existing pollution abatement equipment, the capital cost of that equipment, and current operation costs associated with environmental management. The data are from the late 1960s; a 1966 I-O table is used.

Average annual overall ECC for US exports is found to be 1.75% of the value of US exports for 1968-70. Since foreign ECC costs are unavailable, US import-competing sectors' ECC are used to calculate the average annual overall ECC of US imports. This is 1.52% of the value of US imports. Walter considers this difference insignificant, and concludes that ECC are trade neutral at best and marginally damaging to US export industries at worst. Weighting overall ECC for an industry by its importance in trade, Walter anticipates that some individual industries might be vulnerable to loss of competitiveness--e.g., construction and mining, plastics. No attempt is made to measure the magnitude of such a loss, however.

Both the US DOC (1975) and Yezer and Philipson (1974) studies (as summarized by Ugelow (1982)) look at the effects of ECC on output in a limited number of industries. The US DOC examined the impact of ECC for water pollution control on copper smelting, aluminum, wood pulp, and phosphate fertilizer. They concluded that short-term effects would be more than masked by other factors affecting the state of the economy. No changes in trade patterns in

these sectors were observed. Yezer and Philipson found that the percentage decrease in output attributable to ECC (direct and indirect) for 14 industrial sectors averaged less than 1% (with the exception of petroleum). Ugelow suggests that this underestimates the impact on output, since it only includes incremental costs attributable to federal legislation.

The OECD (1978) study also takes account of inter-industry linkages in calculating ECC effects on output in Japan, the Netherlands, Italy, and the US. Ugelow summarizes the overall results as follows. The increase in prices due to ECC is not terribly significant, but is sufficient to trigger some reduction in output and exports.

Richardson and Mutti (1976) present a general equilibrium analysis. They estimate domestic and import market demand and supply equations for 81 industries, with varying assumptions about domestic elasticity of supply. Again an input-output matrix is used to calculate both direct and indirect ECC. The impact of these ECC on price and output is evaluated under three scenarios: the "polluter-pays-principle," full subsidization of ECC through a VAT; full subsidization of ECC by a production tax. The three methods of financing do not yield significant differences in outcomes overall. However, subsidization implies that displacement costs are spread more evenly across industries. With subsidization, the range of change in price and output is 1%-1.5% (rise and fall, respectively). Under the polluter-pays-principle this range increases to up to 5%. The individual industries found most susceptible are: livestock, chemicals, plastic, paints, petrol refining, non-ferrous metal manufacturing, and utilities.

Richardson and Mutti stress that one cannot assess the trade impact of ECC until one can account for: inter-country differences in controls; financing of controls; inter-country differences in macro policy; and exchange rate flexibility. Not surprisingly, in their 1977 study, these authors try to account for some of these other variables. Four schemata for estimating effects of unilateral controls are compared: a partial equilibrium approach which calculates direct ECC only and uses elasticities to estimate output effects; the use of I-O matrices to capture both direct and indirect cost increases due to environmental regulations; a "macro-orthodox" approach which incorporates feedback on industry output through changes in exchange rates, in domestic income, in demand both at home and abroad due to exchange rate changes, and assumes full pass-through of ECC to prices; a "classical general equilibrium" approach in which

domestic elasticity of supply is not infinite, ECC is not fully passed through to prices, and income and exchange rate changes are not included.

A comparison of the first two approaches reveals that the partial equilibrium method tends to underestimate output effects by 50% compared to approaches which use I-O matrices to account for inter-industry linkages. Inclusion of general equilibrium refinements, as in the latter two approaches, yields displacement costs which are 30% lower and more smoothly spread across firms than those found in the second approach (assuming ECC are subsidized by a VAT tax). This suggests that feedback through other economic variables tends to mitigate the already relatively small impact of ECC on industrial output.

Robison's work (1988) is important for several reasons. First, it updates the study by Walter (1973) on the pollution content of US trade. Estimates are made for 1973, 1977, and 1982, using I-O tables for 1973 and 1977. Secondly, Robison presents estimates of the impact of a 1% increase in ECC on the trade balance. He purposely does not include the general equilibrium refinements discussed by Richardson and Mutti (1977), and purposely assumes full pass-through of ECC to prices. In this way he hopes to generate upper-bound estimates of trade impacts.

In calculating the pollution content of US trade, Robison must again assume that US ECC for import-competing industries are equivalent to actual ECC for US imports. Results indicate that the ratio of abatement content of US imports to US exports has risen from 1.151 to 1.389 between 1973 and 1982. Robison concludes that US comparative advantage has shifted away from goods which in the US have high abatement costs. When the same calculation is done for US trade with Canada, Robison finds no change in this ratio. He hypothesizes that this might be due to similar ECC in the two countries.

Robison constructs the following hypothetical scenario: an increase in abatement costs raises the sectoral price by 1%. For 78 sectors (both manufacturing and non-manufacturing), he calculates the impact on the 1977 sectoral trade balance of this change in relative price (including both direct and indirect effects). The impacts on total US sectoral trade (value) range from -0.12% (special industry machinery) to -7.08% (copper) for merchandise sectors, with an average impact of -2.69%. Omitting all mitigating general equilibrium effects which might come from exchange rate or income changes, the aggregate effect on the US trade balance is calculated. It is not clear what method of aggregation is used here. For 1977, the net reduction

is 0.67% of the value of US total trade. Robison argues that marginal changes in abatement costs will affect the US balance of trade. However, his figures suggest that the impact would be quite small overall.

Tobey (1990) takes a completely different approach to testing whether or not ECC have any impact on US comparative advantage. Following earlier work on shifting patterns of trade by Leamer (1984) and Bowen (1983), he employs a cross-section "Heckscher-Ohlin-Vanek" (HOV) model. Beginning with 64 agricultural and manufacturing industries, Tobey calculates the total ECC as a percentage of total costs of production. "Pollution-intensive" industries are those whose ECC/TC exceeds 1.85%--24 industries. Even for these industries, the range is 1.92%-2.89%. These sectors are aggregated into five groups: mining, primary nonferrous metals, paper and pulp, primary iron and steel, and chemicals. For each of these five groups, net exports are regressed on US endowments of 11 resources (labor, land, capital, natural resources).

In this type of model, one would include a measure of environmental endowment, to ascertain whether or not environmentally rich countries export more of the pollution-intensive good. Clearly, environmental endowment is difficult to measure. Tobey, however, is interested in the effect of ECC on trade patterns. His first test, therefore, involves including a dummy variable for ECC stringency as an additional explanatory variable. Presumably, in an HOV model of this type, Tobey is implicitly assuming that more stringent ECC are correlated with environmental scarcity. Thus the dummy variable should have a negative coefficient. In addition to problems with measuring stringency, this taxonomy ignores the fact that countries may be presently pursuing non-optimal environmental regulation. In that case stringency is a poor indicator of environmental endowment. If the stringency dummy is correlated with ECC, then this may still be a good test of whether relatively high ECC tends to decrease net exports. Tobey finds no significant impact of stringency of ECC on trade patterns.

Tobey's second test is an omitted variable test. If ECC do have an impact on net exports, then countries with stringent regulations (DCs) should have a negative expected sign in the error term, while the opposite is true for countries with lenient regulations (LDCs). The null hypothesis is that there will be no difference in the expected signs of the error terms. Tobey finds that the null hypothesis cannot be rejected.

It has been suggested in a recent work by Chapman (1991) that ECC have been highly

underestimated, because, among other things, they have not included workplace health and safety protection costs. There may be room for more work along the lines of Robison and Tobey, but with better estimates of the actual costs imposed on industries due to environmental regulation. However, it is unclear that this would yield a significant impact on trade patterns, unless it implied radically larger ECC across all regulated industries.

B. Relocation of Industry to "Pollution Havens"

Another fear which has been voiced is that relatively low environmental standards in developing countries compared to industrialized nations will lead "dirty" industries to shift operations to these LDCs (the industrial flight hypothesis). In addition, LDCs may purposely undervalue the environment in order to attract new investment (the pollution haven hypothesis). Both phenomena could lead to non-optimal (excessive) pollution in LDCs.

As has been argued above, some shift in the production of pollution-intensive goods is optimal, since countries possess different assimilative capacities to absorb pollutants (i.e., different environmental endowments). However, as Pearson (1987) points out, there is no a priori reason to believe that increased output in the environmentally abundant country will be captured by multinationals as opposed to domestic firms. There is also no a priori reason to believe that LDCs are relatively environmentally abundant compared to DCs.

Pearson notes that empirical investigations of this issue must contend with the following difficulties: there is no unambiguous definition of ECC; any observed change in FDI is influenced by many other economic variables other than ECC; no good data on foreign ECC exist, rendering it impossible to really calculate the impact of differentials in ECC.

Walter (1982) looks at trends in foreign direct investment by firms from W. Europe, Japan, and the US from approximately 1970 to 1978. He examines trends in FDI both in terms of industry mix and destination. Although there exists a large amount of overseas production in pollution-intensive industries, there is little evidence that it has been influenced by differing ECC. Examination of trends in foreign FDI into the US also supports this conclusion. There is no evidence that foreign FDI is shifting towards states with more lenient standards.

Pearson (1987) surveys several studies, all of which tend to support the conclusion that there is little evidence of industrial flight to developing countries. Results from three of these are discussed below. Pearson (1976) estimates the increase in exports in 18 manufacturing

sectors which LDCs might expect to gain as a result of differentials in ECC. That is, what are the potential gains from maintaining lower environmental standards? His results for 1973-77 and 1978-82 indicate that LDCs might see an increase over existing levels of export revenues of between 2.1% and 4.6%. He considers this small relative to the 8% annual growth which took place during the period.

Duerksen and Leonard (1980) examine trade and investment data to determine if ECC differentials have led to industrial flight toward LDCs. Among their results are: host countries which received the most overseas investment in pollution-intensive chemicals, paper, metals, and petroleum refining were other industrial countries (not LDCs); the percent of US FDI in pollution-intensive industries in LDCs compared to DCs did not increase significantly over time. They conclude that there is no evidence of widespread relocation of US industries to pollution havens. A study by Knodgen (1979) of W. German FDI also supports this conclusion.

Leonard (1988) presents case studies of FDI in Ireland, Spain, Mexico, and Romania. He argues that the industrial flight and pollution haven hypotheses are based on too static an idea of comparative advantage. His approach to the determination of comparative advantage and therefore industrial location incorporates theoretical work on: the product cycle, the existence of foreign direct investment, industrial location decisions by firms, bargaining processes between multinationals and host countries, and development strategies. Examining aggregate trade and investment statistics, Leonard sees no evidence of large-scale industrial flight as a response to US environmental regulations. In the four countries studied, government officials appeared to behave in conformance with the pollution-haven hypothesis in the 1970s. However, the savings realized from the absence of pollution controls were not substantial enough to alter the locational preferences of multinational firms. Other factors, such as the level of training of labor, infrastructure and stability were much more important in location decisions. In addition, growing concern by these countries for the environment has influenced the bargaining process with multinationals. Leonard argues that these countries could not be called pollution havens in any sense today.

C. Policy Responses to Loss of Competitiveness

In 1972, OECD countries agreed to a "polluter-pays-principle" (PPP) regarding the financing of ECC. Presumably this was to facilitate the efficient allocation of resources through

internalizing negative externalities. As argued above, this theoretically implies a loss in comparative advantage in pollution-intensive sectors for the country with relatively high ECC. Empirically, at least some sectors may see significant loss in competitiveness. One proposal has been to subsidize ECC so that industries in countries with "high standards" will not experience this loss in comparative advantage. (Despite the PPP scheme, OECD countries have indeed implemented numerous subsidies to cover ECC.) This would imply that GATT would need to distinguish subsidies for attainment of environmental goals, from other subsidies which ostensibly give firms an "unfair" advantage in trade.

The study of Richardson and Mutti (1977) provides some evidence on this issue. They compare the impact upon US industry output of ECC under the PPP and under a scheme where ECC are subsidized. The subsidy is paid for by levying an identical tax on the value-added of each industry. In several of the models they consider, Richardson and Mutti find that the subsidization scheme makes the distribution of environmental control displacement across industries more equal, as compared to the PPP results. That is, the subsidy scheme reduces the relative disincentives facing industries most severely impacted by ECC.

Government subsidies which compensate firms for the cost of meeting regulations inhibit the optimal shift of resources away from pollution-intensive industries. Thus, on the basis of economic efficiency, there does not seem to be any reason to allow the avoidance of loss of comparative advantage through use of subsidies to meet ECC. In addition, the economic literature on pollution has long argued that tax schemes or marketable permits are usually a more efficient method of internalizing pollution costs than subsidies. This suggests that subsidies used to attain environmental goals are likely to be guises for avoiding losses in competitiveness, and should not be allowed by GATT.

Another popular policy proposal is to allow countries to levy countervailing duties against imported products whose cost advantage is derived from relatively more lenient environmental standards. Pearson (1987) argues that such duties are not efficient for two reasons. First, it must be recognized that efficient environmental regulations in one country will differ from another precisely because of differences in marginal benefits and marginal costs of abatement (i.e., differences in assimilative capacity). These standards should be determined locally. Only if an exporter were to purposely set standards below what was locally optimal, could the ECC differential be viewed as a deliberate export subsidy. Second, existing estimates of ECC show

that they are quite small, and indicate that their impact on trade patterns is probably insignificant. Therefore, a tariff to adjust for ECC differentials appears unnecessary.

If there is any role for GATT here, it would be to attempt to discern if a country's environmental regulations were below those which are locally optimal. Only in such cases might a countervailing duty be justifiable.

Implicit in the argument for countervailing duties is the idea that the more lenient country has the wrong environmental standards. A third proposal is, therefore, that standards regarding production pollution be harmonized internationally. As Pearson (1987) argues, this proposal appears to be based on two misconceptions. First, international ambient, effluent, or emissions standards will not equalize ECC. Therefore, coun' .s which are environmentally scarce will find their ECC relatively high and will still experience loss in competitiveness. Second, equalizing pollution abatement costs (ECC) is inefficient. As argued above, ECC should reflect relative assimilative capacity. Thus we should expect both marginal benefits and costs of abatement to differ across countries. Equalizing standards or attempts to equalize abatement costs would interfere with efficient reallocation of pollution-intensive industries toward countries with relatively large environmental endowments.

IV. TRANSNATIONAL POLLUTION

There are two main issues which link transnational pollution to international trade, and hence to GATT. First, are trade barriers an appropriate way to regulate (and/or diminish) transnational pollution (e.g., acid rain)? If so, in what way must GATT rules be revised to allow for this? Second, how will domestic regulations to control transnational pollution affect trade patterns?

These issues also arose in the analysis of production pollution (above), where the damages from such pollution were within national boundaries. Do the answers change if the external costs generated by production cross national borders?

Baumol and Oates (1988) address the theoretical question of the optimal policy response to transnational externalities. They argue that an internationally optimal tax on emissions is required: one which is equal to the marginal damage generated in all countries taken together.

Given national sovereignty, however, this policy is unlikely to be implemented. Consider countries A, B, and C, where A is the polluter, and B and C are the victims of transnational pollution. A may establish an emissions tax based on marginal cost/benefit calculations within its own borders. B and C might impose tariffs equal to the marginal damage suffered by their own nationals. The prices and allocation of resources which result will deviate from the optimal outcome. Prices in A are not directly affected by the tariffs of B and C. Therefore, prices in A will not fully reflect the social costs of A's production. Similarly, the duties set in B and C will not account for the full social cost of their consumption. In all countries, prices for the polluting good will be too low relative to the outcome with the internationally optimal tax. Baumol and Oates conclude that there is no set of tariffs capable of sustaining the Pareto optimum which would be yielded by the optimal tax.

However, they then go on to explore the role for tariffs as a second-best policy. Is there a case for unilateral tariffs against the polluting country? Baumol and Oates argue that there exists a "quasi-optimal" tariff, provided the importing country is the victim of the pollution and is large in world markets. This tariff is one which incorporates the costs of the damage in the victims' country into the victims' domestic price, and, therefore, lowers the world price of the polluting good. When transnational pollution exists, zero tariffs are not generally optimal. However, the tariff which would maximize the importing country's welfare (given its monopoly power) exceeds the quasi-optimal tariff. Therefore, the narrow interests of the victim country are likely to result in too high a tariff relative to the second-best policy.

Baumol and Oates conclude that, though clearly second-best, there may be a role for tariffs to move the global economy towards a "quasi-optimum," or to be used as a threat to achieve compliance to an internationally agreed upon target.

Merrifield (1989) considers the impact of unilateral action, such as a production tax or an abatement equipment standard in one country, on the level of transnational pollution, the terms of trade and factor rewards. He argues that unilateral action can succeed in reducing the level of emissions, but that free trade in goods and in capital could cause foreign emissions to rise sufficiently to increase the level of emissions on net.

Some interesting empirical work has begun on the impact of regulation of transnational pollution on trade patterns and the gains from trade. Whalley (1991) and Whalley and Wigle (1990), studying carbon taxes, suggest that interregional gains and losses between DCs, LDCs,

and oil exporters are highly sensitive to the type of tax implemented to reduce emissions, but are not insignificant in size. In light of the theoretical argument above, Whalley and Wigle's results regarding a global tax on production of greenhouse energy products are particularly interesting. They anticipate a terms of trade loss for the oil-exporting region, and an overall gain to the developing non-oil exporting nations if the tax revenues are redistributed proportionately to population.

V. PRODUCT STANDARDS AS NON-TARIFF BARRIERS

Environmentally related product standards (ERS) are applied to products for the purpose of preventing environmental deterioration, or protecting consumers from direct environmental contamination (Pearson 1982). Some common types of ERS relate to: motor vehicle emissions, food products, product radiation emissions, toxic substance controls, product noise, and packaging requirements. Again, the main issue linking ERS with trade is the issue of inter-country differences in standards. In the case of production pollution, the country with the more stringent regulations expected a deterioration in its comparative advantage in the regulated sectors. Here the opposite problem arises. The country with more stringent product regulations will find its competitive position enhanced, as imported goods which fail to meet the local standards are prohibited.

In this case, two issues arise. How can GATT ensure that ERS are not being used as a guise for inhibiting trade? Is there a case for an internationally harmonized standard? Two recent events illustrate the contentiousness of these issues. GATT has recently proposed a "Codex Alimentarius" which would internationally harmonize food product standards. Some US groups have asserted that the standards in the Codex are less stringent than FDA or EPA standards, and that the US should be free to adhere to its own standards without being accused of being protectionist. This past year, the US imposed a ban on export of unprocessed logs from US public lands in the Pacific Northwest. Japan contends that this export ban is a thinly disguised non-tariff barrier. The ban does not meet the environmental objective, since it does not apply to processed wood products. It will raise the price of unprocessed wood to Japan (the US is the largest timber supplier to Japan) and encourage ailing US wood processing industries.

A. ERS as Non-Tariff Barriers

There is virtually no literature which examines the conditions under which ERS can become NTBs, nor the extent to which such NTBs have affected trade patterns. An early study by Pearson (1982) on standards in fish and shellfish is a beginning. Pearson suggests three circumstances in which an ERS may intentionally or unintentionally become an NTB. First, an ERS may be deliberately used as a trade barrier. E.g., when imported goods are subject to different standards than domestic goods; when the standard does not meet the stated environmental objective. The costs of these barriers are familiar.

Second, inter-country differences in standards can become an NTB when the differences occur for no inherent reason. This is because they can cause foreign producers to incur extra costs compared to domestic sellers. An example would be the non-recognition of an equivalent foreign testing procedure for radiation or other emissions standards. The foreign exporter may incur: costs in acquiring information on differing standards; direct costs for adaptation of the product; loss in economies of scale due to shorter product runs to meet different export market standards. Such costs may be particularly acute for developing country sellers.

Finally, suppose the differing standards just described exist because of different social preferences--i.e., different assessments of the increase in welfare due to a more stringent standard. To evaluate whether this justifies a difference in standard between countries, one should compare the marginal costs of the more stringent standard with the marginal benefits. The assessment of costs should include the types of costs described above. In cases where marginal costs exceeded marginal benefits, the more stringent standard would not be justified, and would become an NTB.

B. Measuring the Impact on Trade

No literature exists in this area either. Conventional assessment of NTBs seeks to translate them into tariff-equivalents. Along these lines, Pearson makes two suggestions. One could measure the additional costs incurred by the exporter to comply with different standards. One could also measure the number and/or value of shipments denied entry due to failure to meet standards. Pearson measures the value of imports detained in fish, shellfish, fruits, and vegetables. He finds that food ERS have a modest impact on trade, but can be significant for individual commodities.

C. Policy Response

Unlike the case of producer pollution, there seem to be strong arguments for harmonization of product standards to avoid protectionism and to reduce the costs described above. The only case in which different standards appear to be economically legitimate are those in which the marginal benefits of incrementally more stringent standards exceed the cost of such standards.

The types of NTBs described in part A suggest certain policy responses to determine if the ERS is a disguise for protectionism. First, determine if imports are being subject to the same standard as domestic goods. Second, evaluate whether the ERS meets the environmental objective (the Japanese dispute with log exports), and in particular whether it meets it in a least-cost way. Third, determine if differences in national standards are arbitrary. This is a particularly difficult question, since it requires countries to agree on safe levels of emissions of radiation, air pollution from cars, etc. On these issues the scientific community is not in agreement (the food standards debate). However, more stringent ERS should not be accepted without weighing the costs of such a policy. It appears that public debate has focussed solely on marginal benefits without assessing marginal cost. Unlike the case of production pollution, it appears that implementation of harmonized product standards may be efficient, if more stringent regulations exist for no inherent reason, or if the marginal costs of more stringent regulations exceed the marginal benefits.

VI. TRADE IN HAZARDOUS SUBSTANCES

Trade in hazardous substances is related to the issue of product standards discussed in part V. In this case, the question is whether the domestic environmental standards of the exporting country should be imposed on the importing country. E.g., if use of a pesticide is prohibited in country A, should country A be allowed to export the product to country B?

Anecdotal evidence of potential or actual damage due to export of goods which are domestically prohibited or severely restricted abounds (Scherr, 1987). Most of the cases cited

concern exports of pesticides, pharmaceuticals, consumer goods and food, and hazardous waste. Studies by Scherr (1987) and Azevedo (1982) survey the evolution of US regulation of such trade. The main issues in the US involve notice of exportation of such goods, prior informed consent of the importing country, explicit bans on drugs which are domestically prohibited, and procedures for alerting importing nations of the export of hazardous substances.

In 1989 GATT established a Working Group on Exports of Domestically Prohibited Goods and Other Hazardous Substances. Broadly speaking, its task is to examine the trade-related aspects of this issue not adequately addressed by other institutions. Sankey (1989) surveys the activity of seven other international bodies in attempting to regulate this trade: UNEP, FAO, WHO, ILO, UN Secretariat, UNCTC, OECD. The main concern of these bodies has been to provide information on domestically prohibited goods (DPG) and hazardous substances, and to establish procedures whereby export notification is given in the exporting country, and time and information is given for the importing country to make an informed decision to import or not.

The most active of these has been the UNEP. In 1975 it established an International Register of Potentially Toxic Chemicals. In 1987 it adopted the London Guidelines for Exchange of Information on Chemicals in International Trade. Under these guidelines, 74 countries agreed to notify each other whenever they banned or severely restricted a chemical. The guidelines also provided for exporters to notify importing countries of impending exportation of DPG. UNEP has also developed procedures whereby export of hazardous substances could only occur after informed consent of the importing country. In 1989 UNEP also adopted the Basel Convention on Transboundary Movements of Hazardous Wastes. This extensive measure requires, among other things, States Parties to notify the convention secretariat of movement of hazardous waste and sets up procedures of verification and settlement of disputes. Also in 1989, under UNEP auspices the Montreal Protocol of Substances that Deplete the Ozone Layer was established. It came into force in 1989, ratified by 36 countries and the EC. This requires participating states to reduce consumption and production of such substances. It also prohibits export of controlled substances to non-party states, and the importation of such substances from non-party states.

Efforts to provide exchange of information have also been established by the FAO regarding pesticides, the WHO regarding pharmaceuticals and chemical safety, the ILO

regarding occupational safety, and the UN Secretariat. Under the WHO pharmaceutical products certification scheme, the importing country may require the exporter to provide certification of authorization of sale, and certification of compliance with WHO production standards.

In 1984 the OECD adopted guiding principles on export of prohibited chemicals. It recommends that exporting countries give necessary information to enable importers to make informed decisions regarding importation of such products.

The main issue now is whether GATT should introduce its own restriction on such trade and if so, how. In particular, should exports only be permitted after importing countries have given official prior informed consent? Given the arguments in the previous section, it appears that inter-country differences in standards for these products (assuming access to full information regarding the degree of hazard involved) would only be justified if marginal benefits from less stringent standards outweighed marginal costs.

VII. REFORM OF TRADE AND EXCHANGE RATE POLICY: THE IMPLICATIONS FOR NATURAL RESOURCE USE AND ENVIRONMENTAL DEGRADATION

The recent emphasis on reform of trade and exchange rate policy as a means to further development has provoked questions concerning the environmental impact of such reforms. At the center of the debate is whether or not these reforms will lead to a non-optimal rate of depletion of natural resources and increased environmental degradation--i.e., a type of development which is not sustainable. For example, devaluation and/or removal of trade barriers will likely increase output of agricultural exports. Would this imply too rapid a rate of depletion of forests or soil? Would this lead to overcultivation of land? Would this shift production to crops which are more damaging to the environment?

Virtually no analytical work exists in this area. This is not surprising, for two reasons. First, trade liberalization, devaluation, and accompanying policies such as fiscal and monetary austerity, elimination of government marketing boards in agriculture, and other policies will undoubtedly have some impact on the use of natural resources and the extent of environmental degradation. However, the type of impact is not predictable a priori. Second, even if one were able to predict that certain trade reforms would increase the export of, say, a natural resource,

this would not imply that the reform should not be made. The problems of optimal resource use and optimal rate of degradation lie in appropriately determining the shadow prices of resources, and internalizing externalities. These are domestic problems. Although certain trade policies may help achieve such a domestic objective, they are at best, second-best methods of doing so. Most studies which discuss the issue recognize this: Pearce and Turner (1990), Warford (1989), Barrett (1990), Muzondo (1990), Markandya and Richardson (1990).

Markandya and Richardson (1990) provides a detailed examination of the way in which specific liberalization policies might be expected to affect the environment. Devaluation should increase the producer price for export goods and for import-competing goods, and cause substitution away from imported products. To the extent that this causes a rise in the output of export crops, it may imply increased land clearing (increased deforestation) or more intensive use of existing lands. It may also imply changes in the use of fertilizers, pesticides, and the choice of crop. There may be an increase in the rate of soil erosion or increase in the incentive to invest in land improving equipment or techniques. The reaction of the farmer is likely to be heavily influenced by the land tenure system, as this influences the degree to which changes in price incentives actually affect production decisions.

Markandya and Richardson anticipate that removal of tariffs and quantitative restrictions give rise to the same potential impacts as a devaluation, across a more limited number of products. This is also the case for increases in official producer prices of agricultural products. Simultaneous removal of subsidies on agricultural inputs could result in a number of outcomes. Removal of pesticide subsidies, for example, could imply use of more traditional methods which are less environmentally damaging. However, to the degree that they are less effective, productivity falls. To counteract this, farmers may cultivate land more intensively.

Barrett (1990) actually attempts to analyze how farmers' decisions regarding soil conservation will be affected by liberalization policy. He focusses on the following debate. Suppose particular liberalization policies lead to a rise in farm producer prices. Will this lead farmers to deplete the soil less, because they have financial incentive to invest in conservational farming techniques or equipment? Or will this lead to farmers "mining the soil" for a quick return on larger crop yields now? (The phrase is borrowed from Lipton.) Barrett proposes the following maximization problem for the farmer: choose a soil erosion program to maximize the present value of a stream of future profits, discounted at market interest rates. He then

considers the reaction of the farmer to an unanticipated permanent increase in the price of his crop.

The results are provocative. For example, Barrett argues that such a price increase will have no impact on the farmer's choice of optimal soil conservation. This is because the rise in price raises, equally, the benefits to more soil erosion now, and the benefits to adopting more conservation now. He finds that the same result holds for the impact of the price rise on the length of the fallow period. The only way the price increase will have an impact is through its effect on the farmer's decision to employ non-soil inputs. A third result regards fertilizer usage--used to mitigate erosion-induced productivity loss. Here he finds that the optimal conservation decision remains unaffected as long as the technical rate of substitution between soil loss due to cultivation and soil depth is independent of the use of non-soil inputs. If this independence does not exist, then the conservation decision will be affected. However, the direction of the effect is impossible to determine without specific information on the production function.

Barrett concludes that a rise in producer prices could improve, worsen, or have no impact on soil depletion--that it depends upon the technical details of the agriculture production function. He also stresses that the concern should not be whether or not policy reforms conserve or do not conserve soil. Rather they should be: to correctly estimate the shadow price of soil use, given that erosion can cause harm downstream; and to incorporate this externality correctly into the farmers' decision process.

Another interesting conclusion can be drawn from Barrett's work. Reform of land tenure systems and access to rural credit markets may be a more appropriate focus for the achieving of appropriate levels of soil erosion. This is because Barrett does show that higher discount rates will lower the optimal level of soil depth in the steady state. To the extent that sharecropping arrangements and very high interest rates from moneylenders produce a very high discount rate for peasant farmers, these would tend to contribute to higher than optimal rates of soil depletion.

In a recent study on industrialized country trade policies and natural resources, Dunmore and Langley (1988) propose that the link between trade policy and demand for agricultural commodities must first be estimated. Then, the resulting adjustments in agricultural production must be assessed: changes in types of crops planted, production techniques, relative amounts of inputs used. Specific assessment of these adjustments should allow for estimates of the derived demand for natural resources use and value, and consequently, for the potential

additional damage or benefit to the environment. As Barrett's work shows, there is considerable uncertainty as to the adjustments in agriculture which would result from a change in trade or exchange rate policy, as well as their impact on the environment.

The discussion thus far has ignored the non-agricultural sectors of the economy. Removal of overvalued exchange rates (as a means of subsidizing capital inputs), tariffs, and quantitative restrictions is likely to imply reduced incentives to the previously protected import-competing sector. The shrinking of some industries in this sector may imply reductions in certain types of environmental damage. Certainly this must also be weighed in assessing the overall impact of liberalization on the health of the environment.

The study of the links between trade liberalization and environmental damage will be valuable if it pinpoints specific external costs which will be aggravated by liberalization. This may be useful in determining the optimal domestic policy (or policies) to reduce the environmental damage to the appropriate level. It may also indicate necessary reforms in land tenure and credit availability (particularly rural credit) which will be critical in efficiently internalizing the costs of these externalities. However, as trade barriers are an inefficient means of achieving a domestic goal, it is doubtful that such a study would lend support to limitation of liberalization due to its environmental impact. A case for more gradual removal of barriers would need to be based on estimates of the welfare costs of maintaining trade restrictions vs. the gains from delaying environmental damage.

VIII. CONCLUSION

This paper has reviewed the existing literature on the impact of environmental regulation on trade, and the impact of trade policy on the environment. What are the conclusions which can be drawn regarding changes in trade policy and GATT, in light of concern for the environment? On what issues does further work appear necessary?

Inter-Country Differences in Environmental Regulation of Production Pollution

More stringent regulations in one country are thought to result in loss of competitiveness,

and perhaps industrial flight and the development of pollution havens. The many empirical studies which have attempted to test these hypotheses have shown no evidence to support them. There may be room here for better estimates of actual environmental control costs incurred by firms, and estimates by industry of actual losses in output due to these costs. It is doubtful that this would yield a significant impact on trade patterns. However, it might provide useful information on individual sectors where adjustment may be significant.

There is no role here for countervailing duties or an international environmental standard. Both concepts ignore the necessary reallocation of resources that must occur if externalities are to be efficiently incorporated into costs. Both also ignore the fact that standards should be based on local calculations of marginal costs and benefits. Only if an exporter's standards are below what is locally optimal, could a countervailing duty be justified.

Subsidies are likely to be guises for trade barriers, and should in general not be accommodated. They are usually not an efficient means of achieving an environmental objective. In addition, they may hinder the efficient reallocation of resources away from pollution-intensive industries.

Transnational Pollution

When pollution spills over national boundaries, there may be a role for tariffs to move the global economy towards an optimal allocation of resources. However, the tariff will at best be second-best. If it is based on damage to the victim country alone, it will not reduce trade in the polluting product enough. If the tariff is one which maximizes the welfare of the victim, it may reduce trade in the product by too much.

Empirical work thus far suggests that unilateral domestic policy may be ineffective at reducing global emissions, and that a type of global tax may have significant effects on trade patterns. Further empirical work on the effectiveness of various policies and their implications for trade patterns would be useful.

Product Standards as Non-Tariff Barriers

Unlike the case of production pollution, more stringent regulations here are likely to

result in gains in competitiveness for domestic industry, as the regulation becomes a barrier to trade. Again, unlike the case of production pollution, there appears to be a case for establishing some international code of product standards, to prevent the use of standards as NTBs. This would require discerning whether a standard meets the objective, and whether differences in standards exist for no inherent reason. If disagreement exists in the scientific community over the additional benefits of more stringent standards, it is important to weigh these against the additional costs they generate. This suggests the importance of more empirical work assessing the restrictive impact ("tariff-equivalent") of more stringent regulations on trade in the affected products.

Trade in Hazardous Substances

Many international institutions have set up guidelines for their members to follow regarding export of these products. Particular emphasis has been placed on informed consent on the part of the importing nation. To the extent that this is simply a special case of the debate on differences in product standards, the suggestions in the preceding section should apply here as well.

Reform of Trade and Exchange Rate Policy: the Implications for Natural Resource Use and Environmental Degradation

Little work has been done to assess the impact of liberalization policies on the environment, largely because the links are indirect and the outcomes in many cases ambiguous. Furthermore, trade barriers will be, at best, a second-best means of reducing environmental damage. However, empirical work linking changes in trade and exchange rate policy to the environment would be useful to: pinpoint the environmental damage likely to be aggravated by the policy change; perhaps speed up the process of implementing an efficient domestic policy to incorporate this damage into production costs; and illuminate other areas where policy change may be required to effectively reduce damage, such as land tenure and rural credit systems. Any case for more gradual liberalization of policy would need to be based on estimates of the costs of maintaining barriers versus the benefits of delayed environmental damage.

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