Environment and Trade: A Review of Theory and Issues

Xing, Yuqing and Kolstad, Charles

University of California Santa Barbara

23 January 1996

Environment and Trade:
A Review of Theory and Issues

By

Yuqing Xing

and

Charles D. Kolstad*

January 23, 1996

Abstract

This paper illustrates the major issues influencing interaction between environmental regulation and international trade by reviewing the empirical studies and theoretical results of the last 20 years. The second section of the paper discusses how environmental regulation distorts comparative advantage and specialization. The third part covers the impact of environmental regulation on the location of polluting industries. The fourth part covers transnational pollution and trade in wastes. The fifth section discusses major conflicts between trade policy and environmental policy. The final part addresses strategic environmental policy and international trade.

*Graduate School of International Relations, International University of Japan, Niigata, Japan and Department of Economics, University of California, Santa Barbara, CA 93106-9210, respectively. Please direct correspondence to the second author. This work was supported in part by U.S. AID cooperative agreement DHR-5555-A-00-1086 through the Midwest Universities Consortium for International Activities (MUCIA). Editorial assistance from Holly Korab, Sharon Graham and Ellen Maurer is gratefully acknowledged. This paper was prepared in large part during 1992-3. It is thus current as of that date.

I. Introduction

Governments have used trade policies to enforce multinational environmental treaties. Two such treaties are the Montreal Protocol on Substances that Deplete the Ozone Layer (1987) and the Basel Convention on the Control of Transboundary Movement of Hazardous Wastes and Their Disposal (1991). Similarly, individual nations have tried to enforce their environmental standards using trade sanctions such as the U.S. embargo on tuna products from Mexico. Recently, conventional economists have challenged such practices saying that they impede free trade and violate the General Agreement on Tariffs and Trade (GATT). These economists argue that trade measures are inefficient polices for preserving the environment. Some free trade proponents criticize domestic environmental standards as non-tariff barriers and label the environment as the last refuge of protectionism.

Some firms and industries consider stringent environmental regulations a threat to their international competitiveness because the environmental regulations cause a significant increase in production costs. A common theory is that polluting industries located in the countries with tight environmental regulations are economically disadvantaged compared to industries in countries with lenient environmental regulations.

On the contrary, environmental groups often raise concerns over the possible adverse environmental impact of trade liberalization. They fear that a more integrated world economy (as represented by the European Union, the North American Free Trade Agreement (NAFTA), or the World Trade Organization) will hasten the exhaustion of natural resources, increase pollution around the world, and encourage ecological dumping in developing countries. Some cite the experience of the Maquiladora Sector, an export-oriented manufacturing zone of Mexico, as proof of the danger of free trade to environmental protection. Environmentalists argue that without traditional trade policies, fierce international competition may force governments to relax strict environmental regulations. This will lead to lowered environmental standards that are common across nations.

In the case of transboundary pollution, the free movement of capital will not only damage the economy, but also undermine the environment of the countries from which capital flows. Environmentalists favor trade measures for enforcing environmental regulations. They actively lobby legislatures to incorporate environmental policies into trade agreements. In the future, conflict between trade policy and environmental policy will intensify.

The trade and the environment dilemma is another collision between economic growth and environmental preservation in an open economy. Because resources are scarce, it is hard for economists to find ways to promote trade while adequately protecting the environment.

This paper illustrates the major issues influencing interaction between environmental regulation and international trade by reviewing the empirical studies and theoretical results of the last 20 years. The second section of the paper discusses how environmental regulation distorts comparative advantage and specialization. The third part covers the impact of environmental regulation on the location of polluting industries. The fourth part covers transnational pollution and trade in wastes. The fifth section discusses major conflicts between trade policy and environmental policy. The final part addresses strategic environmental policy and international trade.

II. Distortion of Comparative Advantage and Specialization

As early as 1972, the United States Congress expressed its concern over the potential impact of domestic and foreign environmental programs on the comparative advantage of U.S. manufacturing industries. Section 6 of the 1972 Amendments to the Federal Water Pollution Control Act requires the United States Commerce Department to investigate the issue. During the 1970s, 10 empirical studies examined the effects of environmental regulation on international trade (Ugelow 1982). The most recent economic recession and a

persistent trade deficit led some policymakers and industry lobbyists to argue that stringent environmental policy has hurt the competitiveness of U.S. industries. They argue that costly environmental regulations cause American manufacturers to face unfair competition in the world market. A coalition of business people and conservative economists suggests that the United States relax or abolish environmental regulation. Anxiety over the negative effects of environmental policy on the comparative advantage is more intense than ever.

According to the international trade theory, technology and factor endowment (endowment of basic inputs to production) are the sources for comparative advantage. Differential availability of technology can give a comparative advantage to a country and persuade that country to specialize in a given industry because the costs of the associated technology are low. Economists call this viewpoint Ricardo's theorem. We can contrast it with the Heckscher-Ohlin theorem, which states that when technology is constant across countries, comparative advantage and the pattern of trade will depend on factor endowment. A country will have a production advantage if it has abundant resources. Obviously, strict environmental regulations imply higher pollution disposal costs and lower natural capacity to assimilate pollution.

In 1991 the total pollution abatement capital expenditure (PACE) of all U.S. industries was $101.7 billions, 7.5% of their total capital expenditure. For some polluting industries, the share of abatement expenditures in total capital expenditure is much higher. In particular, the PACE of the U.S. chemical industry in 1991 was $2.1 billion, 12.9% of the total industry capital expenditure. For the U.S petroleum industry, the PACE was $1.5 billion, or 24.8% of its total capital expenditure, in 1991 (Jaffe et al, 1995).

Intuitively, if strict environmental regulation increases costs, any comparative advantage from a less costly technology will lessen. In the classic Ricardian model with a continuum of commodities (Dornbusch, Fisher, and Samuelson 1977), a tiny cost increase in a country will cause that country to lose an industry. Readers can

find rigorous theoretical statements about the impact of environmental regulation on comparative advantage in Siebert (1974, 1977), Pethig (1976), McGuire (1982), Baumol and Oates (1989), Carraro and Siniscalco (1992), and Krutilla (1991).

According to classic Ricardian theory, trade patterns and comparative advantages between two countries are determined by the relative prices of the commodities traded between the countries. It also says price differences are due to technology differences. If a country imposes environmental regulations that require regulated industries to pay environmental costs, then the price ratio of the commodities produced by pollution intensive industries may change.

Siebert (1977) constructs a two-commodity open economy model with one nontraded resource as input. In the model, pollution is a byproduct of production. Siebert conducts comparative static analysis on relative commodity prices as a function of pollutant emissions. He suggests that the Environmental Protection Agency should collect effluent charges and enforce external environmental regulation. Industries absorb the environmental costs by paying effluent charges. The constraints of environmental standards determine the best way to use resources. Siebert concludes that relative commodity prices depend not only on an industry's marginal productivity but also on its tendency to pollute, the social damage it sustains, and unit effluent fees.

All these factors determine comparative advantage in terms of environmental abundance or scarcity. Holding other variables constant, the price ratio of more polluting products to less polluting products is an increasing function of the shadow price of the assimilative capacity if the first good is produced less efficiently than the latter. Because an abundant assimilative capacity implies a lower shadow price, the country that has more of a particular environmental resource has a comparative advantage. It can produce more pollution-intensive products and will export pollution-intensive commodities.

Baumol and Oates (1989) presented similar conclusions. In their model, two countries produce an identical traded commodity. The production processes in both countries generate pollution. Under partial equilibrium conditions, Baumol and Oates argue that if a country does not develop an environmental protection program when other countries do, that country will increase its comparative advantage or decrease its comparative disadvantage in the pollution-intensive industry. It will then specialize in that industry at the cost of environmental damage.

Instead of emission fees, some environmental regulations require a technology standard. Carraro and Siniscalco (1992) analyze how the new technologies required by some environmental policies affect the competitiveness of pollution-intensive industries. They consider a polluting industry in an open economy where domestic firms produce only one commodity and compete in the international market. Capital goods and technology are not traded. The authors assume that before the home country imposes mandatory technology standards for reducing emissions, the industry freely trades the product in the world market and all countries have identical technology. Technological innovation increases the marginal cost of the product. Under different market structures--perfect competition, Bertrand oligopoly, Cournot oligopoly -- they examine how the industry's profit changes after the home country imposes unilateral pollution control. Carraro and Siniscalco conclude that in the presence of international competition, the technical changes required by environmental laws will distort the industry's competitiveness causing it to lose profits. They suggest a government subsidy is the best way to compensate for the loss of competitiveness. The optimal subsidy depends on the market structure and abatement costs.

These theoretical arguments only focus on the efficiency losses from trade. They ignore the improvement in environmental quality. In other words, there is no overall measure of gains from trade and improvement in

environmental quality. Siebert (1977) discusses the interaction between trade gains and environmental regulation. He studies a small country with two production sectors engaged in international trade. Initially, this country has a comparative advantage in producing a pollution-intensive product. Siebert finds that if the country exports pollution-intensive commodities but does not enact environmental regulations, its trade gains are partly offset by environment degradation. Also, the welfare loss from environmental damage may outweigh the gains from trade, under certain conditions. If the government imposes environmental regulation, environmental quality will improve, but trade will suffer. On the other hand, with the introduction of environmental policy, industry reallocates resources. Resources for polluting industries will decline and exports will fall. In addition, the environmental policy will cause an overall gain in welfare if the marginal social costs of producing the commodity are higher than the marginal value of consuming the commodity.

As illustrated above, in a two-country open economy, difference in the strictness of environmental regulation may affect the trade pattern and competitiveness of regulated firms. What are the trade effects if the two countries have the same level of strictness but use different environmental policy instruments? Sartzetakis and Constantatos (1994) analyze the case with an international oligopolistic model. In the model, the authors assume that the two countries--the south country and north country have the same emission ceiling but impose different policy instruments to reach their objective. In the south country, the government adopts a tradeable emission permits system. The north country government employs a command and control approach which requires its firms to reduce their emission by a given level. Their polluting firms conduct Cournot competition in the international market. The authors show that at the Cournot-Nash equilibrium, the firms regulated by the tradable emission permit have a larger market share than the firms regulated by the command and control method. The advantage of the market-based instrument becomes greater as the diversity of the abatement technology within the country increases. This is because the market-based instrument system reduces the average pollution abatement costs through permit trading.

In addition to regulatory instruments, policymakers use well-defined property rights as an alternative policy to prevent environmental deterioration. Chichilnisky (1994) uses a north-south trade model to illustrate the interaction between international trade and property rights. The north-south trade model is similar to the classic Heckscher-Ohlin model except that the availability of environmental resources, or production inputs, are price-dependent. In the model, the two regions have identical technologies, resources, and preferences. They only differ in the property rights laws that apply to environmental resources. Environmental resources are unregulated common property in the south but private property in the north. Chichilnisky shows that under common property rights more resources are supplied at any given price. This conveys "apparent comparative advantage" to the south though it has no advantage over the north. Chichilnisky argues that free trade between the two regions increases overuse of environmental resources, resulting from ill-defined property rights in the south. Free trade also transmits the resource misallocation to the north as the prices of the traded goods and factors equalize. More importantly, Chichilnisky shows that under the common property program, tax on the use of environmental resources may increase their use. She suggests that property rights may be more effective in preventing over-extraction of environmental resources in an open economy.

The debate on the impact of environmental regulation on comparative advantage has generated many empirical studies. Because there is no widely accepted indicator to measure this impact, the empirical studies have used different approaches. Most analyses are on the micro-level focusing on individual industries. The Organization for Economic Cooperation and Development (OECD) case studies of Italy, the Netherlands, Japan, and the United States are macro-level evaluations of environmental policy (OECD, 1978). Ugelow (1982) reviews 10 empirical studies through the 1970s on the costs of environmental regulation and its effect on international trade. Ugelow reports that there is no consistent conclusion on the issues. Findings from the U.S. Commerce Department (1975) based on the performance of four individual industries indicate that

environmental programs have only a slight impact on short term trade patterns and the comparative advantage of the United States. Studies by Walter (1982) and Robinson (1988), however, suggest that the impact can be substantial. Also, they find their influence on a country's balance of trade insignificant. Walter and Robinson's conclusions are supported by the OECD's macro-evaluation. Even though it is difficult to compare these diverse studies, it seems that the impact of environmental regulations on international trade is less than expected.

To explore the empirical evidence regarding the impact of environmental regulations on U.S. international trade, Pasurka (1985) examines the change in the United States' "effective protection rate" due to environmental control costs. The effective protection rate is a partial equilibrium measure of the protection that an industry receives from the country's tariff structure. Calculating the value-added for an industry with and without tariff protection, the effective protection rate is the difference in the value added of output in the industry in the two cases, normalized by the value-added in the industry with no tariff protection. Pasurka finds that only direct environmental costs influence the effective protection rate. He also finds that environmental control costs reduce the effective protection rate by only 20%. Using 1971 data, Walter (1982) finds that the loss is 27% of the protection rate.

Robinson (1988) uses two measures to examine the impact of environmental regulation on international trade. First, he uses time series data on the ratio of imported and exported abatement cost content per dollar of product value to identify changes in trade patterns and comparative advantage. The abatement content per dollar of sales is the share of pollution abatement and control costs per dollar of product value (Walter, 1982). The statistical results show that the ratio rose from 1.17 to 1.39% between 1973 and 1982. This suggests that the pollution control content of goods imported to the United States increased at a higher rate than did the control content of exported goods. In other words, imports have higher abatement cost content than do

exports. Robinson asserts that environmental regulation reduced the United States' manufacturing comparative advantage in pollution-intensive industries and caused a shift in trade patterns towards importing pollution-intensive commodities.

In the second approach, Robinson applies a partial equilibrium method to find the marginal effect of abatement costs on the trade balance for individual polluting industries. Instead of considering aggregate trade, he develops a country trade balance equation with 78 agricultural and manufacturing sectors. Assuming that the full costs of environmental regulation are incorporated into the price of the final products, he concludes that the marginal effect of abatement costs on international trade depends on price elasticities of export and import quantities and on relative prices.

For those sectors Robinson considered, the marginal effect of stricter environmental regulation on exports is negative except for the mining industry. Robinson calculates that if the abatement costs drive up price by 1%, the trade balance of the selected agricultural products will decline $245 million. Of that amount $95.8 million is caused by reduced agricultural exports and increased agricultural imports. Robinson attributes the reminder to the indirect effect of agricultural prices on other sectors. In addition, if the marginal effect of abatement cost on the balance of individual industries is measured by the percentage of total trade value of the industry, the impact ranges from -0.12 (special industrial machinery) to -7.08 (copper).

Robinson's statistical results imply that environmental policy has a significant influence on the balance of trade if environmental costs are fully reflected in commodity prices. However, Robinson's model is unclear about how pollution abatement and control costs could drive up prices by 1%. In addition, if monopoly power exists in the market, the assertion that pollution abatement and control costs would translate into price on a one-to-one basis is questionable.

One of the most recent empirical studies on trade and the environment is by Toby (1990). His method is completely different from the others. He uses a Hecksher-Ohlin-Vanek (HOV) model of international trade to test the hypothesis that the strictness of environmental regulations is linearly related to the exports of polluting industries. In his study, Toby defines a dirty industry as one in which total pollution abatement and control costs are equal to or higher than 1.85% of production costs. By this standard, Toby selects all the dirty industries from 64 standard agricultural and manufacturing sectors, including paper and pulp products, ore mining, primary iron and steel, primary nonferrous metals, and chemicals. He develops two different approaches from the extended HOV model.

First, Toby introduces into the model a numerical scale to indicate the strictness of environmental regulation. The scale ranges from one to seven, with seven standing for the strictest regulation. Toby regresses the exports of dirty industries on eleven factor endowments and the strictness indicator with cross-section data from 23 countries. The statistical results do not support the hypothesis of a significant linear relationship between the stringency of environmental regulations and the exports of the dirty industries.

The second approach is an omitted variable test. If environmental regulation is one of the explanatory variables determining exports from polluting industries, and if it has a negative impact, then the model will be incorrect when the environmental variable is omitted. An incorrect model must be biased. The residual of the model should be negative for developed countries but positive for developing countries if the impact of the environmental program is negative. At least, the proportion of negative residuals in the former should be higher than in the latter. By examining the residuals, with no assumed distribution of the residual, Toby concludes that the impact of domestic environmental regulations on the export of polluting industries is not significant.

There appears to be some inconsistencies between the theoretical findings and the results of empirical studies. All theoretical arguments suggest that environmental regulations could create distortions in comparative advantage and specialization in dirty industries. However, some empirical studies, such as those by Toby (1990), OECD (1978) and the U.S Department of Commerce (1975), do not support the theoretical assessment that environmental regulations affect trade. For the empirical studies that reveal substantial evidence in favor of the theoretical arguments, the results are less than expected. This leaves room for further research.

III. Relocation of "Dirty Industry"

Besides the static effect of environmental regulation on comparative advantage, environmental regulations may have a dynamic influence on capital flows in an open economy, particularly on the relocation of pollution-intensive industries. Some observers argue that strict environmental policies in one country may cause dirty industries to migrate to countries with more lenient environmental regulations. This claim is referred to as the Industry Flight Hypothesis. The prediction is based on three arguments.

First, all environmental regulations, no matter how efficient, will drive up the production costs in pollution-intensive industries, either directly or indirectly. Second, stringent environmental regulations make it difficult for polluting industries to find proper sites for new investment. Finally, some regulations have a direct effect on the range of products or the inputs of production, which may cause producers to seek sites outside their original area. A dual theory about the impact of environmental policy on capital movement is the Pollution Haven Hypothesis. It states that developing countries may set lenient or moderate environmental regulations as a strategy to lure industrial investment.

Extensive industrial migration to foreign countries can cause unemployment, undermine the balance of trade, and threaten national security. Thus, industry flight is not only an economic issue, but also a political one. Moreover, free trade agreements, which may improve the mobility of capital, are thought to speed the trend.

Some environmental groups and labor unions, for example, have used these hypotheses to argue against the North America Free Trade Agreement (NAFTA). They predicated that once NAFTA is in effect, dirty industries will head to Mexico to exploit that pollution haven.

McGuire (1982) presents a theoretical analysis of the movement of capital across boundaries resulting from environmental regulation. Based on a Heckscher-Ohlin-Vanek model with two factors and two countries, McGuire introduces an environmental factor as a new input of labor-intensive industry *x*, assumed to be a pollution-generating industry. He measures the environmental regulation by the Marginal Productivity of Environment Factor (MPEF). MPEF is a variable determined by the public. If MPEF is equal to zero, it indicates there are no pollution regulations. McGuire infers that environmental regulation's impact on industry *x* is equivalent to negative neutral technical progress. In other words, for the same bundle of labor and capital inputs, output is lower when the industry must comply with environmental regulation. Therefore, if the price ratio of the commodities is constant, the resource will be reallocated between two industries so that the rent to capital will rise and be higher than in the foreign country. And, the real wage rate at the home country will be lower than in the foreign country. Thus, under free mobility of capital and labor as well as constant relative prices, labor will move out of the home country and capital will flow in.

According to the Rybczynski theorem (Rybczynski, 1995), the regulated industry will diminish until production of *x* reaches zero. Therefore, in an open economy, the polluting industry of the home country will move to the foreign country with lenient environmental regulation. Rauscher (1993) reached a similar conclusion.

Markusen, Morey and Olewiler (1993) developed a two-country and two-firm model to illustrate the impact of environmental regulation on polluting firms' decisions about where to locate. In their model, the firms are able

to enter or exit a country and to change the number and locations of their factories in response to the environmental policies of the countries. Under the assumed environmental policies--emission taxes--their best decision is a two-stage solution.

In the first stage, the two firms choose the number and locations of their factories. In stage two, the firms play Cournot game to determine their output in the market. Markusen, Morey and Olewiler conclude that if a nation imposes unilateral pollution tax, the number of factories will decrease and firms will leave when the tax exceeds a certain point. In addition, because the number and locations of the factories are the internal variables in the model, the best environmental policy will differ significantly from those suggested by the convention Pigouvian marginal analysis in which market structure is influenced by outside factors. Markusen, Morey and Olewiler emphasize that, if a nation ignores the internal influence in determining an "optimal" emission tax the welfare losses caused by its unilateral emission tax is greater than expected.

The industry flight hypothesis has generated several empirical studies. Among them are Walter (1982), Leonard and Duerksen (1980), Pearson (1987), Leonard (1988), Lucas, Wheeler and Hettige (1992) as well as Low and Yeates (1992). Walter (1982) investigates two levels. For evidence at the level of polluting industries to support this hypothesis, Walter surveys three categories of data:

(1) the closing rate of factories when it is related to environmental regulations,
(2) the cost to multinational corporations to comply with environmental regulations, both domestically and abroad, and
(3) foreign investment in polluting industries.

None of these measures suggest a significant relationship between the location of pollution-intensive industries

and environmental regulation. At the corporate level, interviews with executives do not support the hypothesis that environment regulation is a key factor in their decisions about factory locations.

Low and Yeates (1992) discuss the redistribution of polluting industries worldwide with two indicators. Those are the share of polluting industry's export in total world export and the Revealed Comparative Advantage (RCA) of an industry. A country's RCA is defined as the ratio of that industry's share in the country's export to the industry's share in the total manufacturing export. If a country's RCA for an industry is greater than 1, the country has an advantage in the industry. Defining a set of polluting industries, Low and Yeates find these industries' share of export declined from 18.9% to 15.7% between 1965 and 1988. For all industrialized countries, the share of these industries relative to all exports also decreased, from 20.4% in 1966 to 15.9% in 1988.

Obviously, polluting industries have lessened around the world. The RCA indices representing the iron and steel pipes and tubes industry for 109 countries are calculated for two different periods: 1966 to 1968 and 1986 to 1988. From 1966 to 1968, only 11% of the sampled countries had RCA greater than 1. Although the percentage rose to 22% from 1986 to 1988, most of this increase occurred in developing countries. Among the developing countries, the countries with RCA greater than 1 doubled from 6 to 12 between 1986 and 1988. Against a background of polluting industries' declining share, especially in industrialized countries, Low and Yeates conclude that it is likely the environmental regulation of industrialized countries caused polluting industries to move from developed to developing countries.

Lucas, Wheeler, and Hettige's (1992) empirical studies test three hypotheses that describe the relationship between economic growth and air pollution. One hypothesis is that the OECD's environmental policies drive dirty industries to developing countries. The authors test this hypothesis using two regression models. First, they follow backward the toxin emission density on the gross domestic product (GDP) per capita and the time

trend. Second, they do the same with the growth rate of toxin density on the growth rate of GDP per capital and economic structure, which is represented by the Dollar Index[1]. Results for both estimates suggest that the poorest countries have the highest growth rate of polluting industries. However, these estimates are insufficient to infer a causal relationship between environmental regulation and displacement of polluting industries. They reveal, however, that economic growth has a significantly smaller effect on pollution in open economies than closed economies. Even though the authors do not connect their findings with the industry flight hypothesis, their empirical results contradict it. If polluting industries are migrating enmass to developing countries, then developing countries with open economies should experience a rapid increase of polluting industries. This is not happening.

Leonard and Duerksen (1980) analyze the investment and trade data to track the relationship between environmental regulation and the migration of pollution-intensive industries. Their statistical results reveal that the growth of U.S. investment in developing countries did not exceed the entire overseas investment growth rate. In fact, the gap between U.S. investment in developing countries versus developed countries widened for some polluting industries, such as chemical industries. Their analysis of relevant trade data for the United States and the United Kingdom (1971 to 1976) suggests that imports of pollution-intensive products have not grown faster than other categories of imports. Although they would have if polluting industries were fleeing these industrialized countries while demand for the pollution-intensive products remained the same. The share of imported pollution-intensive products from developing countries increased slightly, but the total numbers do not indicate a significant shift of import orientation to pollution-intensive products.

To examine whether NAFTA would strengthen the incentive for the U.S industries to establish a "pollution haven" in Mexico, Grossman and Krueger (1992) econometrically evaluate the explanatory power of the

[1]The Dollar index is the ratio of domestic prices to world prices and is a measure of the openness of an economy.

pollution abatement costs of the U.S. industries compared to the pattern of the U.S-Mexico trade. They consider three different trade patterns:

(1) the pattern of total U.S imports from Mexico,
(2) the pattern of U.S imports from Mexico hat have entered the country under the offshore assembly provisions, and
(3) the sectoral pattern of value added by maquiladora plants (see page 2).

Besides the pollution abatement costs, Grossman and Krueger include factor shares and the U.S effective tariff rate as additional explanatory variables for trade patterns. The statistical results indicate that the pollution abatement cost is not a significant explanatory variable. This implies that Mexico's lenient environmental policy has no significant role in motivating trade and investment flows between the two countries. Additionally, the authors use a computable general equilibrium model to predict the change of the industrial structure under NAFTA in U.S., Canada and Mexico. Contrary to the environmentalists' claim that Mexico would specialize in pollution-intensive industries with trade liberalization, the model indicates that Mexico's labor intensive industries, which are relative clean, would significantly expand. On the other hand, both the US and Canada show substantial increases in polluting industries such as chemicals and metals.

The studies mentioned previously cover the international marketplace. Alternatively, McConnell and Schwab (1990), and Bartik (1988) conduct some empirical studies focusing on the variation of the U.S. domestic environmental regulations among the states. During 1970s, water and air regulations differed among the states. Bartik uses a location decision model (McFadden condition logit model) to examine how this disparity affected the locations of new factories opened by the fortune 500 companies from 1972 to 1978. He applied the state spending on pollution control, pollution compliance costs of regulated industries, and the permitted

pounds of particulates as quantitative proxies of the air and water regulation of each individual state. Bartik's statistical results show that none of the environmental regulations significantly influenced location decisions.

McConnell and Schwab (1990) used the identical location model to test the relationship between the location of the vehicle industry and a states environmental regulations. Their tests did not concur with the industry flight hypothesis.

In fact, the reasons determining the location of an industry are many, including the ability to have access to resources, accessibility to markets, transportation costs, political stability, and labor supply. The decision on where to invest is complicated, and most of the factors have little to do with the environment. Undoubtedly, more and more investors will consider the environmental factor. But perhaps that is not happening yet, which is why authors have been unable to find significant evidence to confirm the industry flight hypothesis.

Leonard (1988) believes the conclusion of relocation based on comparative advantage is too static and narrow. He argues for a more comprehensive analysis that considers product cycle, industry location theories, bargaining processes, and political issues.

Pearson (1987) identifies three pitfalls in the empirical studies on the pollution haven and industry flight hypotheses:

(1) there is no clear definition of environmental costs,
(2) the data are incomplete, and
(3) the authorities of pollution havens will not admit that the real motivation of foreign investment is to escape strict environmental regulation.

None of the empirical studies found convincing evidence that pollution-intensive industries have relocated their facilities to developing countries because of strict domestic environment policy. However, we cannot ignore that the percentage of capital expenditure on pollution abatement and control for Multinational Enterprises (MNE) is generally higher in home countries than in overseas subsidiaries (Ugelow, 1982).

In Walters' (1982) investigation of domestic and overseas pollution costs for five major U.S industries between 1970 and 1980, almost all their overseas subsidiaries had lower pollution abatement and control costs than did their subsidiaries in the United States. Because an MNE has more experience in overseas investment and can easily transfer production facilities to developing countries, we cannot exclude the possibility that the MNE will move its facilities to a developing country if all factors influencing the location decision are the same except environmental regulations.

IV. Transnational Pollution and Trade

Transnational pollution is a complicated problem. To understand its relationship with international trade, we must resolve two questions. First, is trade policy a useful instrument for reducing transnational pollution? And second, does free trade increase transnational pollution? Before we examine these questions closely, it is necessary to clarify some related concepts.

Usually transnational pollution is classified into two types that differ according to the pollutant's characteristics and the way in which the pollution is transmitted from one country to another. The first type of transnational pollution is a pure externality. The pollutant is transmitted via air, rivers, lakes, and precipitation. Examples are acid rain and carbon dioxide emissions. Generally, the externality is undepletable.

The second type of transnational pollution is the trade in wastes, including hazardous and nonhazardous solid wastes. The wastes are shipped from the generating country to another country which disposes of the wastes. In this case, pollution is no longer an externality because the process is governed by bilateral agreement. The exporting country must be able to free itself from the wastes or the waste disposal process. This requires that all the wastes involved in the transaction be depletable.

A. Transnational Pollution as an Externality

As transnational pollution crosses boundaries the country receiving the pollution cannot impose effluent taxes on the other country to control the pollution. In addition, there is no international institution to enforce a Pigouvian tax to improve global welfare. Thus, environmental economists consider trade policy a possible approach to control transnational pollution.

Baumol and Oates (1989) present some theoretical analysis of tariffs as instruments to reduce transnational pollution. If one country exports goods that caused transnational pollution during the manufacture process, the importing country can tax those imports to pay for the pollution damage. Baumol and Oates conclude that, in general, tariffs cannot reach a Pareto Optimum, which would be yielded by the internationally Pigouvian tax on emissions. Here, the international Pigouvian tax is defined as the total marginal damage over all the countries that are victims of the externality. In the presence of transnational pollution, zero tariff levels are not the best solution for the country importing the pollution-related commodities. If the social costs of transnational pollution fall entirely on the importing country, this creates an international quasi-optimal tariff, lower than the one by which the importing country could maximize its social welfare alone. It is possible that the unilateral tariff applied for environmental purposes is larger than the second best tariff. The negative effect of such a

policy is that it may result in trade friction. Even so, Baumol and Oates argue that a pollution tariff could threaten to force polluting countries to negotiate.

As mentioned in Baumol and Oates (1989), the international pigouvian tax (IPT) is the best policy to control transnational pollution. However there are many reasons why policymakers cannot effectively implement IPT. According to conventional wisdom, the reluctance of polluting countries is the major obstacle to such a tax because many presume that polluting countries would be worse off under that ruling. Kohn (1991) challenges this argument. He tests the welfare effect of IPT using the framework of the Heckscher-Ohlin-Samuelson model. Contrary to traditional thinking, Kohn shows that polluting countries would benefit from an IPT, however, countries that pollute less would suffer losses. The intuitive explanation of the finding is straightforward. The IPT will increase the price of pollution-intensive goods, and the polluting country will export the product. So, the polluting country would benefit from the IPT program but a less polluting country would suffer from higher prices.

With a simple graphical illustration, Snape (1989) suggests that the best policy for the victim of transnational pollution is a consumption tax. In his model, country A produces goods *X,* which generates pollution. Country *B* does not produce *X* and is the only consumer. Snape discusses the effect of three different polices towards the externalities associated with producing *X* in country *A* if all pollution falls in country *B:*

(1) country *A* levies a tax on its production,

(2) an international authority collects either a production tax or a consumption tax, and

(3) country *B* levies a tax on its consumption.

The welfare of country *B* is worse under the first two policies compared with the no-regulation situation. Only

when country *B* collects a consumption tax will welfare improve. In Snape's model, the consumption tax is the same as the import tariff on goods*X*.

Using a simulation model to explore the effect of a tariff as an instrument for environmental control, Low (1992) finds interesting empirical evidence. He assumes NAFTA will remove all tariffs on Mexican exports. Instead, the United States imposes Pollution Abatement and Control Expenditure (PACE) tariffs on all products from Mexico's polluting industries. The PACE is equal to the marginal cost of U.S. levels of environmental protection. Using these assumptions, he tests the effect of PACE on Mexican exports to United States. The results show that the impact is modest. The quantity of Mexican exports to the United States declines by no more than 2%. This implies that the tariff does not change the behavior of dirty Mexican industries. Therefore, it is not effective in attaining environmental goals. Low's simulation is an empirical evaluation on using a general tariff for environmental purposes and not of an optimal tariff designed for transnational pollution. So, we can use it as an empirical reference for examining the effect of a tariff on transnational pollution.

First, concerning efficiency, the tariff rate against transnational pollution cannot exceed the PACE because it is equal to (or less than) the marginal damage of pollution by PACE's definition. Second, the U.S. taxes all dirty industries in Mexico. This implies that industries responsible for transnational pollution are also objects of PACE tariffs. Therefore, Low's simulation infers that the tariff instrument for environment purpose is not as effective as expected.

We must note that trade policy as an instrument to control transnational pollution has one limitation. It needs to be based on the flow of commodities. We must measure the tariff against transnational pollution by the marginal damage of pollution. Many empirical studies show that pollution abatement costs are a small

proportion of production costs and may affect trade policy on transnational pollution only slightly. Is it possible to increase the tariff for environmental purposes? Probably not, since it is not efficient to levy a tariff higher than marginal damage from pollution. Furthermore, the tariff itself contradicts the spirit of GATT, promoting free trade. In fact, industries may criticize a tariff for environmental purposes as a trade barrier.

In another study about transnational pollution and trade Merrifield (1988) uses a general equilibrium model to analyze transnational pollution, particularly transnational pollution between the United States and Canada. Merrifield considers a trade system consisting of two countries, *A* and *B*. Country *A* produces commodity *X*. Country *B* produces goods *Y*. Inputs are capital and labor, which can move freely between the two countries. Producing *X* and *Y* will create pollution, which can flow from one country to the other. The countries implement pollution abatement standards using non-traded intermediate goods. Assuming free mobility of commodities, capital and labor between the countries, Merrifield concludes that only tight pollution abatement standards can reduce transnational pollution. The potential result of a unilateral tax policy is unclear. It may increase the volume of emissions.

For example, if the density of emissions per capita in industry *X* is higher than in industry *Y* of country *B,* and country *B* levies a tax on production of *X,* then capital of industry *Y* will migrate to industry *X* in country *A*. The additional capital will generate more emissions than it did in industry *Y*. So, the total emissions will increase. If both countries simultaneously impose a tax on production, the pollution deposited in the two countries will be the same as before. In Merrifield's models, the assumption that only two sectors exist in the economy restricts resource reallocation. To maintain the full use of resources, they have to be used either by industries *X* and *Y* or by pollution abatement.

Rauscher (1993), in his recent study, specifies that a nation may reduce its environmental quality if it

unilaterally imposes strict environmental regulation. Those theoretic evaluations imply that a unilateral approach may be ineffective and counter-productive in an open economy with free capital mobility.

B. Transnational Pollution by Wastes Trade

Trade in hazardous and nonhazardous waste is a recent phenomenon. Since 1986, Western Europe and North America have exported more than three million tons of wastes. At least 73 less industrialized countries are the proposed dumpsites for wastes from industrialized countries (Greenpeace, 1989). According a statement made by the Environment Protection Agency (EPA) to the U.S. Congress (Hajost, 1989), EPA received only 12 applications in 1980 to exports hazardous wastes. However, applications rose to 588 in 1989. Actually, there is no regulation governing non-hazardous solid wastes exported from the United States. Several years ago there was a proposal to export 34 billion pounds of domestic municipal wastes over a five year period (Greenpeace, 1989).

Historically, industrialized nations, such as the United States and Canada conducted trade in wastes among themselves. Now, less developed countries are becoming dumping sites for the garbage of developed countries. Klatte's (1980) data show that among 46 actual and proposed shipments of wastes, all the destinations are developing countries except Canada, while all the exporters are industrialized countries.

There are two contradictory opinions about the regulation of the waste trade. Most industrialized countries prefer to free such trade. On the other hand, the active environmental groups European Environment Entente and Greenpeace want a ban on the trade. In addition, some African countries criticized the waste trade as "toxic terrorism." So far, 45 developing countries have banned waste imports (Greenpeace, 1989). At the

same time, the number of countries that may become potential markets for wastes is increasing. For example, the Eastern European countries and former Soviet republics are preparing to enter this market (Conyers, 1989). Recently, the United Nations Environment Program sponsored an international treaty in an attempt to control hazardous waste trade. It is called the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal. The treaty, however has had the opposite effect. By persuading more than 30 countries to sign the treaty, the United Nations has, in effect, legalized the trade in hazardous wastes.

The gain from trade is a strong motivation for both countries to engage in such garbage trade. The increasing cost of disposing of wastes has increased the pressure on manufacturers to find overseas sites for their wastes. It is cheaper and easier to dump the wastes in developing countries. In the United States, the average cost of disposing of hazardous waste was $15 per ton in 1980. But it soared to $200 per ton in 1987 (Poter, 1986). For example, the cost of shipping wastes from Philadelphia to Africa for disposal was $20 per ton compared with $50 per ton if the wastes are disposed of locally (Dufour and Denis, 1988).

Increasing disposal costs is only one of the reasons producers are seeking to landfill abroad. Stricter environmental regulations in developed countries has caused assimilative capacity in industrialized countries to become more and more scarce. In the United States alone, with tighter regulations being introduced in 1984, two-thirds of existing landfills are no longer able to accept hazardous wastes (Uva and Bloom, 1991). Increasing waste and insufficient processing facilities also contribute to the trend of dumping waste in developing countries. The European Union generates about 30 to 40 million tons of hazardous wastes per year, but can process only 10 million tons (Uva and Bloom, 1991).

On the importing side, less developed countries receive foreign currency as payment for disposing of wastes. These countries, many of which are deeply in debt, desperately need the income from such trade. In 1988,

Guinea-Bissau signed a contract to accept 3.5 million tons of hazardous wastes for $140 million. This amount is greater than its gross national product (Dufour and Denis, 1988).

In some deals, the importing countries' benefits lie beyond cash. Bangladesh, Paraguay, Haiti, Angola, Tunisia, Sierra Leone, Honduras, and some other countries use foreign hazardous wastes as fuel to generate electricity. Some exporting countries promise to construct an incinerator to burn the wastes and generate power. In effect, their trade in wastes transfers waste disposal technology from developed countries to developing ones. As a result, developing countries can improve the technology to control pollution in their countries.

Wastes, used as land reclamation material in a country where land is scarce or unusable, can be equally attractive. The President of the Marshall Islands has given the U.S. firm, Admiralty Pacific, preliminary approval to import about one-third of California's wastes. The residents of the Marshall Islands want to use the wastes to increase the size and elevation of the island (Greenpeace, 1989). Some solid wastes are recyclable. For example, Mexico is one major country importing recyclable wastes from the United States.

This discussion emphasizes that both sides of these transactions, industrialized countries and less developed countries, may be better off through free trade in wastes. Industrialized countries dispose of their wastes at lower costs. Through trade, the developing countries are able to substitute the assimilative capacity (which has low marginal utility) for hard currency or other commodities with high marginal utility in their social welfare function. Hence, trade enhances total social welfare.

It is easy to construct a model of international waste trade. In the market, demand is from all countries generating waste. The countries with excessive assimilative capacity supply disposal facilities. Efficient trade

will be when demand and supply are equal. The crucial question is how to determine the correct supply curve that shows the full costs of disposing of imported wastes. For this transaction, the supply not only depends on excess assimilative capacity but also on waste content and its potential risk. For example, under constant excess assimilative capacity, the supply curve would differ concerning hazardous and non-hazardous wastes. Hence, an importer must get complete information about the wastes.

For the sake of optimal trade, Oates and Schwab (1988) suggest four necessary conditions:

(1) the exporting country should inform the receiving country about the content of the wastes and their potential risks,
(2) the reservation price must include not only the opportunity cost of the land but also the full social cost caused by the disposal of the waste,
(3) transportation costs must incorporate thefull social cost of shipping the wastes from the generating site to the destination, and
(4) developing countries must effectively enforce environmental regulations to reduce the illegal dumping that creates substantial social costs.

Obviously, the first requirement is for complete information, a necessity for optimal trade. Complete disclosure is essential before developing countries can implement the second and third conditions.

Without considering the morality of such actions, it is possible that the exporting country may release only partial information on its wastes. It is in the exporter's interest to withhold or distort such information. More information implies higher prices for disposal. If complete information is not available, the importing country cannot measure the disposal cost and associated social cost correctly. Thus, waste trade conducted under such

conditions is not desirable.

Besides the requirement for complete information, the difference between long- and short-run social cost associated with the disposal of importing wastes would influence waste trade negotiations. We can assume that demand for high environmental quality will increase with increasing income. Eventually, the income of developing countries will rise. The marginal disutility or marginal damage from storing foreign wastes will increase.

For example, marginal damage from nuclear wastes imported by a low-income country will be less now than in ten years when the residents enjoy a higher standard of living. This implies that the average long-run social cost of importing wastes is higher than short-run costs. Thus, if the importing country considers only short-run social cost when negotiating waste trade, it will not achieve optimality. Moreover, if the pollution generated by an imported waste is persistent, developing countries should include the long-run social cost in the measure of reservation price to yield optimal trade.

In the trade of goods the flow of commodities out of the country increases credit in trade accounts. In the trade of wastes, the flow of wastes increases debt in the trade balance account because the exporter pays the importer for disposing of them. The waste importer, on the other hand, gains credit by receiving the wastes. Once the importing country receives the wastes, it must dispose of the wastes in its landfill or incinerating facilities. This implies that the corresponding ownership of assimilative capacity was sold to another country though there is no physical movement of assimilative capacity. In other words, the trade of wastes is equal to the trade of assimilative capacity. In the former, the trade is described in term of bads. In the latter, trade is represented by goods. When the trade of wastes is illustrated by the transfer of assimilative capacity, it is similar to trade in any good. So, assimilative capacity is not only a priced commodity, but also a traded commodity, as is labor,

capital, or any other good.

The pattern of waste trade includes two routes. One route is from a high-income country to a low-income country. The other route is between industrialized countries. This is where the wastes flows from a country with abundant assimilative capacity to one where assimilative capacity is scarce.

V. Conflict Between Trade and Environmental Policy

The conflict between trade and environmental policy focuses on using either international trade instruments, such as tariffs, to achieve environmental goals or unilateral environmental regulations. Many criticize them as non-tariff barriers. Trade instruments belong to the subset of instruments that are based on flows of commodities between nations. They include import tariffs, export taxes, export and import sanctions, and quotas. GATT will reduce or end these instruments.

Over the last decades, many governments and other organizations have implemented environmental treaties. Some rely on international trade restrictions for enforcement. In 1989, the Convention on International Trade in Endangered Species of Wild Fauna and Flora imposed a trade ban on products from endangered African elephants. To regulate hazardous wastes and prevent industrialized countries from dumping them in developing countries, the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal prohibits waste shipments to nonsignatories. The recent "Montreal Protocol," restricts substances that deplete the ozone layer. This treaty also restricts the export and import of chlorofluorocarbon (CFC) products.

Several other unilateral environmental regulations depend on trade instruments for enforcement. Senate Bill 2887, proposed by U.S. Senator Lautenberg, prohibits granting special trade status to countries that do not

meet U.S. pollution and abatement standards under the Caribbean Basin Initiative or the Generalized System of Preferences. A well-known example of unilateral action using trade instruments is the U.S embargo on Mexican tuna and tuna products. The U.S. Marine Protection Act (MPA) was invoked because Mexican fishers were using a method to harvest tuna that killed dolphin at a rate exceeding the standard permitted by MPA (Housman and Zaelke, 1992). These trade restrictions lead some observers to predict a growing trend toward using trade measures to reach environmental goals (Whalley, 1991).

In addition to trade instruments, other measures restrict the free movement of commodities. Some are domestic measures to protect health, safety, or the environment. Some supporters of free trade view these domestic environmental regulations as non-tariff barriers. The German packaging recycling law (Anonymous, 1991) stunned the European Union's packaging industry. This law insists that purchasers my dispose of only 28% of the containers of imported beer and soft drinks containers locally. The remainder must be returned to the producers. Obviously, the law favors domestic manufacturers.

In 1989, the Unites States adopted requirements for increasing the content of recycled paper in newsprint to support its recycling market and reduce solid waste. To Canadian pulp and paper companies, however, these recycling requirements are non-tariff barriers because used newspaper collection and de-inking facilities are more costly in Canada (Knight, 1991). Perhaps the best-known example of environmental regulation as a non-tariff barrier is the case of the Commission of the European Communities versus Kingdom of Denmark. Denmark mandated that beverages be sold only in returnable containers. Beverage importers objected to this rule as an import barrier because of the high costs of collecting the containers. The European Court decided for the beverage importers, ruling that measures to protect the environment should be those that least restrict the free movement of goods (McSlarrow, 1991).

There are supporters and detractors of using trade instruments for environmental purposes. Opponents claim

the measures are inefficient in controlling pollution, hinder free trade, and harm international cooperation in reducing trade barriers. Low and Safadi (1992) say that the only time trade instruments are the best choice for reaching environmental goals is when they are used to enforce international treaties.

After reviewing trade measures that may be employed for environmental problems, Subramanian (1992) concludes that most of the environmental problems have no root in international trade. Rather, they result from market failure and should relate closely to the externality. Subramanian suggests that, instead of trade measures, the best choice for resolving environmental problems is intervention at the level of consumption or production, or developing a suitable property right. He also says a disparity in environmental policies is only one of the factors yielding to comparative advantage. Differences in the environmental endowment, pollution assimilative capacity, and the social valuation of the environment are also factors influencing comparative advantage. So, to apply trade instruments for restoring comparative advantage is inappropriate. Also, since trade instruments are protectionist in intent, they might be used as a to prohibit or limit imports. Subramanian includes the possibility that a trade threat could be an effective means of avoiding free riders on international environmental treaties.

Frequently, governments unilaterally impose trade instruments for environmental objectives. A country with strict environmental policy may try to impose its environmental standards on other countries through trade sanctions or threats. Sorsa (1989) maintains that governments should not impose unilateral sanctions for several reasons. He argues that the existence and extent of many international environmental problems are difficult to measure and subject to value judgments and scientific uncertainties. It is also difficult to identify the sources of pollution and underlying causal relationships, thus applying unilateral trade sanctions is questionable.

Another objection is that only large countries can make such sanctions effective. This fact may lead them to

impose their own values and standards on small countries. In addition, developing countries are likely to become targets of unilateral sanctions because their technological and financial conditions lag developed countries. Sorsa argues that unilateral sanctions will reduce developing countries' gains, desperately needed for economic and environmental protection. Sorsa concludes, therefore, that unilateral sanctions are counter-productive.

Authors who favor trade instruments for achieving environmental goals consider them effective ways to deal with global environmental problems, transnational pollution, and competitive disadvantage caused by strict environmental regulation. Whalley (1991) argues that a moral commitment to an international environmental treaty will not guarantee the fulfillment of environmental goals for global environmental problems, such as global warming and ozone layer depletion. Similarly, Whalley says the assumption that governments will flawlessly enforce international environmental treaties is also narrow minded.

Because global environmental problems largely involve public goods, free riders may undermine efforts to control global environmental degradation, particularly if governments do not implement punishment and enforcement mechanisms. Therefore, Whally says that trade instruments, such as trade barriers or retaliation, may help to enforce environmental treaties. Governments often apply trade instruments to transnational pollution to defend the home environment because domestic environmental laws do not regulate foreign countries. Even as pollution spills over the border, polluters usually have incentives to regulate pollution-intensive industries. Governments can reduce transnational pollution by levying tariffs to decrease demand for the pollution-related goods. They can use revenue from tariffs to abate pollution. In fact, the United States has imposed border charges on some imported commodities derived from chemical materials. The GATT permits this border tax.

Another motivation for using trade instruments for environmental goals is to reduce the disadvantage resulting

from strict environmental regulations. Shrybman (1990) argues that permitting polluters to exploit public resources, such as air and water, is the most common form of "environmental subsidy." If a country tries to maintain its high environmental standard and avoid degeneration of its industrial competitiveness in the international market, its choices are to levy an import tariff on pollution-intensive goods or to subsidize its own pollution-intensive industry.

It is not easy to find a solution to reconcile the dispute between these two sides. So far, GATT panels judge most of the collisions between trade and environmental policy. The overall goal of GATT is to provide contracting countries with standardized principles for international trade and to promote free trade among them. There are some exceptions in the GATT, which permits the application of trade barriers to protect human, animal, and plant life. But environmentalists think the GATT overlooks the environmental dimension of international trade (Shrybman, 1990).

Questions remain about what rules to follow when the environment and trade collide. As noted from the earlier discussions, some attack the use of trade instruments for environmental purposes for its alleged inefficiency. However, the conditions that assure an efficient policy hardly exist outside of theory. In actuality, the existence of free riders has broken the initial conditions for an efficient solution. In addition, irresponsible polluters cause trade instruments to be applied. Thus, the second or the third best choice is the only workable choice.

As conflict between trade and the environment occurs, it is inappropriate to ignore either of the two sides. Since gains or losses in environmental quality are difficult to measure, we may underestimate the value of the environment if we use traditional efficiency measures to justify environmental policy. We might need to redefine efficiency and consider both environmental and trade goals. When considering the conflict between

domestic environmental policy and free trade we must avoid double standards. It is incorrect for a country with high environmental standards to impose its values on other countries. It is also inappropriate to label a country's strict environmental regulation as non-tariff barriers if their domestic environmental policy does not discriminate against imported goods. If we insist that we tolerate environmental pollution because of social judgment and respect for a nation's sovereignty, we can not force developing countries to accept developed countries' standards for environment protection. Neither should we demand that a country loosen its strict environment regulations in the name of free trade.

VI. Strategic Environmental Policy and International Trade

The Studies outlined in previous sections concentrate on the distortion caused by environmental policy on international trade. In those discussions, environmental policy is an external variable to competitiveness, terms of trade, or the relocation of polluting industries. International trade, except the trade of hazardous wastes, is not the target of environmental policy. Most consider the variation of environmental standards across nations to be a result of different social preferences, economic development, and different endowments of nature resources. However, in recent studies, some authors have argued that by removing conventional trade measures such as import tariffs and export subsidies, environmental policy could become an integral part of trade policy and used to promote export of pollution-intensive goods. The term "strategic environmental policy " refers to environmental policy that is oriented toward promoting exports rather than abating pollution.

The starting point of the theoretical discussion is a world of imperfect or oligopolistic competition. In that world, the number of polluting firms is small and there exists super-normal returns or rents to scarce resources. To protect its polluting industries and shift the rent from its foreign rival, a nation has a strategic incentive to deviate from traditional optimal environmental policy (Pigouvian tax). This strategic behavior will be welfare enhancing. The environment is the victim of strategic behavior. And, the gains from trade occur because of

deteriorating environmental quality. Environmentalists describe the phenomenon as " ecological dumping".

Most researchers use the Brander and Spencer (1985) model as the basis for their theoretical studies on strategic environmental policy and trade. In those studies they justify government intervention by way of export subsidies. Within an oligopolistic model, Barrett (1994) provides a comprehensive insight on strategic environmental policy. In his model, there are few nations. Each nation has only one producer. Producers determine their output through Cournot competition in the world market. The researchers excluded what these countries consume from the analysis. Governments use emission standards to control the externality associated with their domestic productions. The internal emission standard, used to maximize a nation's welfare, is defined as the rent earned in the world market less the disutility generated by pollution. Barrett proves that if a nation tries to maximize its international welfare, it will set emission standards too high. That is, the marginal cost of pollution abatement will be less than marginal damage resulting in too much pollution. The author predicts that, in a world of imperfect competition, a nation may strategically distort its environmental policy to support its industry in international competition.

Conrad (1993) finds similar results using an emission tax. He based his discussion on the Brander and Spencer duopoly model. Conrad shows that a country's emission tax associates negatively with domestic profit but associates positively with its foreign rivals. If a government acts strategically the "optimal emission tax" is less than marginal damage. In addition, Conrad suggests using an abatement subsidy to promote export from polluting industries. He claims that, by granting a subsidy to heavily taxed polluting industries, a country will improve its welfare by capturing more market share. The distortion of the emission tax from the optimal Pigouvian tax is less than the distortion that occurs when a government does not implement a subsidy program. Conrad suggests that the subsidy is the better choice for strategic intervention. This is because it not only promotes export but improves the efficiency of resources allocation by high emission tax.

As a choice of strategic environmental policy, emission standards and emission taxes may generate different results. Ulph (1993) showed this crucial difference. In that work, Ulph uses a simple model to show an optimally distorted emission tax will stimulate more exports than will a distorted emissions standard. Ulph incorporates the strategic behavior of producers (in addition to countries) in his analysis. He assumes that producers invest in research and development (R&D) as a strategic response to environmental regulation. Ulph concludes that if only producers act strategically, there will be excessive over-investments in R&D. That is, the marginal revenue from the investments will be less than the marginal costs. If both governments and producers act strategically, they will lessen the incentives for governments to change environmental policy. So, the difference of the actual emissions tax from the Pigouvian tax becomes smaller when only the government acts strategically.

The studies mentioned above provide a theoretical foundation for analyzing ecological dumping and looking at intervention. However, the arguments may not be strong. First, the argument for strategic environmental policy rests on the above-normal return of the particular polluting industry. The return cannot be persistent. As more capital flows into the industry, the above-normal return will disappear. Second, that industry is generating public bads. If a government chose strategic environmental policy, there would inevitably be change in how efficiently the resources are allocated. As the industry absorbs more capital, the country will specialize in the polluting industry and will experience rapidly increasing pollution. Finally, the effectiveness of strategic environmental policy on export promotion depends on how costly the industry finds environmental regulation. The effect would be minimal if the costs are low.

VII. Conclusions

Trade and the environment is not only a high profile policy issue today but is proving to be a fertile subject for academic research. We have identified five areas of debate and research:

- the distortion of comparative advantage due to environmental regulation,
- the impact of environmental regulation on the location of polluting industry,
- transnational pollution and trade in wastes,
- the potential conflict between trade policy and environmental policy, and
- the use of environmental regulations as strategic trade instruments.

These studies not only improve our understanding about the interaction between trade and the environment but also have substantial policy implications. First, in an open economy, environmental policy is one factor determining trade patterns and capital movements. The theoretical literature consistently illustrates this point. Thus, we cannot ignore trade impact when formulating environmental policy. To reduce the potential adverse effect, market-based instruments should have priority over command and control approaches.

Second, besides differences in the strictness of environmental policy, differences in assimilative capacity, social preferences about environmental goods, and property rights also can be sources of comparative advantage for polluting industries. This implies that the standardizing environmental policy across national boundaries will not reduce the negative impact on the competitiveness of industries regulated by high environmental standards.

Third, there exists no convincing evidence from the empirical literature to support many hypotheses about the interaction between trade and the environment. This shows that other factors dominate environmental policy in influencing trade and capital movements. The empirical literature also suggests that trade patterns and capital flows are composite results of a variety of factors. And, governments should frame the assessment of the trade impact on environmental regulation in a system which includes all important factors.

Fourth, concerning transnational pollution or global environmental problems, governments should avoid applying trade instruments to control pollution. Fundamentally, trade instruments, such as tariffs or sanctions, are noncooperative polices and may cause new distortions on trade and confrontation between countries. However, if governments use trade policy to promote the export of pollution abatement and control technology, it may produce positive results.

Finally, evaluating environmental policies without considering the welfare improvements from a cleaner environment biases the results. Trade and environmental policies are designed to serve different economic and social goals. It is unreasonable to justify either of them simply through their side effects. Policymakers should base their cost-effective analysis of environmental policy on the overall welfare change rather than the gains or losses of a single industry.

Two areas of further research warrant further investigation. One concerns how policymakers should modify the standard HOV model to account for environmental quality. Certainly a country's assimilative capacity is a resource that should influence comparative advantage. However, the demand for environmental quality is internal, dependent on income and assimilative capacity. A second issue is empirical. Governments face a continuing challenge to measure the effect of differential preferences/regulations and trade in pollution-intensive goods. The empirical literature to date has been unclear.

VIII. References

Anonymous. 1991. "Free Trade's Green Hurdle." *The Economist* June 15:61.

-----. 1989. "The Freedom to Be Cleaner than the Rest." *The Economist* October 14:21-24.

Barde, J. 1989. "The Economic Approach to the Environment." *The OECD Observer* June/July:12-15.

Barrette, S. 1994. "Strategic Environmental Policy and International Trade."*Journal of Public Economics* 54:325-338

Bartik,T. J. 1988. "The Effect of Environmental Regulation on Business Location in the United States." *Growth and Change* Summer:22-44.

Baumol, W. J. and W. E. Oates. 1989. *The Theory of Environmental Policy.* Cambridge, Massachusetts: Cambridge University Press.

Bhagwati, J. H. 1993. "Trade and the Environment." *The American Enterprise* May/June:43-49

Brander, J. A. and B. J. Spencer. 1985. "Export Subsidies and International Market Share Rivalry."*Journal of International Economics* 18:83-100.

Bratton, D. M. and G. L. Rutledge. 1991. "Pollution Abatement and Control Expenditure 1987-1989." *Survey of Current Business* November:46-50.

-----. 1990. "Pollution Abatement and Control Expenditure 1985-1988." *Survey of Current Business* November:32-38.

Carraro, C. and D. Siniscalco. 1992. "Environmental Innovation Policy and International Competition." *Environmental and Resource Economics* 2(2):183-200.

Charnovitz, S. 1991. "Exploring the Environmental Exceptions in GATT Article XX."*Journal of World Trade* 5:37-55.

Chichilnisky, G. 1994. "North-South Trade and Global Environment." *American Economic Review* 84(4):851-874

Conrad, K. 1993. " Taxes and Subsidies for Pollution-Intensive Industries as Trade Policy."*Journal of Environmental Economics and Management* 25:121-135

Conyers, J. Jr. 1989. Testimony at a Hearing before the Subcommittee on Human Rights and International Organization, and the Subcommittee on International Economic Policy and Trade of the Committee on Foreign Affairs, U.S. House of Representatives, Washington, DC. July 12.

Dohlman, E. 1990. "The Trade Effects of Environmental Regulation." *The OECD Observer*

February/March:28-32.

Dornbusch, R., S. Fisher and P. A.Samuelson. 1977. "Comparative Advantage, Trade and Payments in a Ricardian Model with a Continuum of Goods." *American Economic Review* 47(5):823-839.

Dufour, J. P. and C. Denis. 1988. "The North' Garbage Goes South." November:44-46.

Grossman, G. and A. Krueger. 1992. "Environmental Impact of a North American Freed Trade Agreement." In P. Garber, ed., *The U.S.-Mexico Free Trade Agreement*. Cambridge, Massachusetts: The MIT Press.

Hajost, S. M. H. 1989. Statement at a Hearing before the Subcommittee on Human Rights and International Organization and the Subcommittee on International Economic Policy and Trade of the Committee on Foreign Affairs, U.S. House of Representatives, July 12.

Housman, R. B. and D. J. Zaelke. 1992. "The Collision of the Environment and Trade: The GATT Tuna/Dolphin Decision." *Environmental Law Reporter: News & Analysis* April:10268-10278.

Jaffe, A. B, S. R. Peterson, P. R. Portney and R. N. Stavins. 1995. "Environmental Regulation and International Competitiveness: What Does the Evidence Tell US." *Journal of Economic Literature*, 33(1):132-163.

Klatte, E., F. Palacio, D. Rapaport, and J. Vallette. 1980. International Trade in Toxic Wastes: Policy and Data Analysis. Washington DC: Greenpeace International.

Knight,C. F. 1991. "Effects of National Environmental Regulation on International Trade and Investment--Selected Issues." *Pacific Basin Law Journal* 10:212-223.

Kohn, R. 1991. "Global Pollution: A Hecksher-Ohlin-Samuelson Model of Pigouvan Taxation." *Eastern Economic Journal* XVII(3):337-343.

Krutilla, J. 1991. "Environmental Regulation in an Open Economy." *Journal of Environmental Economics and Management* 20:127-142

Leonard, H .J. 1988. *Pollution and the Struggle for the World Product*. Cambridge, Massachusetts: Cambridge University Press.

Leonard, H. J. and C. J. Duerksen. 1980. "Environmental Regulations and the Location of Industry:An International Perspective." *Columbia Journal of World Business* Summer:52-68.

Lloyd, P. J. 1992. "The Problem of Optimal Environmental Policy Choice." In K. Anderson and R. Blackhurst, eds., *The Greening of World Trade Issues*. Ann Arbor: The University of Michigan Press.

Low, P. 1992. "Trade Measure and Environmental Quality: The Implications for Mexico's Export." In P. Low, ed., *International Trade and the Environment*. World Bank Discussion Paper 159. Washington, DC: World Bank.

Low, P. and R. Safadi. 1992. "Trade Policy and Pollution." In P. Low, ed.,*International Trade and the Environment*, Discussion Paper. 159. Washington, DC: World Bank.

Low, P. and A.Yeates. 1992. Do "Dirty" Industries Migrate?, In P.Low, ed.,*International Trade and the Environment.* Discussion paper 159. Washington, DC: World Bank.

Lucas, R., D. Wheeler, and H. Hettige. 1992. "Economic Development, Environmental Regulation and the International Migration of Toxic Industrial Pollution: 1960-1988." In P. Low, ed.,*International Trade and the Environment.* Discussion Paper 159. Washington, DC: World Bank.

Markusen, J. R., E. R. Morey and N. D. Olewiler. 1993. "Environmental Policy when Market Structure and Plant Locations Are Endogenous." *Journal of Environmental Economics and Management* 24:69-86.

McConnell, V. D. and R. M. Schwab. 1990. "The Impact of Environmental Regulation on Industry Location Decision: The Motor Vehicle Industry." *Land Economics* 66(1):67-81.

McGuire, M. C. 1982. "Regulation, Factor Rewards, and International Trade."*Journal of Public Economics* 17:335-354.

McKeith, M. H. 1991. "The Environment and Free Trade: Meeting Halfway at the Mexican Border."*Pacific Basin Law Journal* 10(151):183-211.

McSlarrow, K. E. 1991. "International Trade and the Environment: Building a Framework for Conflict Resolution." *Environmental Law Reporter: News & Analysis* October:10589-10598.

Merrifield, J. D. 1988. "The Impact of Selected Abatement Strategies on Transnational Pollution, The Terms of Trade, and Factor Rewards: A General Equilibrium Approach."*Journal of Environment of Economics and Management* 15:259-284.

Oates, W. E. 1991. *Global Environmental Management: Toward an Open Economy Environmental Economics.* Working Paper, University of Maryland, Department of Economics, College Park.

Oates, W. E. and R. M. Schwab. 1988. "Economic competition among Jurisdiction Efficiency Enhancing or Distortion Inducing?" *Journal of Public Economics* 35:333-354.

Organization for Economic Cooperation and Development. 1978. *Macro-Economic Evaluation of Environmental Programs.* Paris, France: OECD.

-----. 1975. *The Polluter Pays Principal: Definition, Analysis, Implementation* Paris, France: OECD.

Pasurka, C. A. 1985. "Environmental Control Costs and U.S. Effective Rates of Protection."*Public Finance Quarterly* 13(2):161-182.

Patterson, E. 1992. "GATT and the Environment: Rules Changes to Minimize Adverse Trade and Environment Effects." *Journal of World Trade* 3:99-109.

Patterson, E. 1991. "International Trade and the Environment: Institutional Solutions."*Environmental Law Reporter: News & Analysis* October:10599-10604.

Pearson, C. 1982. "Environment and International Economic Policy." In G. Rubin, ed.,*Environment and*

Trade. Totowa, New Jersey: Allanheld, Osmun.

Pearson, C. S. 1987. *Multinational Corporations, Environment, and the Third World Business Matters* Durham, North Carolina: Duke University Press.

Pethig, R. 1976. "Pollution, Welfare, and Environmental Policy in the Theory of Comparative Advantage", *Journal of Environmental Economics and Management* 2:160-169.

Poter, J. W. 1986. Statement before the Committee on Government Operation, the Subcommittee on Environment, Energy and Nature Resources. U.S. House of Representatives, September 24.

Rauscher, M. 1993. "Environmental Regulation and International Capital Allocation." Working Paper. University of Kiel and Center of Economic Policy Research, London.

Robinson, H. D. 1988. "Industrial Pollution Abatement: The Impact on Balance of Trade." *The Canadian Journal of Economics* 21(February):187-199.

Rybczynski, T. M. 1955. "Factor Endowment and Relative Commodity Prices."*Economica*, New Series 22(November):366-91.

Sartzetakis, E. S. and C. Constantatos. 1994. "Environmental Regulation and International Trade." Working paper. Department d'économique, Université Laval, Quebec, Canada.

Scunkey, J. 1989. "Domestically Prohibited Goods and Hazardous Substance: A New GATT Working Group is Established." *Journal of World Trade* 6:99-108.

Shrybman, S. 1990. "International Trade and the Environment: An Environment Assessment of the General Agreement on Tariffs and Trade." *The Ecologist* 20(1):30-34.

Siebert, H. 1977. "Environmental Quality and the Gains from Trade." *Kyklos* 30:657-673

-----. 1974. "Environmental Protection and International Specialization." *Weltwirtschaftliches Archio* 110(3):494-508.

Sigh, J. B. and V. C. Lakhan. 1989. "Business Ethics and The International Trade in Hazardous Wastes." *Journal of Business Ethics* 8:889-899.

Snape, R. H. 1989. "The Environment, International Trade and Competitiveness." In K. Anderson and R. Blackhurst, eds., *The Greening of World Trade Issues*. Ann Arbor, Michigan: University of Michigan Press.

Sorsa, P. 1989. "GATT and Environment." *World Economy* 15(1): 115-133.

Greenpeace. 1989. Statement in Hearing of the Subcommittee on Human Rights and International Organization and the Subcommittee on the International Economic Policy and Trade of the Subcommittee on the Foreign Affairs, U.S. House of Representatives, July 12.

Subramanian, A. 1992. "Trade Measures for Environment: A nearly Empty Box?" *World Economy* 15(1):

135-152.

Toby, J. A. 1990. "The Effects of Domestic Environmental Policies on Pattern of World Trade: An Empirical Test." *Kyklos* 43(2):191-209.

U.S. Congress, Trade and the Environment. 1990. Hearing before the Subcommittee on the International trade of the Committee on Finance, United States Senate, One hundred First Congress Discussion on Senate Bill 2887, July 30.

U.S. Department of Commerce. 1975. "The Effects of Pollution Abatement on International Trade-III", Washington D.C.

U.S. Environmental Protection Agency. 1990. *Environment Investment: The Cost of a Clean Environment* Washington, D.C.

Ugelow, J. I. 1982. "A survey of Recent Studies on Costs of Pollution Control and the Effect on Trade." In R. J. Rubin and T. R. Graham, eds., *Environment and Trade.* Totowa, New Jersey: Allanheld, Osmun.

Ulph, A. 1993. "Environmental Policy and International Trade when Governments and Producers Act Strategically." Working paper. University of Southampton.

-----. 1993. "Strategic Environmental Policy, International Trade and the Single European Market." Paper presented at Symposium on Environmental Policy with Economic and Political Integration: The European Community and the United States, University of Illinois, Champaign.

Unimonen, P. 1992. "Trade Polices and the Environment." *Finance and Development* June:26-27.

Uva, M. D. and Jane Bloom. 1991. "Exporting Polluting: The International Wastes Trade."*Environment.* 31(5):32-36.

Van Bergeijk, P. 1991. "International Trade and the Environmental Challenge." *Journal of World Trade* (6):105-115.

Walter, I. 1982. "Environmentally Induced Industrial Relocation to Developing Countries." In R. J. Rubin and T. R. Graham, eds., *Environment and Trade.* Totowa, New Jersey: Allanheld, Osmun.

Walter, I. and J. L. Ugelow. 1979. "Environmental Policies in Developing Countries."*AMBIO*, 8(2-3):102-109.

Whalley, J. 1991. "The Interface Between Environmental and Trade Policies."*The Economics Journal* March:180-189.

Zamparutti, A. and J. Klavens. 1993 "Environment and Foreign Investment in Central and Eastern Europe: Results from a Survey of West Corporation. In*Environmental Policies andIndustrial Competitiveness* Paris, France: OECD..