1. Introduction

The linkage between trade and the environment has become an important policy issue in the last few years. Some environmentalists claim that international trade increases environmental degradation across the world, and in developing countries in particular. Business lobbyists in developed countries are concerned that strict environmental regulations reduce their competitiveness and shift pollution intensive industries to developing countries. Policymakers in developing countries fear that links between trade and environmental policy will be used as another avenue for rich countries to erect barriers to imports.

This paper explores the interaction between international trade, capital mobility, and environmental quality in developing countries. We focus on three major issues. The central concern is how increased international trade and investment affect environmental quality. Changes in the scale of economic activity, the environmental impact of economic activity, the institutions which manage environmental quality, and the composition of economic activity all affect environmental outcomes. Much of our focus will be on the latter two channels. Although increases in growth (the scale effect) can cause environmental problems, economic growth is a key objective for developing countries. To distinguish the effects of trade from other sources of growth, we need to determine whether trade moves the growth path in a direction that systematically favours or harms various aspects of environmental quality - that is, does the composition effect of trade harm the environment? And because the environmental effects of either growth or changes in the composition of output depend on the policy regime, we address the interaction between trade and environmental policy in some detail.

The pollution haven hypothesis has dominated much of the discussion of the composition effects of trade between rich and poor countries on the environment. The strong form of the pollution haven hypothesis is that trade liberalization shifts environmentally intensive industries to countries with relatively weak environmental policy. We argue that there is little empirical evidence to support the pollution haven hypothesis: differences in environmental policy are not

the principal determinants of the direction of trade. Although this is still an active area of research, the current evidence suggests that other factors, such as capital abundance, technology differences, infrastructure, or distance to major markets seem to be much more important than environmental policy in determining trade patterns. However, even if the pollution haven hypothesis fails to hold, trade liberalization will nevertheless shift the development path towards environmentally-intensive activity in some developing countries. Countries may have a comparative advantage in environmentally intensive goods for reasons that have nothing to do with environmental policy.

A second major issue is the distinction between environmental problems associated with industrial pollution emissions, and those that effect stocks of natural capital, such as fisheries, soil, forests, and other renewable resources. Environmental problems stemming from industrial pollution are often characterized as trade-offs between income and pollution: the issue is whether the benefits of increased real income from trade are more than offset by the costs of increased pollution. Moreover, because environmental quality is a normal good, there is some evidence that increased income will stimulate the development of institutions to implement and enforce more stringent environmental policy. Increased income can therefore act as a check on environmental degradation in the future. This has been the subject of much debate in the Environmental Kuznets Curve literature, which examines the relation between per capita income and environmental quality.

On the other hand, environmental problems involving natural capital are fundamentally different. If economic activity is based on natural capital, and if trade leads to a deterioration of stocks of natural capital, then it is possible that trade could lead to a decline in both environmental quality and in long run real income. If this is the case, there is a possibility that trade could contribute to a downward ecological spiral in which increased pressure on the environment reduces resource stocks, which reduces income, which weakens institutions protecting resource stocks, which leads to further environmental degradation and income loss. This is the basis of theoretical arguments in Daly (1993), Chichilnisky (1994), Brander and Taylor (1997), and Copeland and Taylor (1997, 1999). There is relatively little cross-country

empirical evidence on the interaction between trade and natural capital; however there are a number of suggestive case studies which we discuss.

The third major issue we discuss is the effects on developing countries of linkage between trade policies and environmental concerns. There are a variety of issues here, but many center around market access issues. There has been much attention given to the possibility that a "race to the bottom" in environmental standards might occur if countries weaken their environmental policy in response to freer trade to shelter their industry from international competition. This has led to proposals to either harmonize environmental policy, impose "eco-duties" to "level the playing field" by ensuring that importers bear the same types of environmental compliance costs as domestic producers, or to make market access contingent on meeting certain environmental standards. We review the empirical evidence first on whether or not environmental policy affects trade flows, and second, on whether or not freer trade affects governments' willingness to implement and enforce tough environmental standards.

Other motives for linkage arise from an attempt by one country to affect the environmental quality in another country, particularly when the particular environmental problem has some global implications. Several recent trade disputes (such as the tuna / porpoise and shrimp / turtle cases) involve a rich country (the US) attempting to make imports contingent on the environmental practices used in harvesting renewable resources. We discuss the implications of current trade rules on these issues for developing countries.

The paper is organized as follows. In section 2, we discuss the role of the environmental policy process and institutions and how they interact with the trade regime. In Section 3, we review the empirical evidence on the effects of environmental policy on trade patterns; and the evidence on the effect of trade on environmental quality. Section 4 considers policy issues, and the final section concludes.

2. The Policy Regime and Institutions

Trade affects the environment through a variety of channels: it changes the overall level of economic activity (a *scale effect*); it changes the type of economic activity (a *composition effect*), and it can lead to change in the environmental intensity of production (a *technique effect*).[1] Each of these channels is affected by the interaction between market forces and a country's policy regime. This section discusses the role of the policy regime.

A country's environmental policy regime is critical in determining how increased international trade or investment affects the environment. If, for example, a country adjusts policy to enforce an ambient air quality standard, then increased economic activity or a shift to industrial manufacturing need not have any effect on air quality. The regulator could adjust emission standards to accommodate the changes in economic activity and aggregate pollution need not change. Similarly if a regulator enforces binding harvest quotas in a fishery, an export-driven increase in the price of fish need not lead to deterioration of the stocks - it would simply increase resource rents. Conversely, if there is no environmental regulation in place, a shift to manufacturing is likely to increase pollution, and increased opportunities to export fish are likely to lead to stock depletion. The regulatory regime and institutions that affect resource management are critical because they can help explain the heterogeneity across countries in their response to the pressures and incentives arising from increased access to international markets.

2.1. Income effects

Environmental regulations differ across countries, and especially between rich and poor countries. The most popular explanation of this difference is based on income effects in the demand for environmental quality. If environmental quality is a normal good, and if environmental regulation is responsive to consumer demand, then the stringency of environmental regulation increases with improvements in income. This hypothesis forms the

[1] See Grossman and Krueger (1993) and Copeland and Taylor (1994) for further discussion of this decomposition.

theoretical basis of most explanations for the environmental Kuznets curve (EKC). The EKC postulates that pollution rises in the early stages of development and falls as countries get richer.[2]

The existence and magnitude of an income effect has been the subject of extensive empirical work. Macro-level studies typically regress cross-country environmental indicators on various specifications of income.[3] This approach does not test directly for the income effect discussed above, but rather looks for a reduced-form relation between pollution and per capita income. In these studies the effects of per capita income on the demand for environmental quality cannot be disentangled from the effects of scale and composition on environmental outcomes. Some of these studies find an EKC for specific environmental indicators, while others do not. Recently Harbaugh et. al. (2002)) and Stern and Common (2001) have shown that the relation between pollution and income is sensitive to the sample of countries or time period chosen. Copeland and Taylor (2003a) argue that this lack of robustness points to a mis-specification of the macro-level EKC. Using a simple theoretical model they demonstrate how different sources of growth will lead to different paths in environmental quality. They argue that there is no reason to expect a simple stable relationship between pollution and income across countries. They suggest a more structural approach to calculating the effect of growth on the environment, one that allows for differences in the source of pollution across different countries. Antweiler et. al (2001) adopt such an approach, and estimate the effects of increases in per capita income on sulphur dioxide concentrations in a sample of cities in both rich and poor countries, while holding the trade regime, scale of economic activity, capital abundance, and other factors constant. A key aspect of their approach is that the effects of per capita income can be isolated from the effects of scale of economic activity on environmental outcomes. They find strong evidence of an income effect: all else equal (in particular, when controlling for scale), higher per capita income is associated with lower SO2 concentrations.

A potentially more promising method to test the effect of increasing income on demand for environmental quality is to use micro-level data. Chaudhary and Pfaff (1998) use a household

[2] See López (1994) for an early formal model incorporating the role of the income effect, and Copeland and Taylor (2003c) for a recent treatment.
[3] See Copeland and Taylor (2003a) and Stern (1998) for surveys.

level dataset on income and fuel use from Pakistan to estimate the relationship between household income and indoor air quality. Using plausible assumptions regarding emissions implied by fuel use, the authors estimate the implied relationship between indoor air quality and household income. They find an inverted-U-shaped relationship between household income and air quality and attribute this relationship to the income effect discussed earlier.

There is also a large literature which uses survey methods to estimate the willingness to pay for various types of improvements in environmental quality.[4] Kristom and Riera (1996) and Hokby and Soderqvist (2002) review several studies from Europe and find that the income elasticity of willingness to pay for improvements in environmental quality is in almost all cases positive, but on average is less than one. These results suggest that environmental quality is a normal good, but not a luxury good.

Other approaches try to estimate how changes in income affect responses to risks. Several studies estimate the income elasticity of the value of a statistical life (VSL). The VSL measures the marginal rate of substitution between income and the risk of death in a given period of time. Hammitt et al. (2000) note that many studies either compare estimates from separate studies across countries, or else use survey methods. The estimates from these studies tend to be positive but less than one. Hammitt et al. (2000) use data on work-place fatality risk and wages from Taiwan over the period 1982-97 to estimate how the VSL responded to changes in income during a period of rapid economic growth. They obtain estimates of the income elasticity of the VSL which range between 2 and 3, which are much larger than previous studies have indicated.

A more direct test for our purposes would be to look at the relation between the stringency of environmental policy and income. By analyzing the country reports prepared for the United Nations Conference on Environment and Development, Dasgupta et. al. (1995) develop comparable cross-country indicators for environmental policy across 31 countries. They find a strong positive relationship between stringency of environmental policy and per capita income across countries. Magnani (2000) shows that second order moments (capturing income inequality) are important in determining the impact of income on environmental policy. She

[4] These are often known as contingent valuation studies.

shows that improvements in income across her sample of OECD countries leads to an increase in environmental spending. However, increases in income inequality can dampen the increase in environmental spending. Pearce and Palmer (2001) review data on public expenditures on environmental protection in OECD countries and find an income elasticity of 1.2, suggesting that public expenditure on the environment as a fraction of income rises with national income.

Overall, the empirical literature provides some support for the existence of an income effect on environmental policy. This has two important implications for the effects of trade on the environment. First, we should expect the stringency of environmental standards to vary across countries, and be more stringent in rich countries than in poor countries. Second, if trade helps facilitate increases in real incomes, then that can lead to an increase in the demand for environmental quality and increased support for more stringent environmental policy. The short and long run effects of trade on the environment may therefore be different if environmental policy responds only after the increases in income are secured.

2.2. Property rights

While environmental regulations are a key factor affecting pollution emissions, the effects of trade on natural resources issues is often dependent on the property rights regime. A significant proportion of income derives from exploitation of natural resources in several regions of the developing world (Dasgupta (1993)). Examples of such resources include forest tracts, fishing grounds, grazing areas, and irrigation waters. However, despite (and sometimes because of) their importance, natural resources in developing countries are often exploited under poorly defined property rights.[5] Some argue that property rights are more insecure in developing countries than in developed countries (see World Bank (1992); ch. 3). Reasons cited include weak judicial and political systems, inadequate income to devote to costly enforcement of

[5] Brown (2000) argues that poorly defined property rights are a consequence of the characteristics of most renewable natural resources. Most renewable resources do not respect political boundaries, making private ownership difficult. Renewable resources often have non-use values making it difficult to set up efficient markets. Ecological complexity and dramatic time lags between action and consequences often obscures their true benefits and costs.

property rights, and a breakdown of traditional common property controls (like tribal or village level institutions) caused either by the stress of population pressure or economic development.

As Gordon (1954) and others have pointed out, imperfect property rights can lead to excessive pressure on renewable resource stocks. Each resource harvester or user imposes a negative externality on other users. For example, in a fishery, an individual who harvests a fish reduces future fish stocks, which drives up harvesting cost for other harvesters. Moreover, individuals lack the appropriate incentives to invest in the resource. An individual who chooses not to harvest a fish today so that it can grow and reproduce will not reap the full benefits of the investment because some other fisher may harvest the fish instead. If these externalities are not internalized, excessive resource depletion can result.

Losses from poorly defined property rights are significant. López (1998c) estimates the loss from non-cooperative behavior on common property lands at the village level in Côte d'Ivoire. He finds that farmers do not internalize the external costs of biomass use in their land allocation decisions. Estimates of the loss in income from such behavior put their value as high as 14 percent of village income. Similar estimates for the loss in income from imperfect controls over common property resources in the developing world are provided by López (1997). Also using data at the village level in Côte d'Ivoire, Ahuja (1998) provides estimates of internalization of the costs of land (and associated biomass) use as an agricultural input. Using a scale where 0 represents the case where there is no internalization, and 1 represents complete internalization, the author finds estimates ranging from 0.07 to 0.27 in the three regions analyzed. The author concludes that there is substantial inefficiency in land use due to imperfect property rights.

The existence of poorly defined property rights can have important implications for how trade affects the environment.[6] McRae (1978), Chichilinsky (1994), and Brander and Taylor (1997) develop theoretical models to investigate the interaction of trade and renewable resources under open access.[7] They find that resource exporting counties may lose from freer trade. When

[6] See Anríquez (2002) for a survey.

[7] Also see Karp et. al. (2001) for a model with a richer set of possible outcomes. They model the non-cooperative behavior between an exogenously fixed number of resource extractors. If there is only one extractor, there are complete (static) property rights. As the number of extractors increases, the property right regime tends to open access. Modeling trade between countries with different exogenously given numbers of extractors, Karp, et. al. (2001) argue that both, an increase, or a decline in steady state utility is

the country opens up to trade at a resource price higher than the domestic price, the short term returns to harvesting the resource increase. This attracts entry. In the short term there may be real income gains, but in the long run there is stock depletion. In short, trade exacerbates the negative production externality. Brander and Taylor (1997) provide a simple example in which the resource exporting country must suffer a real income loss from access to international trade. Moreover, Chichilnisky notes that the country's comparative advantage in resource extraction may only be apparent - a side effect of excessive entry in the industry due to the lack of well-defined property rights.

An important distinction between imperfect property rights in renewable resources and imperfect pollution regulation is in the income effect. In the case of industrial pollution, an exporter of pollution-intensive goods may face an increase in pollution due to poor environmental regulations. However, if the expansion of the manufacturing sector leads to an increase in real income, then the increased income can lead to an increased demand for environmental quality which can lead to improved environmental regulations. The income effect may dampen the adverse environmental consequences of the expansion of manufacturing.

In the case of renewable resources, the reverse may occur. In the Brander/Taylor and Chichilnisky models, a resource exporter suffers a fall in long run real income if trade leads to a depletion of natural capital. Trade both reduces income and environmental quality. This can also be a consequence if industrial pollution damages natural capital. Copeland and Taylor (1997) explicitly model this process in a model of cross-sectoral pollution. In their model, exports of manufactures leads to increased pollution, which damages natural capital. If the decline in natural capital is sufficiently severe, the fall in income leads to weaker pollution policy (via the income effect), which exacerbates the pollution problem and leads to further destruction of natural capital and further income loss. The country gets caught in low-income, low-environmental quality trap.[8]

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possible. They show that the gain or decline in utility is conditional on the resilience of the environmental stock present in the trading country.

[8] Similar problems could occur if industrial pollution causes human health problems – increased pollution could lower labor productivity, which could then both increase environmental damage and lower real income.

If property rights (or their enforcement) are endogenous,[9] then changes in the trade regime may induce changes in the property rights regime. Hotte et. al. (2000) analyze the interaction between international trade and the stock of natural resources in an economy where there are private costs for enforcing property rights. They find plausible conditions under which higher prices gained by international trade encourage greater enforcement of property rights and higher stocks of the natural resource.[10] Margolis and Shogren (2002) consider a model of endogenous enclosure of resource stocks where agents can build a fence for a fixed cost. They show that international trade can induce increased enclosure by raising the value of the resource. However, they find that real income may still fall because the enclosure costs can offset other gains.[11]

2.3. Institutions and Informal mechanisms

Social institutions play an important role in enforcing property rights and preserving natural resources. Formal institutions include legal and legislative institutions. These institutions determine the responsiveness of public policy to concerns about the environment. They also determine the enforcement of public policy.

Ferreira (2004) is one of the few empirical studies that analyze the interaction of openness and government institutions in determining resource depletion. Using data for a cross-section of countries she studies the impact of openness on deforestation in 1999-2000. She finds

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[9] This has previously been emphasized in economic literature (see Anderson and Hill (1975), Field (1989), and Hotte (1997)). See Cohen and Weitzman (1975), De Meza and Gould (1994), and Long (1994) for models where property rights are endogenously determined.

[10] However the authors also show that this increase in enforcement need not always result in higher welfare for the economy. Agents in the model increase private enforcement if higher profits result from such an action. However, increased enforcement involves an increase in unproductive enforcement expenditures. The authors show that due to the unproductive enforcement expenses, an increase in profits can be smaller than the reduction in deadweight loss from open access.

[11] While raising the value of the natural resource might encourage enclosure, or other investment which leads to preservation, Swanson (1994) shows even under socially optimal control, a reduction in the value of a natural resource can lead it to being harvested to extinction. The author shows that a reduction in value of natural capital (resulting from an exogenous reduction in the price of the resource intensive good) reduces the economy's incentive to invest costly resources required for its survival, and can lead to eventual extinction.

that once income and resource abundance are taken into account, openness by itself does not have a statistical significant impact on deforestation. Openness has an impact on deforestation only through its interaction with institutional variables. In particular she finds that variables reflecting bureaucratic quality and government fulfillment of contracts influence the impact of openness on deforestation.

Besides government institutions, self-organized and voluntary institutions (sometimes formal, and sometimes informal) also determine the preservation of the environment. Ostrom (2000) argues that self-organized resource governance regimes exist across the world. She also argues that within these institutions, participants invest in monitoring and sanctioning to prevent free riding by other participants (also illustrated in Ostrom (1990)). Baland and Platteau (1996) highlight the role of rural communities in the preservation of natural resources. Other examples of the role of rural communities in resource management are provided in Bardhan (2000) and McCarthy et. al. (2001).[12]

Using village level data on land use, Ahuja (1998) analyzes community land management in Côte d'Ivoire. In the area analyzed, land ownership rests with the village, and the village chief acts as a land manager. Ahuja provides estimates of inefficiency in land use and finds significant differences across the three regions analyzed. In a subsequent analysis explaining these differences, he finds that all else being equal, larger villages tend to be less efficient in managing common land and its associated biomass. Further, while ethnic homogeneity facilitates management, income heterogeneity in the village does not seem to have any impact.

Another example of informal policy control is citizen activism. One of the most interesting applications is Pargal and Mani (2000). Using data on the location of new industrial plants in India, Pargal and Mani (2000) find that activism measured through the propensity to complain, vote, or join interest groups, translates into pressure for cleaner production on the plant. Due to this pressure, firms take into account the potential for collective action while deciding on a

[12] McCarthy et. al. (2001) discuss the community based cooperative management of common property land in Mexico's ejidos (communally owned farm and grazing lands).

choice of location. Based on their results the authors argue that the potential for collective action is an effective informal regulation on pollution.[13]

Using data from China, Dasgupta and Wheeler (1996) investigate citizen complaints as informal regulation. They provide several examples where regulatory authorities rely on citizen complaints to investigate environmental transgressions. They find that while citizen complaints are correlated with benefits and to the exposure of highly visible pollutants, they are not affected by harmful pollutants which are less visible. They also find that basic education has a strong, independent effect on propensity to complain. This implies that a reliance on complaints alone results in an inappropriately low allocation of inspection resources to less-educated and relatively 'silent' regions. Dasgupta and Wheeler argue that imperfect information is a key problem in environmental regulation, and that regulators who rely on citizen complaints should consider large-scale environmental education programs which pay special attention to communities with lower levels of education. Besley and Burgess (2002) also demonstrate how greater information, and electoral accountability increase government responsiveness. Using data from India the authors show that higher newspaper circulation and electoral accountability in an area encourages state governments to be more responsive to agriculture-related natural calamities.

Some authors argue that formal and even informal institutional quality is positively correlated with development. Using subjective measures of institutional quality from the *International Country Risk Guide*, published by IRIS, University of Maryland including government repudiation of contracts, risk of expropriation, corruption, rule of law, and the quality of bureaucracy, Ferreira (2004) finds that richer countries have higher institutional quality (also see Hall and Jones (1999), and Easterly and Levine (2002) for similar results).

While the institutions analyzed differ, the common conclusion drawn is that communities or countries differ in their control of pollution or management of resources. In communities

[13] Pargal and Mani (2000) is a follow up of Pargal and Wheeler (1996). Using plant level data from Indonesia Pargal and Wheeler (1996) demonstrated the importance of community-factory interactions as an informal regulation of pollution. Using data from Southern India, Santhakumar (2003) verifies that citizen activism can block the establishment of new factories in an area. However, the author argues that citizen activism is not very effective in controlling pollution from existing factories.

where resources are managed well, opportunities to export can lead to real income gains, while in communities where resources are not managed well, the reverse can occur.

Copeland and Taylor (2003b) present a theory of endogenous resource management which reflects the above intuition. They argue that cross-country differences in the effectiveness of resource management can derive from differences in production technology, resource growth rates, and demographic characteristics such as population density, and expected life spans. They also find that access to international markets encourages some countries to effectively manage their natural resources through institutional reform. However, this is not true for all countries. In some countries (especially those with vulnerable slow-growing resources), efficient management is never feasible. They show that for such countries exporting the resource intensive good, trade liberalization reduces long run steady state income.

2.4. Political Economy and Corruption

Several papers analyze the impact of trade liberalization on environmental policy and the environment using political economy models.[14] Governments can use environmental policy as a means to redistribute income to politically influential groups. If trade liberalization reduces income and output in the polluting industry, and if the polluting industry is politically powerful, then the government may face pressure to weaken environmental policy to help shelter the industry from the forces of international competition. The opposite may occur if trade increases income and output in the polluting sector.

There is little empirical work that explicitly incorporates political economy considerations while studying the impact of trade liberalization on the environment. However, there are a few studies that discuss the relationship between trade liberalization and corruption. Krueger (1974) argues that quantitative trade restrictions shift resources from directly productive activities to rent seeking activities, such as corruption. If that is to be believed, trade

[14] See Bommer and Schulze (1999), Fredriksson (1999), Gulati (2003), McAusland (2002), Schleich (1999), and Yu (2000).

liberalization should reduce corruption. In fact, several empirical studies do find such a relationship between trade liberalization and corruption.[15] However, more recent work casts doubts on the robustness of these results.[16] These studies find that the reduction of corruption from trade liberalization is sensitive to the choice of corruption indicator and to sample selection bias. Knack and Azfar (2003) argue that most available corruption indicators only provide ratings for those countries in which multinational investors have the greatest interest. These countries usually include almost all large nations and relatively well governed small nations. They find that the relationship between corruption and trade intensity disappears if they use new corruption indicators and increase country coverage. Nevertheless, there seems to be consensus on a negative correlation between trade intensity and corruption for the sample of larger and relatively richer developing countries. Economies with higher levels of corruption are also likely to have lower flows of Foreign Direct Investment.[17]

All things being equal, an economy with higher levels of corruption is likely to have higher levels of pollution per unit of output (see López and Mitra (2000)). If we combine this with work that suggests that more open economies are less corrupt, thus suggests another channel for via which trade liberalization may affect environmental quality via endogenous changes in the policy process. But until further work, such a conclusion must remain speculative.

3. Environmental policy and the pattern of trade

We now consider how market forces interact with the policy regime to determine the effects of trade on the environment. We focus mainly on composition effects. Although trade can also be expected to generate scale effects (by affecting an economy's growth rate), these are an unavoidable consequence of virtually any type of economic development. Composition effects, however, force us to ask whether trade induces a country to shift towards more or less environmentally intensive activities.

[15] See Ades and Di Tella (1999), Treisman, (2000), and Wei (2000).
[16] Knack and Azfar (2003) and Torrez (2002).
[17] See Fredriksson et. al. (2003), and Smarzynska and Wei (2001).

Much of the literature has been pre-occupied with the possibility that the composition effects of trade will cause pollution-intensive industry to shift from rich to poor countries because of differences in the stringency of environmental regulation. This is often referred to as the *pollution haven hypothesis*.

If the pollution haven hypothesis were correct, a number of implications would follow. First, if poor countries lack adequate and enforceable environmental regulations, then trade liberalization driven by pollution haven forces is likely to increase total world pollution and may lower welfare in low-income countries. Second, such a process could justify concerns raised in richer countries about the possibility of a "race to the bottom." That is, if industry migrates to countries with relatively weak environmental policy, then concerns about the effects of environmental regulation on international competitiveness could lead governments in rich countries to weaken their environmental policy. Finally, if pollution-haven-driven international trade has been an important part of the adjustment process to more stringent environmental policy, then the experience of high income countries in adjusting to more stringent environmental policies may not be a good predictor for poor countries. If rich countries have dealt with environmental problems by shifting dirty good production to poor countries, then eventually the world will run out of new places to shift such production to. Long run abatement costs would therefore increase, and poor countries may not be able to grow their way out of environmental problems.

The literature on pollution havens has focused on two separate hypotheses that are often blurred together. This has led to some confusion in interpreting the empirical evidence. Copeland and Taylor (2003a) suggest that we distinguish between a *pollution haven effect* and the *pollution haven hypothesis*.

A pollution haven *effect* exists if, given world prices, a tightening of environmental policy in a particular country leads to a decline in net exports (or increase in net imports) of pollution intensive goods from than country. In the context of capital mobility, a pollution haven effect exists if tightening pollution regulations leads to a capital outflow in the affected industries. The presence of a pollution haven effect simply indicates that environmental regulations have an influence on trade volumes, plant location decisions, and capital flows.

The pollution haven *hypothesis* is stronger. According to the pollution haven hypothesis, the pollution haven effect is strong enough to be the principal determinant of the direction of trade and investment flows. That is, the pollution haven hypothesis asserts that liberalizing trade barriers will induce polluting industry to migrate (at the margin) to countries with relatively weaker environmental policy. Countries with weaker environmental policy will have a comparative advantage in pollution intensive goods. Moreover, such countries will also attract foreign investment in these sectors.

The theoretical case for the existence of the pollution haven effect is quite strong. The premise is simply that environmental regulations are costly, and that (at the margin), higher costs in a particular jurisdiction tend to make that jurisdiction a less attractive location for production of the affected goods. Two caveats have, however, been suggested. Porter (1991) argues that stricter environmental regulation may actually lower costs by encouraging an industry to be more innovative. Eskeland and Harrison (2003) note that more stringent environmental policy could increase the optimal scale of a firm and thereby increase capital inflows.[18] While these caveats raise the possibility that one might not expect to find evidence of a pollution haven effect in all industries, it is nevertheless fair to say that there is a strong theoretical presumption in its favor.

In contrast, theoretical support for the pollution haven hypothesis is considerably weaker. Differences in pollution policy are only one of many factors that determine trade patterns. Resource endowments, technology, infrastructure, distance, and many other factors all interact with pollution policy differences to determine the trade pattern. The pollution haven hypothesis asserts that pollution policy is the critical factor determining trade patterns. An alternative hypothesis is that other factors are more important. Unless countries are otherwise very similar, or pollution control costs are very high, the theoretical support for the pollution haven hypothesis would seem to be rather weak.

Finally, we should note that developing countries may nevertheless have a comparative advantage in some types of polluting goods even if pollution policy is not an important

[18] They consider only a single firm with no entry and exit and so do not consider the offsetting effects of the increase in average cost implied by environmental regulations that would tend to work in favor of a pollution haven effect. However, in industries with entry barriers, their analysis raises the possibility that the effects of more stringent environmental regulations on trade and investment flows could be ambiguous.

determinant of trade patterns. If polluting goods are relatively intensive in the use of factors in which developing countries are relatively abundant, then developing countries will be net exporters of these goods and trade liberalization could lead to a shift of polluting production to these countries. That is, even if there is no evidence of a pollution haven effect, trade could still shift some types of dirty good production to poor countries.

3.1. Renewable Resource Policy and the Pattern of Trade

The logic of the pollution haven hypothesis has sometimes also been applied to trade in renewable resources. Chichilnisky (1994) considers a world in which North and South each have a stock of renewable resources. The countries are identical except that North fully internalizes property rights while South does not. She argues that the lack of property rights internalization will give South a "false" comparative advantage in renewable resources. Trade will induce entry into the renewable resource sector in the South, and increase pressure on their already over-extended resource stock. In the North, on the other hand, trade reduces pressure on resource stocks.

The distinction between pollution "effect" and "hypothesis" is relevant to renewable resources as well. Comparative advantage in renewable resources is determined by more than just the property rights regime. Differences in technology, capital availability, the natural growth rate of the resource, and other factors may more than offset the effects of differences in property rights.

However, there are several ways in which trade patterns in renewable resources are different than those for polluting goods. The first is that for many types of renewable resources, productivity relies on the health and viability of the natural environment supporting the resource stock. If property rights are not internalized, then an open access resource can become severely depleted. Depletion of the resource will reduce a country's supply and lead to a comparative *dis*-advantage in the resource. Brander and Taylor (1997b) distinguish between mild and severe over-use cases. They consider countries identical except for the property rights regime. In the

mild overuse case, they obtain Chichilnisky's result: weak property rights leads to excessive harvesting, which pushes out the supply curve. However, in the severe overuse case, excessive harvesting depletes the stock and the country with weak property rights enforcement is a resource importer. In this case, openness to trade takes pressure off the resource in the country where it is most depleted. This is the exact opposite in spirit to pollution haven scenarios: trade in such cases is both good for the environment and raises real incomes.

Another way in which composition effects of trade can be different for renewable resources than for polluting goods production arises when there are competing uses for the habitat that supports the resource. Suppose a country has a comparative advantage in agriculture and a comparative disadvantage in forestry. Trade can then take pressure off the forest resource. However, if agriculture and forestry compete for the same land, then a trade-induced shift away from forestry towards agriculture can lead to depletion of the forest as land is cleared for agricultural purposes (Barbier and Schulz, 1997).

Similar effects can occur when there are cross-sectoral pollution externalities. A trade-induced shift from agriculture to manufacturing can take pressure off soils and reduce pesticide use. However, pollution from manufacturing can also lead to soil contamination. Once again, a composition effect that may at first seem to take pressure off a resource may ultimately do the reverse.

3.2. Empirical evidence: The pollution haven effect

Empirical work in this area has been hampered by data limitations. Good data on the stringency of environmental regulations does not exist for most countries. Moreover, to account for unobserved heterogeneity it is necessary to have both time series and cross-sectional variation in the data. This further compounds the data limitation problem.

As a consequence of this, a disproportionately large number of studies use US data. Much of this work exploits variation in the stringency of environmental policy across states or counties within the US. This is not ideal, given the focus of this paper on developing countries.

Nevertheless, we will review the results from some of these studies, as the methodological lessons learned in that literature will likely have wider applications.

We begin by considering studies that test for the presence of a pollution haven effect. That is, these studies try to estimate the effect of variations in the stringency of pollution policy on trade flows, plant location decisions, or direct foreign investment flows.

The first wave of work in this area (up until about 1997) used mainly cross-sectional data, and the results were almost universally negative. Jaffe et al (1995) and Levinson (1996) surveyed this work and concluded that there was little or no evidence that environmental policy had a significant effect on trade flows, plant location or investment flows. This was a striking finding for three reasons. First, it is at odds with the predictions of most theoretical models. Second, if correct, it would suggest that the pollution haven hypothesis is likely to be false as well: if environmental policy does not affect trade flows, then there is little reason to be concerned that freer trade will systematically shift polluting industry to regions with weak environmental policy. And third, it called into question the basis of much of the debate on "race to the bottom." If environmental policy does not affect competitiveness, then there is no reason for governments to be more reluctant to tighten up environmental policy as markets become more internationally integrated.

The results came from several different types of studies. Tobey (1990) used data on factor endowments and a measure of environmental policy stringency to explain net exports of pollution intensive goods for a sample of 23 countries. In all of his regressions, the environmental policy variable was not significant. This result has been widely cited; however, the conclusion is somewhat tenuous. Although the environmental policy variables were not significant, neither were most of the factor endowment measures.

Several other studies of trade flows focus on variation across industries, rather than across countries; mostly using US data. Kalt (1988) and Grossman and Krueger (1993) regress net exports in a sample of US industries on industry characteristics (such as tariffs, shares of various factors in costs, measures of pollution abatement costs (which is meant to capture the importance of environmental policy), and other control variables. These and similar studies tend to find that either that the abatement cost variable is insignificant or that it has the wrong sign

(Kalt (1998) finds that higher pollution abatement costs are sometime associated with increased export success). Similar results were found in the literature on plant location. Levinson (1996), for example, found that differences in the stringency of environmental policy across states in the US had little or no effect on plant location decisions.

A number of explanations for these findings have been suggested. Most authors pointed out that pollution abatement costs were low in most industries (typically less than 5% of costs). Some authors took the sometimes positive association between environmental policy stringency and plant location decisions or net exports as evidence in support of the Porter hypothesis. However, a third explanation is that there were some serious econometric problems (in part driven by data limitations) with earlier studies. A recent group of studies has provided evidence that unobserved heterogeneity across locations and endogenous pollution policy are important enough to bias results if they are not carefully accounted for.

Suppose North is both capital abundant and high income so that it has relatively stringent environmental policy. Moreover, suppose the capital abundance effect dominates so that North exports the pollution intensive good despite having relatively stringent environmental policy. If we ran a regression of trade flows on pollution policy (and failed to account for capital abundance), we would find a positive association between the stringency of pollution policy and net exports. The regression would not reveal a pollution haven effect, even though one is operative (an increase in North's pollution tax would shift its supply of the dirty good inward and reduce its exports). Of course, we could rectify this by controlling for capital abundance, but there are many other location-specific factors that could affect trade flows that we may neglect to account for. In a cross-section framework, we will be unable to account for this type of unobserved heterogeneity; however if we have both time series and cross sectional variation in the data, then the use of fixed effects can help.

Another possibility is that via the political process, pollution policy responds to the pressures of international competitiveness. Suppose that as trade is liberalized, governments try to shelter import-competing industries from foreign competition by relaxing environmental policy. Then (even if stringent pollution regulations do in fact encourage imports) we would find a negative association between net imports and the stringency of environmental policy.

Paradoxically, in cases where there really is the potential for a "race to the bottom", we may be unable to measure a pollution haven effect.

In the context of trade, Levinson (1999) used panel data on hazardous waste trade flows between states in the US. Using data on both trade flows and taxes on hazardous waste disposal, he first used a simple OLS regression and found that higher waste taxes were associated with *higher* import flows of hazardous waste into a state. He notes, however, that states which have attractive sites for hazardous waste processing are more likely to have to respond to waste inflows with stricter environmental regulations. After taking into account the endogeneity of pollution regulations, he finds that, all else equal, higher waste taxes deter waste imports.

Ederington and Minier (2003) use cross-sectional time-series data on net imports in US manufacturing from 1978-92. They treat pollution policy (abatement costs) as endogenous and responsive to political pressure. Using industry fixed effects, they find a small positive effect of pollution policy on imports. However, after correcting for endogeniety, they find a large positive effect. Levinson and Taylor (2003) also use data on US imports. Using industry fixed effects, they find that a small significant and positive effect of higher abatement costs for net imports from Canada and Mexico. The effect is also positive for trade with non-OECD countries, but not significant. However, when they also account for the endogeneity of pollution policy, they find a large and significant effect of abatement costs on net imports, as would be predicted if there is a pollution haven effect.

Several recent studies on plant location, mostly in states in the US, have also found evidence supporting a pollution haven effect. Becker and Henderson (2000) use a panel of county-level US data to investigate the effects of federal air pollution regulations on location decisions for new manufacturing plants in the US. Previous studies had found no significant effect. They had both a better measure of environmental policy, and they were able to control for unobserved heterogeneity across locations. They found a large and significant negative impact of increased stringency of environmental regulations on new plant births. Kahn (1997), Greenstone (2002), and List et al. (2002) have all confirmed these results.

Keller and Levinson (2002) find similar results using data on inward foreign direct investment in US states from 1977-94. Using a pooled OLS regression, they replicate earlier

studies which found that abatement costs do not have a significant effect on invest flows. However, when they include state level fixed effects to account for unobserved heterogeneity, they find that abatement costs have a statistically significant negative effect on foreign investment.

Gray and Shadbegian (2002) use data on the allocation of production across plants in different states in the US in the paper and oil industries during 1967-92. They find evidence that firms shift production to states with less stringent environmental regulations. The results are stronger for the paper industry than for the oil industry. One possible explanation for this difference is that paper is more easily transportable. They note that paper shipments travel an average of 238 miles, while oil shipments travel an average of 79 miles. This suggests that transport costs or other measures of "tradability" may be an important factor which is often unaccounted for in cross-industry studies, a conjecture which receives support from the work of Ederington, Levinson and Minier (2003) who present evidence that pollution abatement costs tend to be higher in industries which are relatively less mobile. If not properly accounted for, this effect can bias results.

While there is now an emerging body of work which finds that pollution regulation does affect trade and investment flows, much of this work has focused on the US. There are as yet almost no studies which attempt to account for issues of endogeneity and unobserved heterogeneity in attempting to determine how pollution regulations may affect trade or investment in developing countries.

Ederington, Levinson and Minier (2003) look at US trade flows, but divide their sample into OECD and non-OECD countries. Their hypothesis is that variations in the stringency of US environmental regulations are likely to be highly correlated with other OECD countries, and so if there is a pollution haven effect, it is more likely to be detected in trade with non-OECD countries. They find evidence in support of this: abatement costs do not have a significant effect on US net imports from OECD countries (the sign of the coefficient is in fact negative). However, abatement costs have a positive and statistically significant effect on net imports from non-OECD countries.

Eskeland and Harrison (2003) consider direct foreign investment across a sample of industries in four developing countries (Cote d'Ivoire, Morocco, Mexico and Venezuela). As with the earlier work on foreign investment, they find little or no evidence that US abatement costs affect the flow of foreign investment to these countries. However, although this study does control for unobserved heterogeneity across regions, it does so by restricting the number of regions to only four.

Smarzynska and Wei (2001) use a firm level data set on investment in 24 transition economies in Eastern Europe and the former Soviet Union. They find some weak evidence that countries with more participation in international environmental treaties are less likely to attract pollution intensive foreign investment. However, their result is not robust to other measures of the stringency of environmental regulation. This study does control for differences in corruption across countries, but is not able to control for unobserved heterogeneity across countries.

To conclude, there is currently very little explicit evidence that environmental policy affects trade and investment flows between rich and poor countries. However, virtually all of the available evidence comes from studies which do not account for the endogeneity of pollution policy and unobserved heterogeneity. This omission is likely to be critically important because there is an emerging body of evidence that plant location within the United States, and US trade and investment flows with the rest of the world *are* affected by environmental policy. These recent studies account for the endogeneity of pollution policy and unobserved heterogeneity across locations. This suggests that it is premature to conclude that there is no evidence for a pollution haven effect. In fact, if there is a pollution haven effect within the United States, it is reasonable to conjecture that such an effect will also be operative in the context of trade and investment between rich and poor countries because of greater variation in the stringency of environmental policy. However, a definitive answer to this question will require more research.

3.3. Empirical Evidence: The pollution haven hypothesis

In our terminology, the pollution haven hypothesis is that trade liberalization will shift pollution intensive industry to countries with relatively weak environmental policy. In contrast to the relatively large number of studies on the pollution haven effect, there have been few studies that explicitly test the pollution haven hypothesis.

Several studies have examined changes in the share of dirty goods in exports from developing countries over time. That is, they study changes in revealed comparative advantage. Low and Yeats (1992) is an early well-known study of this type. They looked at the composition of manufacturing exports and found that over the period 1965-1988, developing countries were increasing their comparative advantage in pollution intensive manufactures. Mani and Wheeler (1997) found similar results.

While these types of results are suggestive, they do not establish whether trade liberalization was responsible for changes in the pattern of industrial production, or whether other factors were more important. Copeland and Taylor (2003a) suggest that capital accumulation or other forms of economic growth in developing countries could also account for the same trends.

An alternative approach is to try to estimate the composition effect of openness to trade directly. Antweiler et al. (2001) use the GEMS data on Sulphur dioxide concentrations to estimate the scale, technique and composition effects of trade. They hypothesize that the composition effect will depend on both per capita income (which will affect the stringency of environmental policy) and capital abundance (which gives countries a comparative advantage in SO2-intensive industry. They define the composition effect of trade as the per cent increase in SO2 concentrations arising from a 1% increase in openness to trade, while controlling for scale, techniques, and other factors. If the pollution haven hypothesis is correct, the composition effect should be decreasing in per capital income: it should be positive for low income countries and negative for high income countries. In fact, they find the reverse. This suggests that higher income countries have a comparative advantage in SO2-intensive industries, so that trade liberalization would shift SO2-intensive polluting industry to richer countries. This is consistent with results from Grossman and Krueger's (1993) study of NAFTA which drew upon CGE simulations of the effects of trade liberalization on trade flows and concluded that NAFTA would, at the margin, shift pollution intensive industrial production to the US. It is also

consistent with the existing pattern of trade, in which pollution intensive industry is heavily concentrated in high income countries.

Much of this work has focused on industrial pollution; however trade may also shift production based on natural capital between countries. If trade increases pressure on renewable resources in countries which do not have institutions that internalize externalities in these industries, then the effects of trade may be potentially more devastating than in the case of the industrial pollution haven hypothesis. This is because excessive pressure on natural capital can both reduce environmental quality and reduce long run real income.

Most of the work on of the effect of trade liberalization on sectors intensive in natural capital has been case studies. Consequently, we do not yet have good evidence as to whether trade liberalization has systematically shifted production in these sectors to countries with weak property rights.

Using an empirical general equilibrium framework, López (1997) and (2000) calculate composition and scale effects for agriculture in Ghana and Côte d'Ivoire respectively. He finds that price movements brought about by trade liberalization in Ghana encourage the expansion of agriculture. This expansion is achieved by pushing the area cultivated into forests. In other words, the composition effect has a negative impact on the environment. Contrary to the case in Ghana, López (2000) finds that Côte d'Ivoire has a comparative advantage in tree crops that are not land intensive. Thus the composition effect of trade liberalization implies that agriculture as a whole becomes less land intensive, and reduces damages to the local biomass. [19]

A potential problem with the composition effect is the implicit assumption of input mobility. Composition effects usually assume smooth structural adjustment. Labor and materials used in the production of the declining industry are assumed to find employment in the expanding industry. However, this is not always true. Labor in developing economies is typically not very mobile. This lack of mobility can be caused by the absence of well defined credit markets, and/or

[19] Like López (1997), Benhin and Barbier (2001) also deforestation in Ghana. They authors analyze the impact of economy-wide reforms on deforestation in the country. They find that a rise in the price of cocoa, or a decline in input prices leads to an expansion of land employed in cocoa, inducing deforestation. Their analysis is different from López (1997) in that it does not estimate composition effects from trade liberalization.

the inaccessibility of education and labor training facilities. Barbier (2000) provides an example where landless, near-landless workers, and the rural poor displaced by agro-industrialization migrate to forest frontier regions and marginal lands. This displacement can potentially nullify the reduction in deforestation gained from agro-industrialization. Similar effects are pointed out in López (1998c) and Barbier and Burgess (1996). [20]

3.4. Measuring the effects of trade on environmental outcomes

The net effect of trade on the environment depends on the sum of scale, composition, and technique effects. Since we can expect heterogeneity across countries in both the direction and magnitude of these effects, we should also expect to see considerable differences across countries in the net effect.

It is useful to think of several different types of countries, classified by their comparative advantage and property rights regime:

I. **Natural-capital-intensive exporters with weak property rights regimes.** These countries are potentially vulnerable to increased environmental degradation from trade liberalization. Trade will place increasing pressure on their natural resources. This can lead to both resource depletion and real income losses. Trade may make it harder for such countries to escape from a poverty trap.

II. **Natural-capital-intensive exporters with strong property rights regimes.** These countries should be able to experience real income gains from trade liberalization without suffering severe resource depletion.

III. **Low income pollution-intensive manufacturing exporters.** These countries will have a comparative advantage in pollution intensive industries and may have relatively weak environmental policy because of their low income. Trade will

[20] Barbier and Burgess (1996) study the effect of reforms induced by the North American Free Trade Agreement on maize production and subsequently deforestation in Mexico. They find that while trade liberalization and economic growth tend to reduce agricultural expansion, return migration to the rural areas during the transition is likely to have an opposite effect. They find that this return migration in the short run can outweigh the positive effects of liberalization and cause overall negative effects on the forest cover.

stimulate pollution intensive production, and will increase industrial pollution. If trade helps to increase real income, improved environmental regulation may emerge, depending on the responsiveness of government. Policy improvements may or may not dampen the deterioration of environmental quality.

IV. **Low income exporters of relatively clean goods.** These countries will also have relatively weak environmental policy, but with a comparative advantage in relatively clean production, both real income and environmental quality may improve with trade. However, increases in real income will increase consumption of pollution intensive goods such as automobiles, and this can also lead to an increase in pollution.

Relatively few studies undertake a comprehensive accounting of the effects of trade on the environment. Applied general equilibrium studies come closest to doing this. Their advantage is that they can be used to run counterfactuals to isolate the pure effects of trade from other effects. Moreover, they can also isolate composition effects, and they can take into account a wide range of different environmental incomes. The disadvantage of these types of studies is that they are simulations and so do not measure actual outcomes.

Some studies investigate the impact of trade liberalization on natural resources (examples are López (1997) and López (2000), and Bandara and Coxhead (1999)). Others investigate the impact on air and water pollution (examples are Strutt and Anderson (2000), and Unteroberdoerster (2003)). Results often vary across countries and types of resources.

López (1997) finds that trade liberalization has a negative effect of biomass in Ghana. This may be an example of a type I country in our classification above. In contrast, López (2000) finds that trade liberalization has a positive effect on biomass in Côte d'Ivoire. As explained earlier the main difference between these two studies lies in the composition effect resulting from trade liberalization. Similar to López (2000), Bandara and Coxhead (1999) find that the composition effect of trade liberalization increases demand for tea production (a relatively less erosive sector) in Sri Lanka. In other words, they too find that trade liberalization has positive effects on the environment. These latter two countries may be examples of our type IV countries above.

Unteroberdoerster (2003) studies the impact of trade liberalization on the environment in countries that make up the Asia Pacific Economic Cooperation (APEC). He finds that trade liberalization does not worsen the environment in these countries. He also finds that an increase in environmental standards by trading partners also has an insignificant impact on pollution in these countries. The primary reason is the favorable composition effect from trade liberalization in most of these countries.

Strutt and Anderson (2000) undertake a comprehensive applied general equilibrium analysis of both WTO-based trade policy reform, and trade policy reform slated for Indonesia under the APEC. They first simulate a base case scenario in which Indonesia grows over the next decade under the current trade regime. Pollution rises. This reflects a combination of industrialization and growth in the context of a relatively weak environmental policy regime. They then simulate a scenario in which Indonesia grows in the context of trade policy reforms. Pollution still grows, but less than in the previous scenario. Moreover, there is less depletion of natural resources. This is because the composition effects of trade liberalization on pollution are negative. Trade liberalization shifts the growth path to relatively cleaner production.

Among empirical analyses of trade reform on the environment, Vukina et al. (1999) examine the relationship between policy reforms and composition of pollution in output in the former Centrally Planned Economies. They use information on 13 pollutants and the energy intensity of output. They find, "policy reforms affecting price liberalization, trade and the foreign exchange system had a beneficial effect on the composition of manufacturing output steering it towards less-polluting sectors." The authors link this improvement in composition to environmental policy reforms that accompany trade reforms. It is important to note the large and negative scale effect in most of these countries. The authors find that in addition to policy induced reduction in pollution; large scale decreases in economic activity also lead to large decreases in pollution.

Another approach to measuring the effect of trade on the environment is to ask whether there is a systematic relationship between openness to trade and environmental quality. Several of the Environmental Kuznets Curve studies (e.g., Grossman and Krueger (1993) and Gale and Mendez (1998)) include openness to trade as an explanatory variable to explain pollution levels.

These studies typically find that openness is either insignificant or else has a positive effect on environmental quality. Frankel and Rose (2001) use a similar approach, but control for the endogeneity of openness to trade. They also find a positive effect of openness on environmental quality.

These studies suggest that on average, trade does not systematically worsen environmental quality. However, they have a couple of important weaknesses. First, they typically focus on only a small number of pollutants. Second, they do not account for heterogeneity across countries in the response of the environment to trade. If some countries have a comparative advantage in dirty goods, and others in clean goods, then we may well find that on average, trade does not have much of an effect on the environment. But this may mask significant effects on individual countries.

Antweiler et al. (2001) used data on sulphur dioxide pollution to estimate scale, technique and composition effects of trade. They allowed composition effects to vary across countries because of differences in comparative advantage. When they add up the scale, technique and composition effects, they find that trade is good for the environment (as measured by SO2 concentrations) for the average country in their sample. However, they also find heterogeneity across countries. The composition effect tended to be negative (pollution-reducing) for poorer countries (reflecting a comparative disadvantage in SO2 intensive industry) and positive for richer countries.

4. Policy Issues

Much of the work on trade and environment has been stimulated by policy issues. From a developing country perspective, these fall into two major categories: internal domestic policies for developing countries; and the implications of policies adopted by other countries and / or their implementation via multilateral trade organizations such as the WTO, the European Union, etc.

4.1 Internal policies

If all countries had efficient domestic environmental policies and well defined property rights for natural capital, then (with the exception of transboundary or global environmental problems), there is a strong theoretical case for avoiding links between trade policies and the environment. The major insight here comes from the policy targeting literature (Bhagwati, 1971): environmental distortions are best dealt with via environmental policy, and once externalities are internalized, the optimal trade policy is independent of environmental concerns (Bhagwati and Srinivasan, 1996).

However, most (and perhaps all) countries do not fully internalize environmental distortions for many different reasons, including information problems, political pressures and a lack of institutional capacity. The problem is particularly acute in many developing countries. Given this reality, the case for pursuing trade policy reforms independently of environmental concerns is considerably weaker. Copeland (1994) considers trade policy reform in the presence of exogenous environmental distortions. If the export sector is on average intensive in its use of environmental inputs, then broad-based trade policy reform can reduce welfare by exacerbating environmental distortions. On the other hand, if the import-competing sector is environmentally-intensive, then broad based trade policy reforms can yield a double dividend - they yield both gains from trade and shift resources out of environmentally damaging activities. Copeland also shows how trade reform in the presence of capital mobility can exacerbate these strength of these effects.

It is always possible to design trade policy reforms that improve welfare [Copeland (1994) and Beghin et. al (1997)]: such reforms attempt to stimulate clean industries and depress dirty industries. One can think of trade policy as a second best instrument of environmental policy since it implicitly taxes or subsidizes various production activities in the economy. However, the information requirements for such reforms are significant.

A better strategy is to consider coordinated trade policy reforms and environmental policy reforms. That is, if broad based trade policy reform will stimulate the environmentally intensive sectors, then a reform of environmental policy directed towards those sectors can mitigate possible problems. While such a strategy will work in theory, it may not be feasible in practice because of institutional constraints and political problems. This raises the issue of timing. Should environmental policy reform be a precondition for trade policy reform?

The sequencing of policy reform is best dealt with in a model with endogenous environmental policy. Here the literature on income effects and the political economy of protection is relevant. First consider our type III countries, which export goods intensive in industrial pollution. If trade raises both income and pollution, then we may expect the income effect to increase support for improved environmental policy in countries where governments are responsive to consumer preferences. This suggests that for these types of countries, making environmental policy reform a pre-condition for trade policy reform could be counter-productive.

The situation is quite different for our type I countries which are heavily dependent on natural capital exports but which also have weak property rights regimes. Trade policy reform in these countries may not raise long run real income, and hence the case for coordinating environmental and resource management reforms with trade policy reforms is quite compelling. Unfortunately such reforms may be difficult in the presence of poverty and with vulnerable natural capital.

When environmental policy fails to fully internalize externalities, the instruments used to control pollution can be important. This suggests that when reforms are implemented, and policymakers anticipate that they may not be able to fully internalize externalities, the choice of instruments can have implications for the consequences of future trade policy reforms. Copeland (1994) and Copeland and Taylor (2003c) note that (if they are enforced) pollution quotas,

ambient standards and tradable permits all do a better job than exogenous taxes or emission standards of protecting the economy from increased pollution when trade liberalization stimulates pollution-intensive activities. Although there is a strong efficiency-based case for market-based instruments such as pollution taxes, these policies require an active and flexible regulator to adjust their levels in responsive to increased pressure on the environment arising from export expansion or other sources of growth. If such flexibility is not going to be politically feasible, they lose some of their attractiveness.

4.2. External policies

Much of the debate about linkages between trade and environmental policies in a multi-country context revolves around issues of market access. Environmentalists concerned about environmental problems in other countries often propose to make the right to import certain products contingent on meeting certain environmental standards. Those concerned about the competitiveness aspects of environmental policy often propose to either "level the playing field" by tying participation in trade agreements to the adoption of environmental standards, or by using "eco-duties" to force foreign firms in countries with weak environmental policy to bear the same environmental cost as domestic firms subject to stringent regulation.

Competitiveness issues

Environmentalists fear that without international coordination, governments will sacrifice environmental quality and the welfare of their citizens to become globally competitive (see Nader et. al.,(1993)). This is often referred to as the "race to the bottom' hypothesis.[21]

Wheeler (2001), Vogel (2000) and others argue that there is little empirical support for this hypothesis.[22] The evidence is of two types. First, early work (as surveyed by Jaffe at al

[21] See Daly (1993, 1997) and Anríquez (2002). For theoretical examination of this issue, see Rauscher (1995) and Markusen et al (1995) and Oates and Schwab (1988).

(1995)) found little empirical support for the pollution haven effect. If differences in environmental regulations do not affect trade flows, then there is little justification for governments to weaken environmental policies to subsidize domestic firms. However, as we have discussed earlier in the paper, recent work suggests that while there is little evidence for the strong form of the pollution haven hypothesis (pollution policy is not the principal determinant of trade patterns), there is emerging evidence that changes in environmental policy do affect plant location and production decisions at the margin. If environmental policy does affect competitiveness, then the 'race to the bottom' issue is not likely to go away.

The second type of evidence looks at actual government behavior. Wheeler (2001) points to evidence of improvements in air quality and other environmental indicators in the face of increased trade. He suggests that this is inconsistent with a weakening of environmental policy in response to increased pressures of trade. However there have been very few studies that attempt to explicitly measure the policy response of governments to freer trade. The two recent studies that do attempt such an exercise find some evidence in support of the hypothesis. Eliste and Fredriksson (forthcoming) and Ederington and Minier (2003) find evidence of the use of environmental regulation as a secondary means to provide protection to domestic industries.

Even if there is does turn out to be some evidence that shows that concerns about competitiveness do affect environmental policy, the possibility of a literal race to the bottom seems highly unlikely. The main reason is that weak environmental policy is an inefficient way to subsidize domestic firms - environmental control costs are relatively small, and weakening environmental policy imposes costs on others and encourages green lobbies to become more active. Instead it is more likely that competitiveness issues may act as a damper on the aggressiveness of environmental policy in some industries in high income countries.

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[22] In obvious contrast to the race to the bottom hypothesis Vogel (2000) also informally discusses the "race to the top hypothesis." By *race to the top* he implies that economic openness and capital mobility might have encouraged nations to enact standards higher than they would have in absence of increased economic interdependency (also termed the *California Effect).* One of the reasons presented for race to the top is alliances between domestic producers and environmentalists. If both groups are politically influential, and domestic producers are relatively more efficient at incorporating environmental standards than their foreign competitors the government might raise standards instead of lowering them. He cites the example of strict German automobile emission controls in the 1980's. The author says that these emission controls protected the domestic market share of German automobiles as Italian and French car manufacturers found the controls too costly to comply with (see Vogel (1995) for other examples).

What are the implications for developing countries? The major effects are likely to be that the 'race to the bottom' issue increases political support for demands for linking environmental standards to trade agreements, and in some cases for policy harmonization. There is some support for including labor and environmental agreements in the World Trade Organization (WTO) (see Suranovic (2002)). Such agreements might require minimum environmental and labor protection across all countries and allow countries to punish violations with import restrictions.

The logic for linkage arises mainly from a concern that when the use of traditional barriers to trade is increasingly restricted, environmental policies can be used as a substitute for trade policies. Ederington (2001) and others have shown that in such cases, the first best solution can be obtained if countries agree to expand the trade agreement to restrict environmental policy as well. The difficulty with this approach is that for such an agreement to be efficient, environmental standards will in general have to be different across all countries. Efficient environmental policy should reflect local marginal damages and local marginal abatement costs. These vary with income, factor endowments, the sensitivity of the local environment, and many other factors. The information requirements for setting such standards efficiently are enormous. Moreover, policy in most high-income countries is set via a political process and not necessarily in a way that is socially efficient. Consequently, an attempt to enforce such linkage on a global basis would introduce so many inefficiencies that it is likely to be unworkable. There is more potential for such an approach to work in regional trade agreements (such as in the EU), where countries are similar in income and in their institutional capacity to deal with environmental problems.

Current WTO practices distinguish between trade measures that target the characteristics of products that enter a country (such as automobile emission standards) and those that target the process by which an imported good is produced in a foreign country. The former are allowed, subject to a national treatment rule (and some other conditions) while the latter tend to not be allowed. This is a distinction which is not ideal, but which is probably reasonable from the perspective of developing countries.

The regime is not ideal because it is inconsistent in the way that subsidies are treated. Explicit export subsidies are vulnerable to countervail duties under WTO rules. But implicit subsidies because of weak environmental regulations are not. This seems anti-environment because it takes the norm to be the market outcome (no explicit subsidies) while in the case of pollution and other environmental problems, the non-interventionist market outcome is not efficient. However, because of the information problems discussed above, opening the door to process standards or "green countervail" would create so many opportunities for disguised protectionism that it is unlikely to generate wide support. Hence a norm that does not allow trade-related process standards or green countervail is in the interests of both developing countries and developed countries.

The current rules on product standards do allow countries some room to manipulate standards to protect local industry, mainly by "raising rivals' costs" (Salop and Sheffman, 1983). If it is easier for local firms than foreign firms to adopt a standard, then the implementation of a more stringent standard will benefit local firms at the expense of foreigners. That is, disguised protectionism is possible even under a national treatment regime. The WTO has moved beyond national treatment, however, by requiring some scientific justification for standards. This has angered some environmentalists, but from the perspective of developing countries reduces the scope for disguised protectionism.

Finally, although most developing countries tend to oppose harmonization across the entire spectrum of environmental policies, it is worth noting that in some cases, harmonization in sanitary and phytosanitary standards across developed countries might actually be beneficial for developing countries. Wilson et. al. (2003 and forthcoming) argue that the unilateral food safety standards are economically inefficient as they create very high transaction costs for exporters. Using data on global trade patterns for certain food products the authors find that if standards recommended by Codex Alimentarius Commission (a commission created by the Food and Agricultural Organization) are adopted there would be large increases in world trade in the food products analyzed. They also find that the largest gainers from such a harmonization would be developing countries.

Targeting foreign pollution

A second market access issue arises from attempts by policymakers or environmental groups to influence environmental policy in developing countries. Many of theses issues involve natural capital such as rain forests, endangered species, and biodiversity issues.

These types of issues have been the subject of some high-profile GATT and WTO cases. In the tuna - porpoise case, the United States banned imports of tuns from Mexico unless Mexican fishers adopted certain practices that prevented porpoise deaths during harvesting (the issue is that porpoises get caught in the fish nets). Mexico filed a complaint with GATT arguing that this was an unfair restriction on imports. The GATT panel sided with Mexico. Although the panel decision was never adopted, it created an uproar among environmentalists because it was taken as a signal that GATT was not environment-friendly.

In the shrimp-turtle case, the US banned imports of shrimp from some Asian countries because of the possibility that endangered sea turtles were killed during harvesting. The US made adoption of US fishing practices (which involve the use of turtle excluder devices) a condition of market access. India, Malaysia, Pakistan and Thailand complained to the WTO that this was an unfair restriction on imports. The WTO panel ruled against the US. Again, environmentalists were unhappy. However, in this case, the WTO panel went to some length to emphasize that it did not rule out the possibility that actions by the US to protect sea turtles (perhaps with trade policy) might be GATT-consistent. Rather it argued that the implementation of the US policy was discriminatory because it treated different members of the WTO differently (Caribbean fishers were subject to different rules than Asian fishers).

These cases have received a great deal of attention. In both cases the GATT / WTO ruled against the attempts by the US to impose its environmental standards in other countries. The shrimp - turtle ruling is not a clear test of the whether such extra-territoriality is WTO-legal because of the discriminatory aspects of the US policy. However, even if more such policy initiatives are implemented by the US or other countries in the future, it is worth noting that the amount of trade involved is very small, the number of cases so far is small, and the trade impact

of such cases pales in comparison to other trade-distorting practices of high-income countries (such as agricultural subsidies, restrictions on textile trade, etc.).

Global environmental problems

Non-cooperative behavior between jurisdictions will lead to inefficiently low levels of environmental regulation when environmental problems are inter-jurisdictional. Some examples include acid rain, depletion of the ozone layer, shared fisheries, biodiversity issues, and global warming. Here there exists a justification for either multilateral or bilateral coordination in setting the environmental policy. While coordination is desirable in the case of several global environmental problems it is usually hard to achieve.

Global environmental agreements are a possible solution. In order for the solution to work many complexities need to be dealt with (see Barrett (2002) for an excellent discussion of international environmental agreements). Some of these are: enforcement of the agreement, the terms that would achieve participation, etc. Ideally these agreements would be self enforcing and elicit large scale participation by most countries. More often than not even after longs periods of negotiation large scale participation is hard to achieve.[23]

As an alternative several authors argue that environmental agreements should be linked with trade agreements. Some environmental agreements that contain trade sanctions. Examples are the Montreal Protocol on Substances that Deplete the Ozone Layer, or the Convention on International Trade in Endangered Species that bans trade of certain endangered species and by-products like ivory and furs. In contrast, the WTO usually does not accept differences in environmental policies as grounds for trade sanctions.

Linkages between trade and environmental agreements can increase incentives necessary to encourage enforcement of agreements on global environmental problems (see for example, Limão (2002), Ederington (2001), Abrego et. al. (1997), Cesar and Zewe (1994), and Runge

[23] Barrett (2002) classifies the agreements into two types, broad but shallow (where there is broad participation but little is achieved by the agreement), and narrow but deep (narrow participation with stricter requirements).

(1994)). The basic intuition behind all these studies is that when trade and environmental policies are strategic complements, linking the two agreements creates incentives for greater cooperation in both issues. Linking the two agreements might allow greater reductions in tariffs and improvements in environmental standards, and thereby raise world welfare.

Nevertheless, there are also several arguments against linkage. The most pertinent one is that linkages will cause a large increase in trade disputes. Looking at recent trends this argument might be important. From 1994-99 the number of trade disputes involving non-trade issues tripled as compared to the previous four years (Limão (2002)). This increase was largely caused by intellectual property issues. Non-trade issues are typically harder to prove, and increase the cost of litigation in any dispute. Thus while linking trade and environmental agreements might encourage greater adherence to both agreements, it might also make the task of dispute settlement in these agreements harder.

From a developing country perspective, whether or not such agreements are in their interest depends on the terms negotiated. If pressure on the global environment is proportional to consumption, and if willingness and ability to pay for environmental quality is an increasing function of income, then it is both efficient and fair for higher income countries to bear a larger share of the costs of implementing international environmental agreements.

5. Conclusion

Increased international trade between rich and poor countries is not incompatible with improvements in environmental quality. The effect of trade on the environment depends on the interaction between the pattern of trade and the institutions in place to manage environmental policy.

While there is some evidence that differences in environmental policy do affect trade and investment flows, there is no evidence that it is one of the major factors. And there is little convincing evidence that trade liberalization leads to pollution havens. However, even if environmental policy is not an important determinant of trade flows, some countries will

nevertheless have a comparative advantage in environmentally intensive industries, and trade will lead to increased pressure on their environment. Whether or not this leads to excessive deterioration of environmental quality depends on the policy regimes and the institutions in place to manage resources and the environment. If there is good domestic environmental policy in place, there is no reason for increased trade to cause environmental problems - in fact in can yield benefits by providing increased access to environmentally friendly technology from other countries.

In countries with weak environmental policy regimes, trade can lead to increases in pollution and degradation of natural capital. If trade also contributes to income growth, there is some evidence that the increase in income will increase the demand for environmental quality and can lead to improved environmental policy. However countries with weak property rights regimes that are heavily dependent on natural capital exports can potentially suffer increased environmental degradation without offsetting income gains. In such countries, improvements in resource management and environmental policy may be an important pre-condition for broad-based trade policy reform.

There has been some support for linkages between trade policies and environmental policies in global trade negotiations. This has roots in concerns about both competitiveness and environmental quality. To deal with competitiveness issues, the WTO currently bans explicit export subsidies. However it tolerates implicit exports subsidies arising from weak environmental policy. While this is inconsistent, an attempt to make market access contingent on meeting environmental standards would lead to disguised protectionism. Consequently, this type of linkage at the global level is in the interests of neither developing nor developed countries.

Linkage to address issues of environmental quality is more likely to occur. Currently only a small amount of world trade is affected by such measures. However, there is likely to be pressure for more such linkage in the future, and developing country interests may be best served if these issues are dealt within a multilateral forum rather than on a unilateral basis.

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