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Master in Economic Development and Growth

Trade and the Environment in Central America

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Abstract: During the last decades, the policies of trade liberalization and export promotion have been crucial to Central America's economic growth. Because of the linkages between trade and the environment, this dramatic shift in Central America's trade patterns could have important implications for the environment and use of natural resources. This paper looks at the dynamics between trade and the environment in the Central American region during the decade of the 1990s, focusing on export flows with its main partner, the United States. By making use of relevant econometric techniques, such as instrumental variables and fixed effect estimation, in order to address problems caused by the endogeneity of environmental policy and unobserved country characteristics, we found evidence supporting the existence of a pollution haven effect. These results show that after controlling for other factors that influence trade flows more stringent environmental regulation acts as a deterrent to dirty good production.

Key words: Pollution Haven Effect, Environment, Central America

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1. Introduction

Trade liberalization is usually seen as a way of stimulating economic growth in developing countries. However, along with the potential benefits that this policy can bring it is also important to assess whether such initiatives can lead to negative outcomes for the environment. During recent years the subject of the environmental consequences of trade liberalization has become a topic of increasing concern which has also called for ample debate. In the Americas, this debate started since the early 1990's when the North American Free Trade Agreement (NAFTA) allowed for the direct competition between companies located in high income and strongly regulated countries, such as the United States (US) and Canada, and companies located in a lower income and weakly regulated country, such as Mexico. Critics of this treaty pointed to the difference in environmental control costs across countries, and the already poor environmental record in the Maquiladora sector in Mexico, to argue that NAFTA was on the way to become an environmental disaster for Mexico and a jobs disaster for the US and Canada (Grossman & Krueger, 1994). Thus, the economic literature related to these issues was stimulated by the policy debates of these past two decades. A large part of the recent work focuses on policy analysis through testing hypotheses about the dynamics of trade, growth and the environment.

In the last decades, countries from the Central American region have searched for growth and development through their inclusion in the world's economy. The policies of trade liberalization and export promotion have been crucial to Central America's current economic development. To this end, the region has pursued an approach to gradually reduce trade barriers and increase the outward orientation of the economy. This process of liberalization occurred initially under the Structural Adjustment Program (SAP), which called for the adoption of policies based on the Washington Consensus. The ultimate goal of this set of policies was to promote economic stability and, in turn, stimulate the reallocation of resources toward the export sector. These policies were complemented by incentive programs for the promotion and diversification of non-traditional exports (Desruelle & Schipke, 2008).

Because of the linkages between trade and the environment, this dramatic shift in Central America's trade patterns could have important implications for the environment and use of natural resources. Although the precise environmental impacts of the different trade liberalization programs undertaken are often difficult to estimate, an analysis of the dynamics of trade in the region could give us a broad understanding of the environmental implications of greater economic openness. This could provide useful guidance for incorporating environmental concerns in economic policy making. For example, trade may encourage a relocation of polluting industries from countries with strict environmental policy to those with less strict policy. These shifts may additionally increase global pollution or they may have a negative effect on environmental policy formulation, as countries will not be willing to strengthen their environmental standards in order to avoid losing

competitiveness. Here is where the issue of the environmental impact of trade liberalization comes to play.

A key question of this study will be whether the significant acceleration of Central American economic growth under trade liberalization and other structural reforms since the 1990s has led to environmental improvements, as argued by advocates of trade and investment liberalization, or whether, as maintained by many environmentalists, has occurred at the expense of the environment.

Two central hypotheses have been derived from this debate. The first, referred to as the *pollution haven hypothesis*, states that increasing trade may promote that developing countries with lax environmental standards will specialize in the production of high polluting goods. In contrast, the *factor endowment hypothesis*, predicts that the liberalization of trade will lead to trade patterns consistent with the Heckscher-Ohlin (HO) theory of comparative advantage, and thus, based on factor endowment differentials without influence of environmental regulations (Copeland & Taylor, 2004).

Early studies on the link of trade and the environment have concluded that there is little connection between the stringency of environmental regulation and trade flows. Nevertheless, more recent work suggests that there could be some issues with these studies' estimation approach that may have led to these results, such as the endogeneity of pollution abatement costs and unobserved country characteristics. Therefore, by making use of econometric techniques like instrumental variables and fixed effect estimation to address the problems caused by endogeneity and unobserved characteristics, this later group of work has found some evidence supporting the existence of a *pollution haven effect*. This evidence shows that after controlling for other factors that influence trade and investment flows more stringent environmental regulation acts as a deterrent to dirty good production. Our study will follow this same line of work by making use of the appropriate econometric techniques to account for endogeneity and unobserved characteristics.

This paper then aims to contribute to this recent literature by evaluating the implications that environmental policy has had on trade flows during the initial period of liberalization that took place in the Central American Region (Costa Rica, El Salvador, Guatemala, Honduras, and Nicaragua) and Dominican Republic during the 1990s (1990–1999). Our theoretical framework builds upon the standard models used in the study of international trade and the environment, such as the Heckscher-Ohlin model, Copeland and Taylor's (1994) model, and the Gravity model. From this, we derive an econometric approach which as mentioned, in line with the later group of empirical work, will make use of fixed effects and instrumental variables estimation in order to account for the problems of endogeneity and unobserved characteristics mentioned in the literature.

2. Theory

This section addresses the basic theories and models that will be used throughout this paper and provides the foundation for the analysis of trade and environmental regulations.

2.1 International Trade and the Environment

The theory of international trade is concerned with the structure of trade, specifically which goods are either exported or imported by each country and the reason behind this patterns. It also looks at the gains from trade and how are these distributed, at the determination of relative prices, the process of international specialization, and the consequences on the domestic patterns of consumption and production (O'Brien & Williams, 2007).

Heckscher-Ohlin Model

When we look at the traditional theory of international trade we can identify one essential model that has been used as the foundation for explaining the dynamics of international trade and the environment: the Heckscher-Ohlin theory. The Heckscher-Ohlin theory provides an explanation for the pattern of production and trade that results when countries have different endowments of factors of production, such as capital, labour, and land. The central message concerning trade patterns is that countries tend to export goods that are intensive in the factors with which they are abundantly endowed. An important implication of this is that trade has an effect on the relative earnings of factors, and thus, it tends to lead to the equalization of prices of factors across countries. This is demonstrated using a relative supply and relative demand analysis that shows that the country with a relatively abundant endowment of a certain factor will produce the good that uses that factor more cheaply than the other country (O'Brien & Williams, 2007).

As mentioned, the study of international trade and the environment has been based in the Heckscher-Ohlin model by using a similar approach, in which international trade is explained by differences in the environmental policy of countries, states, or regions. Copeland and Taylor (1994) analysed the issue by using applied theory in what is considered a seminal work in the trade and environment literature. They develop a two country static general equilibrium model of international trade with a range of goods differentiated by their pollution intensity. In this model, there is only one primary factor of production, human capital, and for the most part the authors assume countries only differ in their endowment of this factor. The focus is on how differences in human capital across countries affects their income, regulation, and resulting trade flows and pollution levels. A review of this model will provide the foundation for our study and will set the stage for our survey of the empirical literature.

Copeland and Taylor's Model

In their paper, Copeland and Taylor (1994) examine the effects of trade on the environment in a small open economy facing fixed world prices in order to emphasize three major points: a) that a country's characteristics, while helping to define its comparative advantage, determine the effect of trade liberalization on the environment; and therefore, not all countries will have the same results; b) that the effects of trade on the environment will also be contingent on whether environmental regulation is rigid or if it adjusts to the changes brought about by trade; c) that the welfare effects of trade liberalization differ as well, base on both a country's comparative advantage and the flexibility of its policy regime. In addition, the authors also look at a two-region model to evaluate two of the major hypotheses that relate country characteristics to the environment; these are the factor endowments hypothesis and the pollution haven hypothesis.

Copeland and Taylor (1994) explain that before trade liberalization, two types of distortions are present in the economy, trade barriers and an inefficient pollution policy. The consequences of having a weak pollution policy can either be reduced or aggravated by the reduction in trade barriers. Therefore, the standard gains predicted from trade theories do not really apply. As such, in order to examine the welfare effects of trade liberalization, these authors propose to consider a different model in which we can evaluate the effects of a small fall in the trade friction (δ) on the utility of a representative consumer.

For this, the authors assume that there are N identical consumers in the economy, with each consumer maximizing utility and treating pollution as a given. Preferences over consumption goods are homothetic and the utility function is separable with respect to consumption goods and environmental quality. Based on this, the indirect utility function for a typical consumer would be:

$$V(p, I, z) = v\left(\frac{I}{\beta(p)}\right) - h(z)$$

where z represents pollution emissions, h is increasing and convex, , I is per capita income, β is a price index, and v is increasing and concave. Pollution is damaging to all consumers and is treated as a pure public bad, thus, all consumers experience the same level of pollution.

For modelling purposes, they capture the effects of increased opportunities to trade by assuming that there are some trade frictions between countries that can be reduced. This is done by assuming that trade consumes real resources, and the amount of trade frictions increase as δ rises. Therefore, an importer who wants to receive one unit of X from the foreign country has to ship (1+δ) units because δ is lost in transport. Trading costs contribute to the disparity of domestic and foreign price of a good. So if we let p denote the world price of X, then the price of X for an importing country is:

$$p_m^d = p(1 + \partial)$$

On the other hand, in the case that home exports X, to deliver a unit of X to a foreign market (where the price is p), a home exporter must send $(1+\delta)$ units, which are acquired locally at the domestic price p_e^d. Thus, the domestic price is lower than the foreign price:

$$p_e^d = \left(\frac{p}{1+\partial}\right)$$

How this price compares to the world price depends on the country's comparative advantage. So based on the indirect utility function for a typical consumer, and after further manipulation, we replace p with p^d and differentiate to obtain:

$$\frac{dV}{V_I} = -Mdp^d + (\tau - MD)dz$$

where MD is a representative consumer's marginal damage from pollution, or the marginal rate of substitution between pollution and income; and τ is a price that firms face for each unit of emissions that they release. This price may be implemented with an emissions tax for example.

According to Copeland and Taylor (1994), trade liberalization will have two effects on welfare: 1) the standard gains from increased trade, and 2) the consequent change in the environment. Both importers and exporters will see positive gains from trade, since if Home imports *X*, then *M > 0* and the domestic price of *X* falls with trade liberalization, and then, $Mdp^d < 0$. If Home exports *X*, then *M < 0* but the domestic price of *X* rises with trade liberalization, but once again we find $Mdp^d < 0$.

The authors note, however, that changes in pollution can reduce the benefits of trade liberalization. For example, when emission intensities are constant and regulation is lax *(τ - MD),* if home exports *X*, pollution rises with trade. Since the pollution tax is lower than the marginal damage, the increased pollution would lower welfare *(τ -MD) dz<0* . Therefore, the net welfare effect of liberalization is in this case ambiguous. One would have to compare the costs of greater pollution with the benefits of increased goods consumption. Instead, if home imports *X*, trade liberalization can both decrease pollution and generate increased consumption. Once again, with lax pollution regulation *(τ - MD)*, the economy would gain from reduced pollution and the standard gains from trade. In addition, the policy instruments that are used also have an important role in defining the welfare effects of trade liberalization. For example, if pollution regulation is in the form of a binding aggregate pollution quota, then increased trade would always lead to higher welfare, even if marginal damage is high and pollution regulation is weak. This is because with a binding pollution quota, pollution does not change with trade liberalization, and in this case, we would have *(τ -MD) dz=0*, which would leave us only the standard gains from trade (Copeland & Taylor, 1994).

So, the conclusion brought by Copeland and Taylor (1994) is that if environmental regulations are not responsive then the welfare effects of trade liberalization will vary according to the pattern of trade, the kind of policy instrument used, and the stringency of

pollution regulation already in place. One can see this, for example, in the case that the number of pollution permits is kept constant during trade liberalization, then trade would end up raising welfare with no additional environmental consequences. On the other hand, if pollution is regulated based on emission intensities and these are unchanged with trade, then trade would lead to increase pollution in countries with a comparative advantage in dirty goods, and decreases it in countries with a comparative advantage in clean goods. In this way, in cases on which pollution policy does not completely internalize externalities, countries with a comparative advantage in dirty goods may end up losing from trade.

The Determinants of Comparative advantage

An important subject in the literature on the effects of trade on the environment has been to look at what type of countries attract dirty industries when trade is liberalized. This is because a country's characteristics, or more specifically, its comparative advantage helps to determine the composition effect of trade liberalization, which in general plays a key role on the final outcome (Cunha & Muthukumara, 2011).

The literature presents two basic theories. One is the pollution haven hypothesis, which states that countries with relatively weak environmental policy, usually seen as low income countries, will specialize in production of dirty goods. On the other hand, an opposing view is that trade patterns are determined by standard forces, such as technology and differences in factor endowments, and that environmental policy has no effect on this outcome. Therefore, under this view, referred to as the factor endowments hypothesis (and which pretty much resembles the HO model), capital abundant countries will tend to export capital-intensive goods, irrespective of differences in environmental regulations (Rutqvist, 2009).

Once again, we can use Copeland and Taylor's model (1994) to illustrate these competing theories using their basic set up but now assuming there are two regions in the world, North and South. These regions may have different factor endowments or pollution policy, but are otherwise identical. The authors apply a simple relative supply and demand analysis to determine autarky prices in each country, and illustrate in this way the interaction between factor endowments and pollution policy in determining the patterns of trade.

Figure 1 - Trade Liberalization
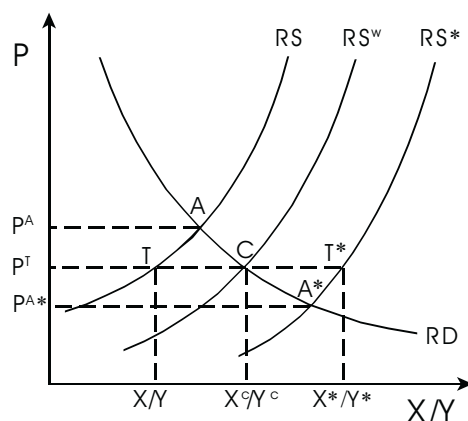
Source (Copeland & Taylor, 1994)

In their analysis, as can be seen in Figure 1, given their assumption that preferences over goods are homothetic and separable from environmental quality, the demand for X relative to Y is independent of income and can be written as $RD(p)$, where $RD'(p) < 0$. Furthermore, the relative demand curve is the same in each country because preferences are identical across countries.

As for the supply side, the relative supply curves for each country can be written as a function of K/L and prices, exploiting constant returns to scale:

$$RS(p, \tau, K/L) = \frac{x(p, \tau, K/L, 1)}{y(p, \tau, K/L, 1)}$$

As can be seen, the relative supply curve is upward-sloping since increases in p raise the supply of X relative to Y. In addition, due to differences in factor endowments and pollution policy between North and South, their relative supply curves will also differ, as shown by the relative supply curves labelled RS and RS*. Autarky prices for each country are accordingly determined by the intersection of relative supply and demand curves, and we can then use these differences in autarky prices to infer the pattern of trade. This model can be used to consider the pollution haven and factor endowment hypotheses separately, and then consider how they interact.

Factor Endowments Hypothesis

Copeland and Taylor (1994) illustrate the factor endowments hypothesis with a model that can be seen in Figure 2. We take relative demand RD as presented previously. We also assume that pollution taxes are identical and exogenous across countries and that only relative factor endowments vary. Specifically, we have that North is relatively capital abundant so that K/L > K*/L*. South's relative supply curve is shown in the figure as RS*. Since emission intensities are kept at the same level and being X the capital intensive good, North's relative supply curve RS is found to the right of South's. Therefore, we could see how the relative price of X in autarky would be lower in the North than in the South. And so if we have the same emission intensities in both countries, then North, which is the country that is capital abundant, will export the capital-intensive but also more polluting good, and this will lead to an expansion of the polluting, capital-intensive industry in this country, making pollution rise. On the other hand, pollution goes down in the capital scarce country since the dirty good industry declines.

Therefore, the main point from the factor endowment hypothesis is that the impact of trade on the environment is determined by a country's characteristics and production capabilities. Those countries that are relatively abundant in factors used in polluting industries will tend to get dirtier or more polluted as trade opens up, but countries that are relatively more abundant in factors used in the production of clean goods will get cleaner with trade. Consequently, as we will see in the following sections, the outcome suggested by this theory differs from those of the pollution haven hypothesis, since in the factor

endowments hypothesis if a low income country happens to be abundant in those factors used intensively in clean industries, then pollution will tend to fall as trade is liberalized.

Figure 2 - Factor Endowment Hypothesis
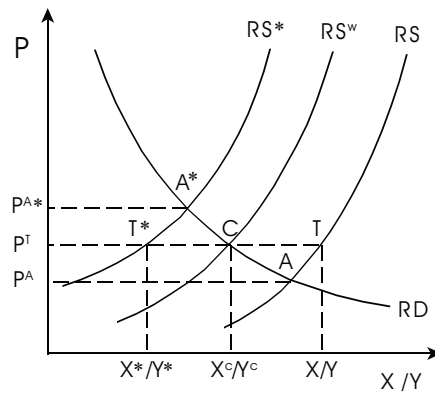
Source (Copeland & Taylor, 1994)

Factor Endowments and Endogenous Policy

However, we should take into consideration that higher income countries would probably have both a stricter pollution policy and also be characterized as capital abundant. Thus, while pollution policy will promote the import of dirty goods into the economy, capital abundance will tend to make this country a dirty good exporter. And so, ultimately the pattern of trade will depend on which of these effects is greater. If for example, relative factor endowment differences dominate relative income differences, then despite of having a stronger environmental regulation than the lower income country in the South, North will be exporting the dirty good (Copeland & Taylor, 2004).

Therefore, as explained by Taylor (2005), even though stricter environmental regulations contribute to a higher production costs for good X in the North, this can be offset by the relative abundance of factors used intensively in X. Hence, trade liberalization does not necessarily stimulate dirty industry migration from high income to low income countries, and it could even lead to an opposite effect. Similarly, this would mean that in cases in which the income elasticity of marginal damage is not too high in the North, and if this region is also sufficiently capital abundant, then trade could also lead to an increase in pollution in the North and a reduction in the South. However, if the income elasticity of marginal damage is high enough in the North, trade may decrease pollution both in the North and South.

Consequently, when the factor endowment effect dominates trade would actually promote production of the dirty good not in the country with weak pollution regulation but in the country where regulations are more stringent. In this case, the composition effect would tend to reduce global pollution. This is in contrasts with the pure pollution haven model where trade led to higher global pollution by moving production of dirty goods to countries with weak regulations, as we will see next.

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Pollution Haven Hypothesis

When looking at the Pollution Haven Hypothesis, usually, the basic version of the model is set up by assuming that countries are identical if not for exogenous differences in pollution policy. For example, in some of the earlier work Pethig (1976) showed that countries with weaker regulation would export the polluting good, and he did this by making the assumption that countries differed only in exogenous emission intensities.

So to look at this case it is now important to make reference to Figure 1. Copeland and Taylor (1994) explain that we can think of North and South as initially identical, so that the two countries would have the same relative supply curve RS. Prices in autarky would be the same, and so these countries would have no incentive to trade. However, if we take into consideration the effect of weaker pollution policy in the South than North ($\tau^* < \tau$), then South's lower pollution tax will encourage production of X and contract Y because resources would be taken out of Y and put into X. Therefore, the country with the weaker environmental regulation produces relatively more X for any given p; and as seen in figure 1, South's relative supply curve will shift out to the right, as depicted by RS*.

From this, we could infer that the relative price of X in autarky is lower in the South than in the North, with pA* < pA, since the South has a comparative advantage in the dirty good industry. Because in the South pollution taxes are lower, relatively more of the polluting good is produced there, which brings down the autarky price and promotes trade. With trade, the North will import X from the South, and the South will import Y from the North. This expands dirty good production of X in the South and reduces it in the North. Pollution increases in the country with weak regulations, and falls in the country with strict regulations. In this way, a pollution haven is created in the country with weaker regulation thanks to trade being promoted by pollution policy differences (Copeland & Taylor, 1994).

The results shown by this basic pollution haven model are in line with some of the arguments of environmental advocates. North gains from trade by moving some of its production of dirty goods to the South. Furthermore, because polluting industries are shifted to the parts of the world with weaker environmental policy this tends to raise world pollution.

The Pollution Haven Hypothesis with Endogenous Policy

Most of the literature relates the disparities in environmental regulations between countries to their differences in income level, such as when comparing developed and developing countries. Therefore, we should notice that a weakness of pollution haven models with exogenous policy is that in these models pollution policies are not responsive to the changes in income level produced by trade. Although, these models could still be applied to look at a short run, its important to also look at the case where pollution policy is treated as endogenous and thus, as responsive to trade (Grether & Mathys, 2006).

Copeland and Taylor (1994) also present a model dealing with this case. In this version of the model we consider two countries which vary only in the scale of their endowment vector, such that, $K = \lambda K^*$ and $L = \lambda L^*$, where $\lambda > 1$. We also assume that each country has the same number of consumers, which is normalized to one, so increases in L should be thought of as an increase in the supply of effective labor. Therefore, North's workers are more highly skilled than South's but the ratio of capital to effective labor is the same in both. This means that North is richer than South, but because the K/L ratios are the same across countries, there is no incentive to trade in the absence of disparities in pollution policy. In addition, it is assumed that the regulator acts as a price taker in world goods markets when choosing pollution policy. Since environmental quality is treated as a normal good, the country with a higher income level would choose a higher pollution tax for a given good's price, and it is these variations in environmental policy what would create an incentive to trade. Once again, this can be shown in figure 1. North and South have the same K/L ratio, but North's higher income means that its pollution tax is higher, and so $\tau > \tau*$. Therefore, North's relative supply of X for any given p is to the left of South's. North's high income gives it a comparative advantage in the clean good. When trade is opened, North will export the clean good Y and import the dirty good X. Production in the polluting industry will be reduced in the North and will expand in the South, and so the low-income country becomes a pollution haven.

Therefore, the effects of trade on the environment can be inferred from this results. In the North, both the substitution and income effects of trade liberalization would lead to less pollution. However, in the South, pollution will increase as long as the income effect is not strong enough. At a global level, pollution can also increase with trade until the income effect becomes strong enough since the more polluting industries would move to the country with lax regulations. However, it is important to note that in this case since both North and South fully internalize pollution externalities, trade liberalization can be welfare increasing for both, and so variations in policy induced by income differences are an efficient source of comparative advantage (Copeland and Taylor, 2004).

In general, pollution haven models are consistent in their prediction that trade liberalization usually leads the country with lax regulation to export the dirty good. When we take policy as endogenous, these models show that lower income countries have weaker regulation, and thus, will export the dirty good. However, as mentioned, the final outcome of trade on pollution and welfare will vary according to the policy regime. In addition, we should also note that a major weakness of the pollution haven models is that they assume that differences in environmental regulation are the only incentive for trade.

The Porter Hypothesis

A contrasting view from the Pollution Haven Hypothesis is the theory referred to as the Porter Hypothesis, which suggests the presence of mechanisms that make stringent environmental policies in the home country promote greater efficiency and innovation, and thus, help to improve the domestic industries' comparative advantage. This theory was

proposed by Porter (1991) and Porter and van der Linde (1995) and the main idea is that part of the negative environmental consequences of an economic activity can be attributed to the inefficiency in the usage of inputs. Therefore, the authors argue that if stringent environmental regulation encourages firms to reduce pollution, and when planned in a way that it allows companies to innovate and improve efficiency, this can produce offsets by increasing productivity that can actually save more money than the compliance cost incurred and thus, improve comparative advantage (Rutqvist, 2009). Although not the focus of this study, it is important to mention this view since we can also find it being acknowledged in the empirical literature on trade and the environment, as we will see later in the paper.

Gravity Models

Another trade model that we should discuss, and that is frequently applied in the study of international trade, is the now popular gravity model. Anderson (2011) explains the origin of this model, which as the name suggests, is derived from Newton's law of gravitational force and states that "the interaction between two geographic entities through trade is subject to forces that are inversely proportional to the distance or income differential between them and on some relevant measure of their 'masses', including population or market size, and income." Anderson (2011) adds that gravity models also typically include other geographical controls, such as whether the country is landlocked and its distance to the equator, as well as other bilateral controls between countries such as a common border, common language, and colonial past. This author further explains that the central premise behind these models is that these structural features are likely to determine a country's international trade patterns. These authors hold that many studies so far have confirmed that international trade is indeed subject to and driven by gravitational-like forces. The model is clearly a useful starting point in applied international trade research.

Environmental Kuznets Curve

Finally, it is worth noticing that there have been many studies focusing on examining the link between incomes per capita and environmental quality. Among the main papers on this issue is the work by Grossman and Krueger (1994) on NAFTA, which led to many more studies on what has come to be known as the Environmental Kuznets Curve (EKC). The Environmental Kuznets Curve describes that there is an inverse-U relationship between per capita income level and the degree of environmental quality in a country, thus, according to this, increases in income are accompanied by increase in pollution levels in low income countries, but are seen to lead to a decline in pollution in high income countries. Since sometimes the argument that trade is, in all cases, good for the environment has been presented in policy circles, these findings play an important role in the discussion. However, there is also some skepticism about the existence of such a simple relationship between pollution and per capita income.

Nevertheless, the EKC literature has played a key role in bringing about important questions about the dynamics of growth and the environment, and it has also shown that there is an income effect in which higher per capita income promotes an increase in the stringency of environmental regulation. Therefore, an analysis of the effects of trade and growth on the environment cannot be carried without taking into account policy responses. The link between income growth and the environment is important since treating pollution policy as endogenous and thus, as responsive to the changes in income level produced by trade can have an effect the expected results (Copeland & Taylor, 2004).

2.2 Summary on Theoretical Background

Therefore, as can be seen from these theories, the effects of trade liberalization on both the local and global environment are contingent on the comparative advantage of countries, which we can consider to be determined jointly by differences in pollution policy as well as on other aspects, such as differences in factor endowments. Pollution havens will not be necessarily created in cases where the high income country is relatively abundant in the factors used intensively in pollution-intensive industries; and then trade may lead to both less pollution in low income countries, as well as a decrease in global pollution. So this means that differences in environmental regulations on their own do not imply dirty industries will shift production to low income countries as a result of trade. Similarly, even if high income countries show a comparative advantage in polluting goods production based on their capital abundance, increases in the stringency of regulation may decrease this comparative advantage and lead to a reduction in polluting exports. This is one of the reasons why, as we will see, the empirical literature is usually more focused on the intermediate case referred to as the *pollution haven effect*.

3. Literature Review

Therefore, as seen the Heckscher–Ohlin model provides the basic theoretical foundations to the pollution haven hypothesis by showing that regions will export goods in which they have a comparative advantage. Empirically, the literature can be put together into three different groups that look at the effect of pollution regulation on trade flows. One of these is what can be seen as a test of the existence of a *pollution haven effect*, in which authors check whether or not variations in environmental regulations between countries or regions have an effect on trade flows or on industry location decisions. A less flexible group is what we have referred to as the *pollution haven hypothesis*. Under this view, trade promotes the shift of dirty good production from strongly regulated countries to those with weak regulations, and so, in these cases the pollution haven effect is so strong that it completely overcomes other incentives for trade in polluting goods. A final group, and alternative view to the pollution haven hypothesis, is that patterns of trade in polluting goods are primarily determined by the standard determinants of comparative advantage, such as *factor endowments* and differences in technology (Levinson & Taylor, 2002).

One of the main problems that authors have to face in this subject is that pollution and environmental data tend to be very limited; and so this issue has influence the evolution of the empirical literature. Many papers have chosen to focus on cases that look at the U.S. because of the availability of data. Also, studies of many important pollutants have been pretty much neglected, once again because of lack of data. Even worst is that this data scarcity is more evident in developing countries, whose study is more than necessary for a complete analysis of this issue. The main problem being that these countries do not count with well established methods for recording and monitoring environmental data.

So as mentioned, part of the literature has been focused on testing the existence of a pollution haven effect; and thus, seeing whether or not environmental regulations have an effect on trade flows, foreign direct investment decisions, or the location of production in certain industries. Work on this area can also be put into two groups. Most of the early work made use of cross-sectional data, by linking the cross sectional variation in trade or investment flows to industry, country, or region specific measures of regulatory costs and other determinants of trade and investment, such as factor costs. In this group of studies, most authors came to the conclusion that differences in environmental regulations between countries have no effect on trade and investment patterns. Later work on the same issue has taken into account the possible endogeneity of pollution policy and unobservable country specific characteristics that may also have an effect on trade an investment flows. Contrary to previous research, many of these studies have found that differences in environmental policy do have an effect on trade and investment patterns. In order to make a thorough review, we can take a quick look at the cross-sectional studies while pointing to some of the problems with this approach that have been highlighted in the literature, and then we can review more recent work.

As mention, the literature using trade data has been motivated by the Heckscher-Ohlin (HO) model of international trade. In his study Tobey (1990) regressed cross-country data for a group of 23 countries of exports of polluting commodities, on country specific variables of factor endowments and environmental stringency. This author found the variable on environmental stringency to be an insignificant determinant of net export patterns. However, while this study has been cited quite often to argue against a link between environmental stringency and trade flows, it has also been criticized by other authors for basing these results on weak econometric grounds.

A different method, used by Grossman and Krueger (1994), has been to link the cross-sectional variation in trade flows to industry characteristics. Most of this work employs US data on the pattern of trade in manufactures as well as data on factor shares and pollution abatement costs. The general conclusion in this literature is that pollution abatement costs do not seem to explain the cross-sectional pattern of trade (Rutqvist, 2009). As stated by Rutqvist (2009), some of these studies have even found a counterintuitive sign on the coefficient of abatement costs, which would point to a positive relationship between stronger regulation and exports. This result has often been interpreted as evidence in favor of the Porter hypothesis, which as previously mentioned, states that

stricter environmental regulation promotes technological innovation, and hence could either raise exports or lower imports. Other studies following this approach have also concluded that there is little connection between the stringency of environmental regulation and trade flows.

Nevertheless, more recent work suggests that there could be some issues with this approach that may have led to these results, such as the endogeneity of pollution abatement costs and unmeasured industry (or country) characteristics. For example, the literature poses a relationship between pollution abatement costs and imports conditional on some observable control variables, such as factor endowments or costs. However, there could be some unmeasured industry characteristic that creates co-movements in pollution abatement costs and imports and leads to some misinterpretation of the estimates. Similarly, we could also assume that dirty goods have relatively high transport costs, then the domestic industry would have a natural protection from imports. And so, if transport costs are not included in the estimation, then cross-sectional results could be biased. Likewise, we could face a problem of simultaneously, for example, if we take into consideration that trade and environmental regulations may be linked via governmental policy process (Mutafoglu, 2012). We can find studies that have directly made reference to these issues. For example, when looking at the case of NAFTA, Grossman and Krueger (1994) also found counter-intuitive signs for the pollution abatement cost variable in some regressions. Thus, the authors themselves pointed out to this strange signs and claimed that it may be arising from omitted variable bias.

Therefore, we can see how endogeneity and unobserved characteristics can lead to misleading results. More recent studies have made progress trying to address these concerns. Levinson and Taylor (2002) present a model with endogenous pollution policy to test for the effect of regulations on trade patterns. The results of their cross-section regressions with no correction for endogeneity showed that there is little relationship between net exports and pollution abatement cost; on the other hand, once they instrument for pollution abatement costs their results were completely changed, showing that stricter environmental regulations reduce net exports considerably. Likewise, Ederington and Minier (2003) study the link between pollution abatement costs and imports considering that these are determined simultaneously. They find a small, but statistically significant relationship between pollution control costs and imports.

Keller and Levinson (2002) use fixed effects estimation to show that environmental regulation has an effect on investment decisions, which also works as evidence that econometric problems could have led to the outcome of the previous literature. As done in earlier literature, they first estimate the results using a pooled OLS regression of foreign direct investment on abatement costs, without including state effects. These results indicate that FDI seems to be positively related with abatement costs. However, once they include state fixed effects they find that this same coefficient is negative and significant, which points to the presence of unobserved state-level variables driving the earlier results.

Therefore, by making use of specific econometric strategies (such as instrumental variables and fixed effect estimation) in order to address the problems caused by endogeneity and unobserved characteristics, this later group of work presents an important turnaround of the earlier findings that pollution policy did not affect trade or investment, and thus, some evidence supporting the existence of a pollution haven effect. This evidence shows that after controlling for other factors that influence trade and investment flows more stringent environmental regulation acts as a deterrent to dirty good production. This paper will follow this same line of work to see whether the difference in environmental stringency between the group of Central American countries and the Dominican Republic (members of CAFTA), and their main trading partner, the US, has had an influence on the development of trade patterns.

4. Trade and the Environment in Central America and Dominican Republic

This paper aims to contribute to this recent literature by evaluating the implications that environmental policy has had on trade flows during the initial period of liberalization that took place in the Central American Region and Dominican Republic during the 1990s. This section will provide some background information on the process of liberalization in this region as a point of reference.

It is known that FDI and trade liberalizations have played a key role in promoting industrialization in many developing countries and the Central American region has not been an exception to this fact. After trade liberalization and the implementation of structural reforms FDI inflows have increased significantly in the region, which has led to a pattern of international integration specially with the United States, who has become the leading destination for exports as well as the main source of foreign investment.

Since the 1980s, the Central American economies and the Dominican Republic have taken measures to promote integration in the global economy, ranging from structural adjustment programmes to foreign trade policies carried out through different trade agreements aimed at building up the conditions for access to international markets and stimulating exports (Cunha & Muthukumara, 2011). Since these countries have small domestic markets and relatively low consumption levels due to their income per capita, they promoted a process of regional integration as early as the 1960s, leading to the establishment of the Central American Common Market (CACM). Later, the region join the Caribbean Basin Initiative, so as to be able to gain access to the United States market who granted preferences to its members. These initiatives worked as foundations for the creation of export platforms for manufactures in the region. The growth of exports of manufactures in these countries has been mostly based on a labour-intensive model. For example, FDI was essential for the creation of the maquila industry and in more recent years to the development of the export of services (Desruelle & Schipke, 2008).

Trade liberalization is definitely the most important structural reform implemented in the last 30 years in these countries; however, we should note that the reform process in the region was not really coordinated and has occurred more or less selectively and slowly in each economy. Also, trade and investment flows were particularly low in the 1980s, mainly due to the civil conflicts in Guatemala, El Salvador, and Nicaragua. In this period, however, the countries initiated a process of diversification of exports in order to improve relations with the United States market. Both trade and FDI started to increase in the 1990s with the end of the conflict in the region, but also specially in the wake of the investment opportunities from the privatization of public entities, a better business environment, and the new policies to promote FDI. In line with the process of liberalization, the countries in the region established legislation for the creation of export promotion regimes that included tax and subsidies granted for export performance. In addition, free zone areas were created where companies could operate as offshore enterprises for taxes and customs (Desruelle & Schipke, 2008).

In addition, to have an idea of the environmental background of the countries in our study, it would be beneficial to carry a review on the recent environmental developments on these countries. From this review we will be able to see that while the region has made some progress in the management and protection of the environment, lots of improvements are still needed. Cunha and Muthukumara (2011) provide valuable information on some of these countries.

1. Costa Rica

Since 1991, Costa Rica has made substantial progress in the development of institutions and organizations that look out for the environment. In 1995, the Ministry of the Environment and Energy was created and a new General Environmental Law was also approved in the country. This law declared air as a common property and gave the state the authority to protect the environment and control pollution. In addition, the Act provided guidelines, mechanisms, and established the legal framework for the sustainable management of natural resources and for the protection of the environment. For example, after this law many institutions and entities that work in specific areas related to the environment and climate change have been created. Also, it is worth mentioning, the Forestry Act, created in 1996, which determines the role of the state to ensure the conservation, protection and appropriate management of forests; the Biodiversity Act and the Land Use Management and Conservation Act, both established in 1998. In more recent years, after the establishment of the DR- CAFTA, the environment agenda in Costa Rica has been described as very ambitious and one of the most advanced among developing countries. For example, the government aspires to become carbon-neutral by 2021, though it still has do deal with limitations associated to the rise in energy prices and population pressures. Overall, Costa Rica needs to maintain its efforts on preventing deforestation and lost of biodiversity, while also trying to strengthen environmental controls and evaluations.

2. El Salvador

Since liberalization, El Salvador has also progress in strengthening its institutional capacity to tackle environmental and natural resource issues. The Ministry of the Environment and Natural Resources and the country's Environmental Law (LMA) were created in 1998. The LMA is the foundation of the country's regulations in terms of the environment and it assigns the Council of Ministers with the responsibility of the maintenance of environmental policy. In 2000, the Council established a National Policy on Strategic Guidelines on the Environment, which promotes a view towards Environmental Balance, Joint Responsibility and Public Interest. The LMA establishes the functions and administrative powers of the Ministry of Environment and Natural Resources (MARN), the National Environmental Management System (SINAMA) and other government institutions. The key instrument of the LMA is a system of permits that requires any new project to present an Environmental Impact Assessments. In addition, the government has passed the Conservation of Wildlife Law (1999) and the Forestry Law (2002). More recently, in 2004 and in line with CAFTA negotiations, the government presented a national development plan which included a new environmental strategy referred to as "Environment: Legacy for Future Generations," promoting the preservation of natural resources, and efficient management of water reserves, and disposal of solid wastes. The government has also established an Environmental Superintendency in order to prevent and manage any environmental risk and land degradation.

3. Honduras

Honduras has also created several institutions and organizations to manage natural resources and protect the environment. In 1993, the General Law for the Environment was created, which establishes that protecting, preserving, and managing the environment and natural resources is an issue of public interest, and that the state and local governments should encourage a rational use and sustainable management of resources. Honduras has entered into more than 60 international environmental treaties and protocols, at a global and regional level. The country's has worked on strengthening its legal and regulatory frameworks to address issues such as management of water resources, protected areas, and forests; pollution control; environmental health; and rural development. Among the more recent national policies related to the environment it is worth mentioning: Honduras Environmental Policy (2005); Agriculture and Rural Environment, (2005); Environmental Mainstreaming (2005); and Simplification and Decentralization of Environmental Management (2002). Furthermore, the National System of Environmental Information (SINIA), formed in 1993, is accountable for developing databases, maintaining geographic information systems, and indicators on environmental issues.

4. Nicaragua

In 1994, Nicaragua established the Ministry of the Environment and Natural Resources (MARENA) aiming towards the design, organization and administration of environmental policy. Later the General Law on Environment and Natural Resources was

the passed by the government, which became the basis of the environmental legal and regulatory framework in this country. MARENA is responsible for the administration of the National Protected Areas System, the implementation of Environmental Impact Assessment (EIA), management of the National Environmental Information System (SINIA) and the organization of response systems and disaster prevention measures together with the National System for Disaster Prevention, Mitigation and Response (SINAPRED). In 2002, the government also passed the Law on Exploration of Geothermal Resources, and the Law on the Promotion of Hydropower. As for water resources management, in 2007, the National Council on Potable Water and Sanitation (CONAPAS) announced a comprehensive sector strategy for the country's water and in 2008 the National Water Law was passed by the government. The Ministry of Natural Resources (MARENA) has established regulations in several areas, such as preservation and productive use of water resources, protected land and marine areas, national reforestation campaigns, sustainable land management, control and reduction of pollution, solid waste management, mitigation and adaptation to climate change, and education on environmental issues.

As mentioned by Cunha and Muthukumara (2011), even with this list of achievements there are still many weak areas in terms of an efficient and rational use of the environment and natural resources in the region. Areas in need of improvement include information and data availability on natural resources and the environment; institutional operations; coordination between environmental authorities and other agencies; regulatory instruments; and monitoring and implementation mechanisms.

5. Empirical Strategy

The aim of this section is to develop a model of how trade is influenced by the laxity or stringency of the environmental regulation in a country. We postpone to the next section of the paper the issue of the econometrics of estimating the model and testing hypotheses.

The theoretical background provided in our first section will guide us in developing an empirical model of trade determination. For this task, we have to consider two issues: 1) what are the determinants of trade, including as we are assuming, the stringency of environmental regulation.; 2) how to deal with the difficulties posed by the measurement of the stringency of environmental regulation.

As for the determinants of trade, following our discussion on international trade models, the literature suggest the use of the gravity model framework as a useful starting point in applied international trade research. Therefore, in order to avoid erroneously attributing variations in bilateral trade flows to our two effects of interest (environmental stringency and factor endowments), our empirical specification will also include a set of other control variables suggested by the gravity model framework. One benefit usually acknowledged of the gravity model over other methods is that it takes advantage of the

variety of information contained in bilateral trade flows. These controls include: Distance ($lnDistance_{i,j}$) ; the extent of the Potential Market ($MKT_{ij} = ln(GDP_i * GDP_j)$) ; Importer Trade Openness ($(Exports_j + Imports_j)/GDP_j$); Exporter Trade Openness ($(Exports_i + Imports_i)/GDP_i$). We should point out that the gravity model also mentions the addition of other controls variables, such as common religion, common language, and landlockedness; however, in this case these have not been included since all Central American countries share the same characteristics in these respects and thus, we would have no variation in the data.

In addition to these variables, as stipulated in the basic Heckscher-Ohlin (HO) model, trade is also determined by differences in factor endowments. Hence, to account for this we include a proxy for differences in endowments between the importing and exporting country. For our sample of countries, we could only obtain data on aggregate capital and labour, so we included the difference in capital-labour ratios for each respective country compare to the US ($\Delta KL_{ij} = ln[\frac{KL_i}{KL_j}]$).

Finally, to test for the presence of the Pollution Haven Effect we need to include a measure of the difference in the stringency of environmental regulations between the countries, which brings us to our second issue: how to deal with the difficulties of finding proper data. The problem with this issue is not only about collecting the appropriate data, but also of figuring out what kind of data could represent environmental regulation stringency. This variable should give us some reference of how much more costly production is in a given area relative to others due to environmental regulations. However, these environmental compliance costs could take many forms, such as environmental fees or taxes, permitting costs, emissions limits that require installation of some special technology, lawsuits, product or process redesign, forgone output, among others. (Copeland and Taylor, 2004). Some studies have tried to measure these costs by creating indices that weight several country characteristics such as the budget of environmental agencies in the country, public awareness of environmental issues, the number of environmental treaties the country has joined, or other general indicators. A review of the literature shows how some authors claim that these indices of stringency can be considered somewhat subjective, hard to interpret, and are typically not available for that many countries (Javorcik & Wei, 2004). Other studies have used measurements of pollution directly, reasoning that, for example, high sulphur emissions are evidence of lax regulations.

This study then faces a similar difficulty to that found in other studies of the environment, the task of quantifying the strictness of environmental regulations. One approach could be to look at the number of Multilateral Environmental Agreements that the countries have joined. The disadvantage with this method is that we cannot really ensure whether these agreements are actually enforced. One thing is to have rules established, but another is to actually abide by them.

Hence, to address this difficult task, we narrowed our choice to environmental measures that show both within-country and between-country variation, as this will be

necessary features for our estimation. Choices were limited, but we selected as a proxy for the level of environmental stringency a measure of the grams of lead-content per gallon of gasoline, which in our model will be included as the differences in the lead content of gasoline between the exporting and importing countries ($\Delta LEAD_{ij} = ln\left[\frac{LEAD_i}{LEAD_j}\right]$). This measure is a market-share weighted sum of the maximum lead content of different gasolines that has been used by other authors, such as Damania et al (2003); Fredriksson et al (2005); and Cole et al (2006). This variable has a number of features that make it appealing as a measure of environmental regulations. Cole et al (2006) discuss that some of these features include: 1) that the content of lead in gasoline is almost entirely a policy decision that is unlikely to be influenced by other factors; 2) that lead emissions are precursors to damaging local air pollutants with significant health implications. As a result, the control of these emissions is usually done as an early environmental objective during a country's development. In addition, Damania et al (2003) report that lead-content regulation has a statistically significant correlation with other measures of environmental regulations (public environmental R&D expenditures as a proportion of GDP; and per capita membership of environmental organizations). Therefore, a country with relatively strict environmental regulations would allow smaller levels of lead content per gallon of gasoline. As for its measurement, the average has been calculated by using different types of gasoline and weighting them by their market share.

Whichever proxy is used for the stringency of environmental policy pollution emissions and environmental regulations are expected to be negatively correlated. Furthermore, the pollution haven hypothesis would suggest that environmental regulations and trade are also negatively correlated. Consequently, if the pollution-haven hypothesis holds, then emissions and trade would be positively correlated, and thus, we would expect this variable to be positive.

Therefore, the approach in this study will be to apply a variation of the gravity model to panel data in order to investigate the relationship between environmental regulations and exports (X) from the Central American countries, and the Dominican Republic, to the US. This model will try to account for factor endowment effects; it will include a proxy for environmental stringency to account for the pollution haven effect; and as well as other standard controls usually applied in gravity models.

$$X_{i,j,t} = f\begin{pmatrix} Relative\ Pollution\ Stringency_{i,j,t}, Relative\ K/L\ Ratio_{i,j,t}, Potential\ Market_{i,j,t} \\ Distance_{i,j}, Importer\ Trade\ Openness_{j,t,} Exporter\ Trade\ Openness_{i,t}, Z_{i,j,t} \end{pmatrix}$$

Let then subscripts i and j refer to the exporting and importing countries respectively, and subscript t refers to time. We follow a specification of the gravity model that includes a set of country fixed effects. With this specification the country dummies can control for all determinants of bilateral trade that are country-specific, such as income, population, infrastructure or any other omitted country-specific effects that can have an

influence on trade volumes. This method can be very useful in our case since this lets us put more attention on those variables that are more relevant for the analysis of trade and the environment.

5.1 Data

This exercises will focus on exports directed towards the United States from six countries, which include the Central American countries (Costa Rica, El Salvador, Honduras, Guatemala, and Nicaragua); and also the Dominican Republic. It will cover an 10-year period (1990–1999).

As for the sources, the OECD Statistical Database provides data on exports by partner country to each of the OECD member countries. Capital and labour endowment data are extracted from World Bank, Employment Lab - Diagnostic Toolbox. Distance between two countries is found on the CEPR website. The World Development Indicators is the source of country data on: GDP, and Importer and Exporter's Trade Openness Ratio. Data on average years of education was obtained from Barro and Lee Data Set on Educational Attainment (updated on 2013). Finally, the database for the maximum lead content in gasoline has been elaborated (and kindly shared) by Grether and Mathys (2002) on the basis of Octel's Worldwide Gasoline Survey.

5.2 Methodologies

As mentioned before, econometric studies of the pollution haven hypothesis have typically followed a reduced form regressions of some measure of economic activity on some measure of regulatory stringency and other variables:

$$Y_i = \alpha R_i + X_i B_i + e_i$$

where Y is a measure of economic activity, R is environmental regulations stringency, X is a set of other variables that will determine Y, and e is the error term. The pollution haven hypothesis is that estimates of $\frac{\Delta Y}{\Delta R}$ will be negative ($\alpha < 0$). The empirical literature contains a variety of implementations of this equation. Some studies focus on foreign direct investment. Other studies focus on international trade, where Y represents, for example, exports (Levinson & Taylor, 2002).

As pointed out previously, finding an appropriate measure of environmental regulations stringency is not simple, but even when it might be possible to find some suitable measure to proxy for regulatory stringency, it is important to consider that for OLS to give consistent estimators the error term must be unrelated to the regressors, and this is often not an assumption that can be made. As seen before, an issue that is mentioned in the literature is that economic activity and pollution regulations may be determined simultaneously. In theory the solution to this problem is to use instrumental variables. Nevertheless, in practice this means finding instruments for a variable of environmental regulations stringency that is difficult to measure, and in the panel structure

it means finding something that changes over time, shows correlation with R_{it}, and is not correlated with e_{it}. Thus, finding a valid and strong instrument is often very hard.

Nevertheless, in order to pursue consistent, unbiased and efficient estimates, we will carry out our estimation using instrumental variables. Consistent with the literature, we seek instruments which are uncorrelated with the errors but are correlated with the variable use to proxy for regulatory stringency. We have chosen to include as instruments all exogenous variables in our model and four external exogenous variables: 1) average years of schooling; 2) health expenditure as a percentage of government expenditure; 3) protected area as a percentage of total territorial area; and 4) the number of tuberculosis cases per 100,000 habitants (data for these variables comes from The World Development Indicators). These external exogenous variables are unlikely to be correlated with the error but are indicative of a general level of social consciousness in the country, which is likely to accompany strict environmental regulations.

There is a further econometric issue that should be considered, which as mentioned before, is that some unobserved characteristics of the countries that are being studied are likely to be correlated with both economic activity and regulatory stringency (Copeland and Taylor, 2004). This means that R and the error term, e, would be correlated, and thus our estimates will be biased.

The solution found in the literature for the problem of unobserved heterogeneity is to estimate a panel-data version of the previous equation, and include fixed effects by country:

$$Y_{it} = v_i + \alpha R_{it} + X'B_{it} + e_{it}$$

These fixed effects v_i capture the unobserved characteristics of countries that make them likely to have both strict environmental regulations and high levels of economic activity. However, this also means that including fixed effects requires panel data on regulatory stringency.

A fixed effect model examines whether intercepts vary across groups or time periods. If individual effect v_i does not exist $v_i = 0$, then OLS would produce efficient and consistent parameter estimates. However, if individual effect v_i is not zero in longitudinal data, heterogeneity or individual specific characteristics that are not captured in regressors may cause a problem for estimation (Stock & Watson, 2009). Then panel data models provide a way to deal with these problems.

There are several strategies for estimating a fixed effect model. The least squares dummy variable model (LSDV) uses dummy variables. This method is widely used because it is relatively easy to estimate and interpret. However, LSDV can becomes problematic in a short panel setting in which we have to include a large number of dummy variables, and so our estimation loses degrees of freedom. On the contrary, in cases where there is a long panel setting, with only a few individuals and more time periods, LSDV can be the preferred method for estimation (Stock & Watson, 2009). This is useful in our case since we are looking only at a few countries in particular.

Thus, in line with the later group of empirical work on this issue, we will make use of econometric strategies such as instrumental variables and fixed effect estimation in order to address the problems caused by endogeneity and unobserved characteristics.

6. Results

On the modelling stage, we can begin with pooled OLS and then evaluate the potential problems if unobserved heterogeneity is not taken into account. We can deal with heterogeneity by adding individual specific intercepts using a fixed effect model. Next, we should conduct instrumental variables estimation to appropriately account for the possible endogeneity of environmental regulations, remembering to implement formal tests to examine the validity of our instruments.

Table - Regression Results			
	Pooled OLS	Fixed Effects (LSDV)	IV
Relative Pollution Stringency	0.312	0.142	0.346
	(0.223)	(0.175)	(0.032)
Relative Capital-Labour Ratio	-0.039	-7.113	-7.016
	(0.940)	(0.010)	(0.003)
Potential Market	2.086	0.387	0.868
	(0.000)	(0.474)	(0.193)
Exporter Trade Openness	-0.039	-1.747	-1.938
	(0.978)	(0.192)	(0.093)
Importer Trade Openness	5.092	6.048	5.580
	(0.128)	(0.014)	(0.014)
Distance	-0.075		
	(0.976)		
Constant /Co1(Costa Rica)	-90.378	-31.056	-48.015
	(0.026)	(0.045)	(0.019)
Co2 - Dominican Republic		-2.335	-2.513
		(0.021)	(0.004)
Co3 - El Salvador		-8.653	-8.763
		(0.007)	(0.001)
Co4 - Guatemala		-7.302	-7.219
		(0.014)	(0.005)
Co5 - Honduras		-7.570	-7.381
		(0.010)	(0.004)
Co6 - Nicaragua		-9.790	-9.189
		(0.006)	(0.003)
F-Statistic	27.88	38.94	-
Wald Chi2	-	-	448.19
R-squared	0.538	0.828	0.823
Root MSE	1.245	0.790	0.725
N (Total Observations)	60	60	60
T (time)	10	10	10
N (countries)	6	6	6

*p-values in parentheses

6.1 Statistical Analysis

Pooled OLS estimation is a pooled linear regression without any type of fixed (or random) effects. It assumes a constant intercept and slopes regardless of having different individuals (Stock & Watson, 2009). Therefore, in our case the pooled OLS estimation posits no difference in intercept and slopes across countries.

We summarize the estimation of our model in Tables I, which includes results from the different estimation methods. First, Table I shows the OLS estimate does not exactly give us much to work with; although it shows a F-statistic of 27.88 and p<0.000, most of the coefficients are not statistically significant, including our variables of interest. The R-squared of 0.5378 says that this model accounts for 53.8 percent of the total variance in net exports.

Thus, as mentioned, we may suspect the need to include individual specific effects to deal with the heterogeneity or country individual effects that may or may not be observed. Then, let us examine fixed group effects by introducing country dummy variables. We can notice that five group dummies, Co_2-Co_6, are added to the pooled OLS equation; one of six dummies, Co_1 in this case, was excluded from the regression equation in order to avoid perfect multicollinearity. The Fixed Effect (LSDV) estimation fits the data a bit better than does pooled OLS. The F statistic increased from 27.88 to 38.94 (p<0.000); and the R-squared increased from 0.5378 to .8277. We can also notice that parameter estimates of individual regressors are quite different from those in the pooled OLS; although, most remain not statistically significant with the exception of our factor endowment variable, which can now be considered statistically significant at a 10% level. Therefore, we can see that there are some difference between the pooled OLS and Fixed Effect. Estimation by Fixed Effects (LSDV) improved all goodness-of-fit measures like F-test, root MSE, and R-squared significantly, but lost 5 degrees of freedom by adding five group dummies. Overall, Fixed Effects seems to be a bit better than the pooled OLS.

Table I also shows the instrumental variables estimate (IV). The OLS estimate involves the observed measures of our pollutant indicator, the maximum lead content of gasoline, whereas the instrumental variables estimate uses the fitted values of this measure in estimating our model. The two estimates show very different results, which illustrates the importance of using instrumental variables. It also suggests the importance of choosing the right instruments.

As noted, to have valid instruments these must be correlated with the endogenous regressors but uncorrelated with the error term. Below, we present a test for judging the explanatory power of the instruments in our study. This table shows a test for the joint significance of all of the instruments. We can see that they are jointly significantly different from zero, with a p-value of 0.000. In addition, the partial R-squared is 0.294. It has been suggested that an F statistic around 10 is required to consider that the instruments are sufficiently strong (Stock & Watson, 2009). Our value of 9.728 is quite close to this

requirement, so in the lack of better instruments at the time we chose to work with these variables

Table - First Stage Regression Summary Statistics					
Variable	R-Sq	Adjusted R-Sq	Partial R-Sq	Robust F	Prob > F
Lead Ratio	0.659	0.563	0.294	9.728	0.000

As for the estimation by instrumental variables, overall, results are encouraging. First, the variables of interest show the expected signs for this specification, and are also significant. So, contrary to estimates by OLS and Fixed Effects, the variable that accounts for the stringency of environmental regulations "Relative Pollution Stringency" now becomes significant through the instrumentation. Therefore, since as noted by the literature there is always the likelihood of endogeneity, we would rely on the results obtained by IV estimation.

We can begin the discussion with the pollution variable since this is the main purpose for our study. The impact of environmental regulation on trade relies on the significance of the stringency measure and the sign of its coefficient. Our results show that the variable "Relative Pollution Stringency" is positive at the 5% significance level. We should remember that according to a priori expectation this variable is negatively related to environmental regulations. These regulations, in turn, are supposed to be negatively related to trade. Thus, the positive and significant coefficient on the "Relative Pollution Stringency" variable provides evidence of the pollution-haven effect. Thus, it would appear that trade patterns are affected by the stringency of environmental regulations.

In addition, our variable for the "Relative Capital-Labor Ratio," which represents factor endowment differences, is statistically significant at a 1% level and shows the expected sign. Hence, it seems that differences in the costs of inputs also significantly factor into the decision to trade. "Importer trade openness" is likewise statistically significant at a 5% level, but this is contrary to "Exporter trade openness" which besides being significant only at a 10% level, also shows a counterintuitive sign. On this specification "Potential Market" shows little evidence of being significant, though, it does have the expected sign.

6.2 Economic Interpretation

As for the interpretation of these results, we can see that if the other trade determinants (factor endowment, potential market size, trade openness, etc.) are held constant across the exporting countries, those countries with relatively lax environmental regulations will end up having higher exports. It may be a bit difficult to understand the quantitative inference of our finding. However, an intuitive interpretation could be given in terms of our proxy, the differences in the lead content of gasoline, as the following: if a host country relaxes its environmental regulation such that the difference in the lead

content of gasoline with that of the US increases by 1%, on average it will be able to increase its exports to this country by 0.35% that otherwise the case. In terms of economic significance, we might not considered this effect so substantial, but it is also not negligent since for example, in terms of average GDP for our group of countries during the period of study, it would have meant that a 10% increase in the difference in the lead content of gasoline with that of the US would have led in average to a 0.58% greater GDP.

7. Conclusion

A controversial issue debated in recent years is whether disparities in environmental regulations between countries are turning developing economies into pollution havens. The basic argument is that stringent environmental policy in developed countries is promoting production of polluting goods in developing countries where regulation is usually weaker. Since pollution-intensive industries will have a bigger incentive to transfer production to these countries, a haven of these industries will be created. A related claim is that developing countries may deliberately reduce environmental standards, in order to attract more firms and increase exports. This could produce a "race to the bottom" with countries lowering environmental standards to achieve this.

Early empirical literature has typically concluded that environmental stringency has no apparent effect on trade flows. However, most of these early studies used cross sectional data, so they did not control for unobserved heterogeneity across countries and usually treated pollution regulations as exogenous. But, if as suggested by theory, pollution regulations are in fact endogenous or if there are important omitted factors, then the estimated results would be misleading. Instead, a group of recent studies has found that both trade and investment are influenced by pollution regulations. This is a major turnaround from the previous consensus that environmental policy did not affect trade and investment flows. Several recent studies have addressed the issues of endogeneity and unobserved characteristics and found evidence for the existence of a pollution haven effect. Hence, this later group of work shows the benefits of combining theory and empirical work.

This paper contributes to the debate on trade and the environment by adding to this recent literature. The primary objective of this study has been to evaluate the effect of the stringency of environmental policy on the patters of international trade focusing on how exports to the United States, from Central American countries: Costa Rica, El Salvador, Honduras, Guatemala, Nicaragua; and also the Dominican Republic, are influenced by the environmental regulations of these countries. Our theoretical framework builds upon basic models used in the topic of international trade and the environment, such as the HO model, Copeland and Taylor's (2004) model, and the Gravity model. From this, we derive an econometric approach based on the use of fixed effects and instrumental variables estimation in order to account for the problems of endogeneity and unobserved characteristics mentioned in the literature.

Our results show that after controlling for other factors that influence trade flows more stringent environmental regulation works as a deterrent to production of polluting goods. The statistical evidence suggests that there exists a negative relationship between exports to the US and the relative stringency of environmental regulation of Central American countries and the Dominican Republic. In general, lax environmental policy tends to promote an increase in exports to the US. To appropriately interpret these findings, we should keep in mind that the environmental variable is only one of the determinants of trade. Therefore, it would not be correct to conclude that environmental policy alone can determine the patterns of trade. Consequently, the evidence presented supports the existence of a pollution haven effect, not the more strict pollution haven hypothesis.

A final point to note is that, as further research, it would be interesting to extend this study to the more recent period of the 2000's onward, since important trade trade agreements have been established in the region during this period. This was not possible in our case, as it was intended initially, due to lack of data on environmental variables which as mention is one of the main problems for studies on the subject.

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