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Environmental Regulation and International Trade

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Introduction:

The early twenty first century is seen as an important time for the environment. The latter portion of the twentieth century has been seen as bad for the environment which has lead to many areas of concern where the environment is concerned. Problems with pollution of water ways and pollution of the air, global warming resulting from depletion of the ozone layer and carbon dioxide emissions as well as the degradation of natural resources are all major concerns. The major problem with the environment is the fact that the resolution of these problems remains uncertain. There are those who put more emphasis on the present and therefore are more concerned with jobs rather than the environment and then there are those who are concerned with both the present and the future who feel it is important to take into account what production processes may do to the environment and how it may affect us in the future.

The biggest problem with the environment is the fact that it is a public good that everyone has access to. As this well documented with public goods, the major problem is that no one wants to pay for them. As a result, no one wants to pay for the environment degradation that may take place when there is production of a good. Without intervention, firms only take into account their private costs rather than social costs. When this is done, social welfare is not being maximized and society can be

made better off. This is usually done by an intervention taken by the government policy maker (for example the Environmental Protection Agency) either in the form of a quota, a tax or a permit system. It is generally thought that a tax will do much better because then the tax can be applied to all firms in a particular market whereas if a quota is put in place, each firm would have a different standard based on their information and this may prove to be too costly and difficult for policy makers to do. [Baumol and Oates 1993]. The permit system allows firms to purchase permits that allow them to pollute so much. These permits can be bought and sold by firms but the total number of permits is determined by the policy makers. The point of the government intervention is to make sure that social cost is being considered when firms make decisions on how much to produce rather than just private costs. When only private cost is taken into account there is usually too much production of a particular good.

One of the biggest problems affecting the environment is the fact that different countries have different standards and different ways of dealing with pollution. With the different standards it is bound to be true that the environmental regulations will affect trade and trade will affect environmental regulation which will affect the environment. It seems as if there is a simultaneous system that develops when trade is added into the mix with environmental regulation. In the absence of regulation (or any other trade distortion such as an import or export tax) the efficient amount of trade should take place and trade patterns should depend on comparative advantage, where the country that can produce the good more cheaply relative to another country will end up being a net exporter of the good. The country will then become a net importer of goods that it cannot produce as relatively cheap as another country. When environmental regulation is added and it is not uniform across all countries there is the possibility that trade patterns may change because comparative advantage has changed. In general it is

thought that, all else constant, in the presence of regulation the country with less regulation has an advantage over a country with higher levels of regulation.

The shift in advantage or comparative advantage is thought to be a shift in production from a developed country to a developing country because developed countries usually have higher regulations than do developing countries. This leads to what is known as the "pollution haven hypothesis." The "pollution haven hypothesis" says that "dirty" industries will then relocate to countries that have lower environmental regulation because it is cheaper for them. The idea is that all "dirty" industries will then be in developing countries causing them to be a pollution haven for the industries. This was one of the main concerns of NAFTA. It was hypothesized that U.S. firms would move to Mexico where standards were not enforced. As Antweiler, Copland and Taylor (1998) state

> "Empirical work by Grossman and Krueger (1993), Jaffe et al. (1995) and Tobey (1993) cast serious doubt on the strength of the simple pollution haven hypothesis because they find trade flows are primarily responsive to factor endowment considerations and apparently not responsive to differences in pollution abatement costs."

Work by Letchumanna and Kodama (2000) also seems to dispute the pollution haven hypothesis by looking at foreign direct investment and showing that positive measure of it are needed for technology upgrades in less developed countries, but also bring about an increase in the condition of the environment because the new technologies have more environmentally friendly processes.

There is also the thought that there could be a "race to the bottom" in terms of environmental standards. This says that countries will lower their standards to remain competitive in the open market and hence reach an extreme substandard standard. Porter (1999) looks at this problem and shows that

it is the industrializing countries, not the developed countries. He shows that it is the industrializing countries that lower their standards to remain competitive with other industrializing countries that causes a "stuck at the bottom problem." Porter also states that though there is empirical evidence that industrializing countries are now producing more pollution intensive goods and the production of those goods are disappearing from industrialized countries that the environmental standards may only be one of the factors that are causing this shift. It seems that developing or industrializing countries get hit from both sides.

Low (1992) has a different take and claims that although dirty industries and exports have expanded faster than cleaner industries, this does not mean there is a migration from developed to developing countries where dirty industries are concerned. The fact that dirty industries are more labor intensive may be what is causing this and this may predominate the early stages of economic development.

There are several major concerns when it comes to trade and environmental regulation. The first is how to conduct trade and how countries choose levels of emissions or degradation. The second is to encourage international cooperation in improving the environment. The third is not to let environmental concerns lead to protectionism for a country. (Yarbrough and Yarbrough 1997) WTO basically takes care of this concern. As for the other two, the question becomes, is regulation the right thing to do? Yarbrough and Yarbrough (1997) claim that openness of a country may be good for the environment. They claim that environmental protection demand comes from income and that free trade raises income which will in turn raise the level of protection. Another of their claims is that the openness of trade will lead to newer, greener technologies being implemented in more countries. One major

claim by most economists is that trade restrictions should not be used in place of regulation as a policy for the environment. The major concern is how exactly does environmental regulation affect comparative advantage and hence the competitiveness of a firm.

When dealing with trade and the environment there are usually five industries that are considered to be "dirty industries." These are 1) iron and steel, 2) nonferrous metal, 3) industrial chemicals, 4) pulp and paper, and 5) nonmetallic products. These industries are considered to produce the most pollution as a by-product and therefore have higher abatement costs than other industries. As a result they are the ones that are likely to be most affected by an environmental regulation.

The way taxes are set and who has taxes will be shown to play an important role in what happens to comparative advantage. If a country has a comparative advantage in a good that causes an externality and it is then taxes and another country is not, then it will lose its comparative advantage. However, if both countries are tax optimally, then comparative advantage should not change.

The paper will proceed as follows; Section 1 a literature review, Section 2 develops a model, Section 3 uses simulations, Section 4 discusses the simulations and Section 5 draws conclusions and extensions.

Section 1, Literature Review:

The literature surrounding how environmental regulation affects international trade or comparative advantage does not come to one specific conclusion. Depending on the model used and in some instances even when the same model is used, different conclusions are reached. This can lead to confusion as to whether there is really a problem going on or not. Most of the papers tend to be empirical in nature with very little theoretical basis other than stating that the environmental regulation

should affect comparative advantage. This seems to be part of the problem with this literature.

A typical way in which to look at this question is through the idea of revealed comparative advantage. Revealed comparative advantage can be defined as.

$$XRCA_i^k = \frac{\left(\frac{x_{iw}^k}{x_{iw}^{lt}}\right)}{\left(\frac{x_{ww}^k}{x_{ww}^{lt}}\right)} \qquad (1)$$

Where the definition is a country's share in exports of a particular commodity divided by that particular commodity's share in world exports of manufacturing. Both Xu (1999) and Low and Yeats (1992) use this definition to determine if regulation has affected comparative advantage. The idea is if XRCA is greater than one then a country has an advantage in that good and should be a net exporter of it. If the XRCA is less than one then the country has a disadvantage in that good and should be a net importer of it. Xu looks at whether the export of environmentally sensitive goods has undergone a systematic change due to environmental restrictions. He looks at the time period between the 1960's and the 1990's. He compares two years from each decade to determine whether there has been a change in XRCA. He uses data from thirty-four countries that account for eighty percent of all exports of environmentally sensitive goods. He finds that for the most part, countries that had an XRCA in the beginning also have an XRCA. His conclusion is then that there has not been a change in comparative advantage due to environmental restrictions. Low and Yeats do the same time of analysis, but instead of looking at whether or not there has been a change in XRCA, they look at how many countries have

XRCA's in environmentally sensitive goods in the past and the present. They find that more countries do have XRCA's now than they did before and most of the new countries with XRCA's are developing countries. They do not necessarily show that there is a shift but a growth in the export of environmentally sensitive goods. It is believed that dirty industries may be the beginning of industrialization, which may be why developing countries are developing XRCA's in them.

Both of these studies use the same methodology, but come to different conclusions. The reason for this seems to be the fact that there are some problems with using revealed comparative advantage to measure comparative advantage. Specifically the measure does not take into account growth of endowments separately. The measure essentially cancels out a lot of macroeconomic factors and does not allow for different growth rates of factors of production. Revealed comparative advantage tends to use circular reasoning as to who has a comparative advantage without looking at why a particular country does have a comparative advantage.

Another method that has been used to test whether or not environmental regulation affects comparative advantage is to use a Hecksher-Ohlin-Vanek model of international trade. Tobey (1991) uses this type of model that allows for non homogenous preferences and scale economies and product differentiation. He includes a qualitative variable to represent pollution control measures. It has a value of one to seven with seven being the strongest measures. He also examines the model without the variable and examines the signs of the estimated errors. Endowments are regressed on net exports and the variable to measure environmental regulation is included. The conclusion that the environmental regulation variable does not matter leads him to the conclusion that this has no affect on trade and therefore no affect on comparative advantage. Tobey himself states there are some problems with this

study. First by including an environmental parameter a H-O type model is no longer being used and the estimates of the parameters can be hard to interpret. The second is the fact that there has been some problem with the testing of the H-O model itself and so it may not be able to capture what is going on when environmental regulation is included.

Another way in which the affect of environmental regulation on comparative advantage has been tested by looking at how this affects price. This type of study was undertaken by Robinson (1998). A partial equilibrium approach is used because using ex-ant forecasting calls for an assumption about abatement cost or an estimation and assumptions about how abatement costs are allocated. A model that looks at price elasticities is used. Trade between the U.S. and Canada is what is looked at by Robinson and he determines that there is some evidence that the pollution control programs put in place by the U.S. can change comparative advantage. He shows that goods that have higher abatement costs will be imported while low abatement cost goods are exported. The impact on the U.S. balance of trade of marginal changes in industrial pollution abatement is negative for most industries and growing with trade volume.

Getting away from the specific environmental regulation affect on trade and just looking at regulations affect on trade is what Navaro (1989) does. He looks at the role regulation plays in the electricity industry in Japan and the U.S.. It is believed that the cost of electricity in Japan should be higher than in the U.S. because the U.S. has more abundant natural resources (coal, Niagra Falls). Therefore the U.S. should have a comparative advantage in industries that use electricity as an abundant factor. It is then shown that if Japan had the same regulation put on its electricity industry that its price for electricity would be even higher than it is now. This would cause a decrease in Japan's trade

surplus. Therefore, due to the differences in regulation, U.S.'s being higher than Japan, Japan has been able to reduce the U.S.'s comparative advantage in goods that use electricity as the abundant factor. The fact that regulation in the U.S. has a political influence while in Japan it does not, seems also to play an important role.

A signaling approach is used by Boomer (1999) to show that relocation by a firm to a place with fewer environmental restrictions can be undertaken for purely strategic reasons. He looks at standards rather than taxes. A firm may be undertaking indirect rent seeking behavior by moving to convince policy makers not to tighten regulation. He shows that when there is trade liberalization, this possibility actually increases because when there is less restriction on trade it increases the competition for a firm. Therefore a firm may not move from one place to another because of reduced competitiveness, but to signal to policy makers not to increase regulation.

Porter (1999), though no model is developed, gives a very good discussion as to what needs to happen when looking at what happens with environmental regulation and comparative advantage. It is his belief that competitiveness between developing countries is what keeps their environmental standards down, not the countries with high standards. This goes back to the idea of the "race to the bottom." He is dissatisfied with the studies that have been done and believes that a more complex model where political institutions are a key independent variable needs to be developed to help explain the impact of trade competition on standards. Again, he believes that pollution control requirements are only one of the factors that will shift production, but the fact that firms, as well as government, believes differences in environmental costs do affect competitiveness may be even more important. This may lead to lower standards than are justified if this was not believed. This is known as the "political drag

effect." Though this paper does not specifically look at how comparative advantage is affect by environmental regulation it brings up some very good points that need to be considered when looking at this phenomenon. This leaves open the possibility of using environmental regulation as a strategic trade policy.

Section 2,The Model:

2.1

In the model it will be assumed that there are two goods, X and Y, that can be consumed. There are two countries, the home country and the foreign country. The values for the foreign country will have a * to denote them. Good X is a production good and the production of X cause's pollution to be released into the air. Each country is assumed to have only one producer of X so that before trade each producer is a monopolist and when they enter into trade they act as a doupoly or Cournot competitors. Therefore, each firm, both the home and foreign, will earn positive profits. Good Y is an endowment good and therefore does not cause any pollution. Good Y can be consumed, but can also be used as part of income and therefore can be used to purchase good X. The two countries can each produce good X and both good X and good Y can be traded between the two countries. The price of X will be defined as P and the price of Y will be defined as 1, so that Y is the numeraire good. The home country has a population of M and the foreign country has a population of N. It is assumed that the size of the population is equal to that country's endowment of Y. It is assumed that consumers want to maximize their utility, producers want to maximize their profits and the government wants to maximize a social welfare function that will be defined below. Since the production of X causes pollution to be

released into the air, the government has the option of putting a tax of t on each unit of X produced and this is true in both the home and foreign country. The tax revenue that is obtained from this is then payed back to the consumers and is equal to tx_1 and tx_2 for the home and foreign country respectively.

2.2 Consumers

In the model it will be assumed that all consumers, in both the home and foreign country, have the same preference. The home country's utility function is a quasilinear one. This can present some problems because income is therefore not part of the demand for either good, but it is used because it is easier to manipulate than any other form of a utility function. Another problem that presents is with determining the optimal tax, but this will be discussed in the that portion of the paper. The home country's utility function then looks like,

$$U(C_x,C_y) = \alpha C_x - \beta C_x^2 + C_y \qquad (2)$$

Where C_x is the amount of good x that is consumer and C_y is the amount of good y consumed. This is true for both the home and foreign country. The foreign country's utility function looks exactly the same. The income for each country is defined by the profits earned by firms plus the tax revenue that they get paid. The profit for the firm is then defined as:

$$\pi = PX - Y - tX \qquad (3)$$

Therefore income for a country is defined as I and I is equal to:

$$I = PX + Y \quad (4)$$

Foreign income looks exactly the same.

Consumers want to maximize their utility subject to their income constraint. Since both countries have quasilinear utility functions, it is hard to separate the demands for X for each country. This will be discussed later in the paper. The total demand for the good looks like a normal linear demand curve where

$$P = \alpha - \beta(X+X^*) \quad (5)$$

This is what will be used to determine maximum values in all cases.

$$C_x = \frac{\alpha - P}{2\beta} \quad (6)$$

$$C_x^* = \frac{\alpha - P}{2\beta} \quad (7)$$

By definition of quasilinear preferences, the demand for Y is what is left from income after X as been consumed. This will be true for both the home and foreign country's so that their demands for Y will look like,

$$C_y = I - PC_x \quad (8)$$

and

$$C_y' PX' + Y' + PC_X' \quad (9)$$

When the two countries enter into trade the following two conditions must be met:

$$C_x + C_x^* = X + X^* \quad (10)$$

and

$$C_Y + C_Y^* = Y + Y^* \quad (11)$$

This states that the amount of each good consumed in each country must be equal to the total amount produced in each country. Given these two conditions the price of X can be determined and is determined to be:

$$P' \$ * (X + X') \quad (12)$$

This is the price that producers will used to maximize profits.

2.3 Producers

As was stated above the goal of producers is to maximize their profits based on all the information that they have. Given this the producer's maximization problem, taking into account the price, their cost and the tax that is levied upon the production of X is then:

$$A' PX + C_0 X + C_1 X^2 + tX \quad (13)$$

$$A' PX' + C_0 X' + C_1 X^{2'} + t' X' \quad (14)$$

For the home and foreign country respectively and where P is defined above. After doing the

maximization for each country the value of X and X* can be determined and they are determined to be:

$$X = \frac{(2C_1 - *)(\$ - C_0) - 2(C_1 - *)t - *t^{*}}{(2C_1 - 3*)(2C_1 - *)} \tag{15}$$

$$X^{*} = \frac{(2C_1 - *)(\$ - C_0) - 2(C_1 - *)t^{*} - *t}{(2C_1 - 3*)(2C_1 - *)} \tag{16}$$

As would be expected, the derivative of X with respect to t is negative, the derivative of X with respect to t* is positive, the derivative with X* with respect to t* is negative and the derivative of X* with respect to t is positive. This makes sense so that, for the home (foreign) country, when they raise their taxes the amount of X that gets produced gets reduced and when the foreign (home) country raises their taxes the amount of X that gets produces rises. Downward-sloping reaction functions for X and X* are also obtained, see Figure 1

2.4 Government

The government now must determine the optimal tax to maximize a social welfare function. The social welfare function that government for the home country will maximize is:

$$W = \alpha + \beta C_x + \gamma C_x^2 + C_y + \left(\frac{m}{m+n} + \frac{Y}{Y+Y^*}\right)\left(\alpha_0 X + \left(\alpha_1 X^2\right)\right) \quad (16)$$

The social welfare function for the foreign country will be:

$$W^* = \alpha + \beta C_x^* + \gamma C_x^{2*} + C_y^* + \left(\frac{n}{m+n} + \frac{Y^*}{Y+Y^*}\right)\left(\alpha_0 X^* + \left(\alpha_1 X^{2*}\right)\right) \quad (17)$$

The governments know the value of X and X* and they know that the value of C_x and C_y as well as C_x* and C_y*. The values are obtained from the consumer's maximization and plugging in for the values of X, X* and P. After this is done the values that are obtained are:

$$C_x = \frac{m}{m+n} \cdot \frac{2(\beta - C_0) + (t + t^*)}{2C_1 + 3\gamma} \quad (18)$$

$$C_x^* = \frac{n}{m+n} \cdot \frac{2(\beta - C_0) + (t + t^*)}{2C_1 + 3\gamma} \quad (19)$$

$$P = \frac{\beta(2C_1 + 3\alpha 2\gamma) + 2\gamma C_0 + \gamma(t + t^*)}{2C_1 + 3\gamma} \quad (20)$$

$$C_Y = \frac{\beta(2C_1 + 3\alpha 2\gamma) + 2\gamma C_0 + \gamma(t + t^*)}{2C_1 + 3\gamma} \cdot \frac{(2C_1 + \gamma)(\beta - C_0) + 2(C_1 + \gamma)t + \gamma t^*}{(2C_1 + 3\gamma)(2C_1 + \gamma) + (2C_1 + 3\gamma)(2C_1 + \gamma)} + \frac{m}{m+n} \cdot \frac{2(\beta - C_0) + (t + t^*)}{2C + 1 + 3\gamma}$$

$$+ Y \quad (21)$$

$$C_Y^* = \frac{\beta(2C_1 + 3\alpha 2\gamma) + 2\gamma C_0 + \gamma(t + t^*)}{2C_1 + 3\gamma} \cdot \frac{(2C_1 + \gamma)(\beta - C_0) + 2(C_1 + \gamma)t^* + \gamma t}{(2C_1 + 3\gamma)(2C_1 + \gamma) + (2C_1 + 3\gamma)(2C_1 + \gamma)} + \frac{n}{m+n} \cdot \frac{2(\beta - C_0) + (t + t^*)}{2C + 1 + 3\gamma}$$

$$+ Y^* \quad (22)$$

Since it is nearly impossible to separate out each country's demand for X, it is assumed that the demand each country has is proportional to their percent of the world's total population and that they get that they demand that percent of the total amount of X produced. Knowing this information, the government of each country can then maximize their respective welfare functions and obtain t and t*, which are the optimal tax for the home and foreign country.

There are some problems with the Welfare functions defined above. First of all, since income is not found in the demand for X or Y, the difference in taxes will come from the weight that each country puts on the externality. Several different weights were used and the one above seemed to give the best results. The externality is weighted by the percent of each country's population plus their percent of the endowment good. Ideally the weight would be a function of entire income, but that made the model more difficult and nearly impossible to solve, so that is the reason for the weighting scheme used.

It seems to make sense that a country with a larger endowment of Y and the larger population may put more weight on the externality. First, since they have a larger endowment in Y, they more than likely have a comparative advantage in Y and therefore by weighting the externality more heavily they may actually improve their comparative advantage. The second reason for this is that in the absence of taxes it is actually the population, not the endowment of good that determines trade patterns. This will be shown in a simulation exercise later in the paper. The reason for this appears to be the way the demand for X is a function of each country's percent of total population.

Section 3, Simulations:

Simulations are now done to see what affects taxes actually have on trade patterns in this model. Four situations will be looked at; 1) Trade patterns when there are no taxes in either country,

2) Trade patterns when there is just a tax in the home country but not the foreign, 3) Trade patterns when there is just a tax in the foreign country but not the home and 4) Trade patterns when there are taxes in both the home and foreign country's. The following parameter values are used throughout the simulations unless otherwise noted.

$$\$ ' 10, C_0 ' 1, C_1 ' 5, (_0 ' 1, (_1 ' 5.5, m ' 110, n ' 100, Y ' 110, Y^{(} ' 100, a ' 110, * ' 0.5 \qquad (23)$$

3.1, Trade in the absence of taxes

When neither country has a tax on emissions (the production of X) the following results are obtained from the simulation.

Variable	Value
X	0.782609
X*	0.782609
C_x	0.819876
Cx*	0.745342
C_y	109.656
C_y*	100.344
P	9.21739
X - C_x	-0.037267
Y - C_y	0.344

So the home exports 0.344 units of good Y and imports 0.037267 units of good X.

3.2 Only the home country has a tax

The optimal tax for the home country comes from maximizing their social welfare function and as a result the optimal tax for the home country is 0.828409. This tax seems to be extremely high, but

do to the nature of the model it is not that unrealistic. The values of the parameters chosen play a big role in the value of the tax. In future research I would like to look at different values of the parameters. When this value is used, the following results from the simulation are obtained.

Variable	Value
X	0.707143
X*	0.786039
C_x	0.782143
Cx*	0.711039
C_y	109.306
C_y*	100.694
P	9.25341
X - C_x	-0.075
Y - C_y	0.694

When the tax is included for the home country, they import more of good X then when there was no tax and they also export more of good Y. The Price of X has also gone up and this is to be expected. Both the home and foreign country's consumption of X falls, while the production of X in the home country falls and the production of X in the foreign country increases. This makes sense. With the tax on the home country, this is the foreign country a bigger advantage then they had before because it causes the home country's costs to go up. The total production of X has also gone down as a result of the tax in the home country.

3.3, Only the foreign country has a tax

The optimal tax for the foreign country is 0.0273609. This number seems very low, but does

make sense for the same reason that the high home country tax made sense. Again in future research I would like to use different values of parameters and therefore get different values of taxes and be able to compare them all. When this tax was used, along with the parameter values stated above the following results are obtain.

Variable	Value
X	0.782722
X*	0.780116
C_x	0.81863
Cx*	0.744209
C_y	109.669
C_y*	100.331
P	9.21858
X - C_x	-0.035908
Y - C_y	0.331

When there is a tax on the foreign country, the home country imports less of good X and exports less of good Y. Consumption of good X falls in both country while the production of good X increases in the home country and decreases in the foreign country and again price rises. The total production of X falls again. All of these go along with the theory and seem to make sense. The foreign country's advantage in X seems to be diminishing compared to when it had no tax. This is the most interesting of all the cases and goes along with most of the theory that is out there and has been discussed.

3.4, Taxes in both the home and foreign country

When both countries have taxes, the optimal taxes are the same as those that were discussed in

Section 3.2 and 3.3. Specifically, the home country's tax will be 0.828409 and the foreign country's tax will be 0.0273609. When these are combined with the parameter values that are stated above, the following values are obtained.

Variable	Value
X	0.707256
X*	0.783546
C_x	0.780897
Cx*	0.709906
C_y	109.318
C_y*	100.682
P	9.2546
X - C_x	-0.073641
Y - C_y	0.682

Given these taxes, the home country imports more of good X and exports more of good Y and again the price rises. Consumption of good X in both country's falls, while the home country's production of good X falls and the foreign country's production of good X rises compared to when there are no taxes in either country. The total production of X falls.

Section 4, Implications of the simulations

Section 3.3 seems to illustrate what most people are concerned with when they talk about environmental regulation and trade. The fear, as was stated earlier, is that a country that has more stringent standards will be hurt in trade by these standards. This scenario shows that a country that has an advantage before taxes are in place actually loses some of its advantage it when they have taxes put

on them. The loss is not enough to cause a switch in the trading patterns though. This seems to be important. The major concern is a change in comparative advantage and therefore a change in trading patterns. There is an increase in production of good X in the home country and a decrease in production of good X in the foreign country. In this case, there is a loss of some of the advantage, but the foreign country continues to export good X, but the change in production patterns is what most people are concerned with. It appears that when a tax is placed only on the country that has a comparative advantage in a good that causes an externality there may be a shift in trade patterns against the country with the tax.

Section 3.4 illustrates that if both countries set taxes optimally then the advantage does not change, but actually increases. In this case, the foreign country actually produces more X then before there were taxes and as a result of this exports more of good X and imports more of good Y from the home country. This is a good argument for why environmental regulations have not shifted comparative advantage as some of the theory would suggest. As mentioned in the literature review, some studies have found that the data does not match the theory and this would an example of that assuming that both counties set their taxes optimally. If taxes are not set separately then that causes a whole new set of problems that I would like to pursue in future research.

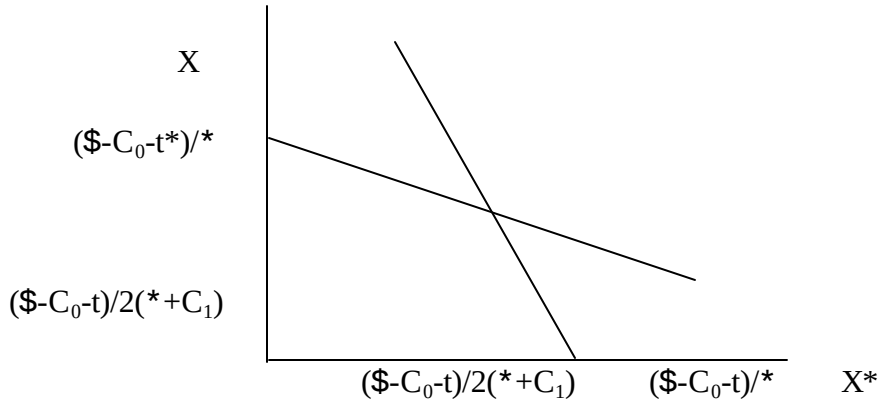
Section 5, Conclusions and extension

It appears that environmental regulation may or may not have an affect on trade patterns and therefore comparative advantage. If both countries set taxes optimally, then trade patterns are not affected, but if only one country has a tax and that country has an advantage in the production good, then trade patterns do shift. The country still exports the good, but it produces less, while the other

country still imports it, but produces more of the good. This is what most people are concerned with when thinking about environmental regulations. The fear is that a country may actually lose its comparative advantage because of more stringent regulations. Although there are only simulations done on one set of parameters, this exercise seems to show what the results of such regulation will be.

The above study does have some short comings. The utility function is very simple and does not have income in the demand functions and therefore a weighting mechanism has to be used on the externality in the welfare function. All of these can cause serious problems that were discussed in the paper. It would also be appropriate to use different parameter values to see what happens to the results when this is done. Another thing to looks at would be how do trade policies affect the results when they are put in place. How taxes are chosen is another area that could be looked at. Are they set to maximize social welfare or are they set to maximize trade balances and therefore used as a trade policy? Developing an empirical model that could be tested using real world data would be the best possible extension of all. The simulations tell us what should happen, but real world data is going to tell us what exactly is happening. One of the major problems with this is to actually determine comparative advantage in a way that can be measured. These are all possible extensions of the paper that the author would like to look at in the future.

Figure1



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