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The Effect of Trade Openness on Environmental Quality: Evidence from Iran's Trade Relations with the Selected Countries of the Different Blocks

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Abstract

The aim of this paper has been to evaluate the effect of trade openness on the Iran's environmental quality arising from its trade relations with the selected countries in East Asia, Middle East and OECD over the period 1991-2007. The study emphasizes on the scale, composition and technique effects as a result of the relationship between trade and environment. For the environmental quality, the CO2 data has been used alternatively. This article thus examines such relationship by estimating a panel regression CO2 emission model. The empirical results indicate a positive effect of increasing GPD on pollution of the countries in the first and second blocks. Additionally, the empirical results have shown that Iran could not benefit from its trade incomes with the OECD countries and in the Middle East. Also, due to the estimated positive coefficient of the capital-labor ration in the OECD block, the Iran's comparative advantage has been in dirty products.

Keywords: Trade Openness, Environmental Quality, Scale Effect, Composition Effect, Technique Effect and Panel Data.

1- Introduction

Over the course of almost 20 years a burgeoning field of interdisciplinary research and policy work has emerged surrounding the issues of international trade and the environment.

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Recent events have regenerated interest in global environmental concerns. Environmental disruptions such as the problem of global climactic change are the results of both man-made and natural causes. Other major pollutants such as lead, nitrogen dioxide, particulate matter and sulfur dioxide can impose physical and financial costs on the environment. The Institute for Agriculture and Trade Policy (IATP) and the Minnesota Center for Environmental Advocacy (MCEA) report that pollution costs Minnesota $1.5 billion annually in childhood diseases (IATP and CEA 2006). The World Health Organization (WHO) Regional Office for Europe calculates that air pollution with particulate matter (PM) shortens life expectancy by 8.6 months for every person in the European Union (EU) and that a reduction in the number of deaths from PM could save the EU an amount of €58-161 billion (WHO Press Release 2005). Economic development is often cited as a reason for the degradation of the environment. The two fastest growing economies in the world today, China and India, are countries experiencing simultaneous growths in international trade. According to the World Bank (2006), China and India represent a third of global pollution. In the period between 1992 and 2002, China's emissions levels increased by 33 percent and India's emissions levels increased by 57 percent (World Bank Little Green Data Book 2006). Between 2000 and 2005, China's exports increased from 23 percent of GDP in 2000 to 37 percent of GDP in 2005, while India's exports increased from 13 percent to 20 percent in the same period (World Bank Statistics 2006).

In other words, over half of all economic activity in the world economy, which is close to US$50 trillion in size, is traded. The environment has also experienced profound change during this period. According to the recent Millennium Ecosystem Report conducted by 1300 experts from 95 countries, '60 percent of the ecosystem services that support life on Earth – such as fresh water, capture fisheries, air and water regulation, and the regulation of regional climate, natural hazards and pests – are being degraded or used unsustainably'(UNDP, 2005). Such degradation is proving to be costly in economic terms. The World Bank and other international agencies estimate that the economic costs of environmental degradation range from 6 to 10 percent of GDP on an annual basis.

The literature on trade and environment, mirrored in part by policy discussions on the subject, can be divided into three sub-categories:

1. Trade and environmental quality: this body of work examines the extent to which trade and investment flows, and the policies that lead to increases in such flows, affect environmental quality both positively and negatively. This literature consists of work largely (but not exclusively) conducted by economists and natural scientists.

2. Trade and environmental politics: here scholars examine the political economy of environmental aspects of trade policy and conversely the trade aspects of environmental policy. This work is largely conducted by political scientists.

3. Trade and environmental policy: this sub-field examines the extent to which new trade rules affect the ability of nations and the global governance institutions outside the trade regime to deploy effective environmental policy. There is also a literature on the extent to which new environmental policies will affect the ability of firms to compete internationally. This literature is often conducted by legal scholars, economists and political scientists. Since the early 1990s some have contended that trade liberalization would lead to economic growth and that once nations reached a certain level of income they would begin to reduce their negative impacts on the environment. Others countered that trade liberalization would lead to a mass migration of pollution-intensive firms to nations with weaker environmental laws. This would lead to increases in pollution in the developing world and put downward pressure on environmental regulations in nations with stringent norms. In theory international trade and the environment can be mutually compatible, and perhaps even reinforcing. According to independent theories of international trade on the one hand, and environmental economics on the other, trade liberalization can bring economic benefits that can be distributed so as to reduce poverty and protect the environment. The economist David Ricardo showed that because countries face different costs to produce the same product, if each country produces and then exports the goods for which it has comparatively lower costs, then all parties benefit. The effects of comparative advantage (as Ricardo's notion became called) on factors of production were developed in the 'Heckscher–Ohlin' model. This model assumes that in all countries there is perfect competition, technology is constant and readily available, there is the same mix of goods and services, and that factors of production (such as capital and labor) can move freely between industries.

Within this rubric, the Stolper–Samuelson theorem adds that international trade can increase the price of products (and therefore the welfare) in which a country has a comparative advantage. Foreign direct investment (FDI) can contribute to development by increasing employment and by human capital and technological ‘spillovers’ where foreign presence ‘crowds in’ new technology and investment. In theory, the gains from trade accruing to ‘winning’ sectors freed to exploit their comparative advantages have the (Pareto) possibility to compensate the ‘losers’ of trade liberalization. Moreover, if the net gains from trade are positive, there are more funds available to stimulate growth and reduce poverty. In a perfect world, then, free trade and increasing exports could indeed be unequivocally beneficial to all parties. These theories have been extended to conceptualize the trade and environment relationship.

In a January 2000 article in the journal *Bio-Science*, noted scientist David Pimentel and his colleagues estimated that the annual economic costs of alien invasive species in the USA could amount to $137 billion. According to Pimentel et al., roughly 90 percent of these invasive enter the USA through trade. Therefore the trade-related economic costs are approximately $123 billion (Pimentel et al., 2000).

A recent study found that total emissions from ships are largely increasing due to the increase in foreign commerce (or international trade). The economic costs of SO2 pollution range from $697 million to $3.9 billion during the period examined, or $77 million to $435 million on an annual basis.

This paper sets out a theory of how "openness" to international goods markets affects pollution levels to assess the environmental consequences of international trade. We develop a theoretical model to divide trade's impact on pollution into scale, technique and composition effects and then examine this theory using data on CO_2 concentrations. We obtain this conclusion by estimating a very simple model highlighting the interaction of factor endowment and income differences in determining the pattern of trade. We would be the first to admit that our simple theoretical model carries a heavy burden in providing us with the structure needed to isolate and identify the implications of international trade. We suggest however that earlier empirical investigations failed to find a strong link between environmental outcomes and freer trade precisely because they lacked a strong theoretical underpinning. With a more coherent theoretical framework we are able to look in the "right directions" for trade's effect.

The application goes toward an examination of inter industry trade effects on Iran's environmental quality arising from its trade relations with the selected countries in East Asia, Middle East and OECD during 1991-2007. This paper will focus on theoretical discussion of the subject in section 3. The rest of this article includes the following. In the section 4 of this paper we develop a trade-environment framework that shows the explicit decomposition of the impact of trade on pollution levels. Section 5 and 6 presents results and conclusions.

2- Literature Review

In the last few decades, economic globalization has brought increased welfare to trading nations (Baldwin 1992). In particular, trade liberalization in developing economies has led to accelerated development and rapid economic growths which have brought modernization and improvements in standards of living. While global economic integration and income growths are shown to have increased consumer welfare, issues have been raised pertaining to the desirability of international trade as it relates to economic and environmental sustainability (Chichilnisky 1994; Strutt and Anderson 2000). The growing concerns of environmental degradation due to market expansions and economic activities have led to studies that attempt to answer the question: is international trade beneficial given the environmental consequences of economic development and the detrimental effects of pollution-intensive production?

Studies that investigate the relationship between international trade and the environment began as empirical investigations. The central underlying question investigated is whether the economic benefits of international trade are counteracted by the harmful effects of the exchange of dirty goods across borders.

To date, empirical investigations have generated mixed findings on whether trade increases economic welfare given the damaging effects of pollution (Stern and Common 2001; Wheeler 2001). The relationship between income growth and environmental quality, now known as the environmental Kuznets curve (EKC), was first described in the seminal study by Grossman and Krueger (1993). The authors provide evidence that environmental indicators such as sulfur dioxide concentrations increase in the initial phase of economic growth but decrease in the later phase of development, with a turning point at an estimated per capita income of about $8,000.

Subsequent investigations into other trade-environment phenomena such as the pollution haven and the race to the bottom hypotheses face similar mixed findings. The phenomenon known as the pollution haven hypothesis postulates that more developed nations relocate dirty industries to less developed nations (LDCs) to take advantage of lax environmental protection as they face more stringent environmental policies at home. In contradiction to the pollution haven hypothesis, Leonard and Duerksen (1980) find that trade and investment data suggest pollution-intensive industries relocate to other industrial countries instead of to less developed nations (LDCs). Leonard (1988) concludes that other factors such as labor training, infrastructure and political stability, as opposed to cost-savings from pollution regulations, play more important roles in the relocation decisions of multinational firms.

3-The Effect of Inter-Industry Trade

One reason frequently cited for inconclusive evidence in the study of trade-environment linkages is the lack of theoretical underpinnings to ground empirical predictions of the trade-environment relationships (Copeland and Taylor 2003). More recently, formal theoretical frameworks are advanced to provide basis for empirical hypotheses. In particular, the framework developed by Antweiler et al. (2001), based on the Heckscher-Ohlin type trade model, provides an explicit description of the environmental impact of inter-industry trade. An important contribution of the Antweiler et al. (2001) framework is the formal decomposition of the environmental impact of inter-industry trade into the scale, technique and composition effects.

A population of N agents lives in a small open economy that produces two final goods, X and Y, with two primary factors, labor, L, and capital, K. Industry Y is labor intensive and does not pollute. Industry X is capital intensive and generates pollution as a by-product. We assume constant returns to scale, and hence the production technology for X and Y can be described by unit cost functions $c^X(w,r)$ and $c^Y(w,r)$. We let Y be the numeraire, set $p^y = 1$, and denote the relative price of X by p.

By choice of units, 1unit of pollution is generated for each unit of X produced. We call this the base level of pollution and denote it by B. Producers have access to an abatement technology however, which for simplicity we assume uses only good X as an input. For a given base level of pollution B, the amount of pollution abated, A, is given by the function $\lambda A(x_a,B)$, where x_a is the amount of resources allocated to abatement. We will treat λ as a parameter that may be affected by technological change. *Pollution emissions* are then given by B minus A, or:

$$z = [x - \lambda A(x_a,x)]. \quad (1)$$

We assume $A(x_a,x)$ is linearly homogeneous, increasing, and concave in x_a and x. Hence we can write

$$A(x_a,x) = xa(\theta), \quad (2)$$

where $\theta = xa/x$ is the fraction of X output devoted to abatement, and $a(\theta) \equiv A(\theta,1)$. We assume there is no abatement without inputs, and that it is not possible to fully abate all pollution: i.e. $a(0) = 0$ and $\lambda a(1) < 1$. Note our specification implies increasing marginal abatement costs since, for a given level of base pollution, there are diminishing returns to abatement activity. Using (2), we can rewrite pollution emissions (1) as

$$z = x[1 - \lambda a(\theta)]. \quad (3)$$

We can now specify the equilibrium conditions for the production side of the economy. We assume the government uses pollution emission taxes (which are endogenous) to reduce pollution. Given the pollution tax τ, the profits Π^x for a firm producing X are given by revenue, less production costs, pollution taxes, and abatement costs:

$$\Pi^x = px - c^x(w,r)\, x - \tau\, [1 - \lambda a(\theta)]x - p\, \theta\, x. \quad (4)$$

Firms will jointly choose gross output (x) and their abatement fraction θ to maximize profits.

Define

$p\sim = p(1 - \theta) - \tau [1 - \lambda a(\theta)]$.

Then (4) becomes:

$\Pi^{x} = p\sim x - c^{x}(w,r)x$.

Because of constant returns to scale, the output of an individual firm is indeterminate, but for any level of output, the first order condition for the choice of θ implies

$$P=\lambda \tau a'(\theta). \tag{5}$$

(5) implicitly defines the optimal abatement θ^{*} as an increasing function of τ /p:

$$\theta^{*}= \theta (\lambda \tau/p), \tag{6}$$

where $\theta' > 0$. As one would expect, abatement activity is increasing in the level of the pollution tax. With free entry, firms will enter each industry until profits are zero. Using (4), we have for the X industry

$$c^{x}(w,r) = p\sim \tag{7}$$

and for the Y industry, we have

$$c^{Y} (w,r) = 1. \tag{8}$$

We assume both industries are active, and hence (7) and (8) determine factor prices w and r as functions of p~. Factor prices in turn determine the unit input coefficients for each sector. For example, by Shepherd's Lemma, the unit labor requirement in X is given by $c^{X}_{W} \equiv \partial cx/\partial w$, etc. The full employment conditions then determine outputs:

$$c^{X}_{W} x + c^{Y}_{W} y= L \tag{9}$$

$$c^{x}_{r} x + c^{Y}_{r} y = K \tag{10}$$

Each consumer maximizes utility, treating pollution as given. For simplicity, we assume preferences over consumption goods are homothetic and the marginal disutility of pollution is constant. The indirect utility function of a typical consumer is given by

$$V(P,G/N,Z)=U\left(\frac{G/N}{P(P)}\right)-бz \tag{11}$$

where G is national income (so G/N is per capita income), *P* is a price index, u is increasing and concave, and *б* is the marginal disutility of pollution. Note that pollution is harmful to consumers and is treated as a pure public bad (all consumers experience the same level of pollution). It is convenient to define real per capita income as $I=\frac{G/N}{P(P)}$ .and rewrite the indirect utility as

$$u(I)-б\,z \tag{12}$$

Pollution policy is determined by the government, and will vary with economic conditions. We model the policy process very simply by assuming the government sets a pollution tax, and that the level of the tax is an increasing function of the optimal tax. This allows for the possibility that government behavior varies across countries (perhaps depending on country characteristics and political systems), but also allows pollution policy to respond endogenously to changing economic conditions. Since all consumers are identical, the optimal pollution tax maximizes the sum of utilities:

$$MAX_{\tau}\{N[U(I)-бZ]\}$$

The solution to this problem yields $\tau^{*}=N\,б\varphi[p,I]$, (13)

where $\varphi=P(p)/u'$, and $\varphi\ I>0$ since u is concave. $б\varphi\ [p,I]$ can be interpreted as marginal damage per person, and hence (13) is just the standard Samuelson rule. The pollution tax is the sum of marginal damages across all individuals and is increasing in real income because environmental quality is a normal good.

Scale, Technique and Composition Effects

Because the relationship between economic activity and environmental quality is complex, it is useful to begin by decomposing the total effect of a change in pollution into scale, composition, and technique effects. To investigate further, define the scale of economic activity S as the value of the economy's gross output at world prices:

$$S = px + y. \tag{14}$$

To define the composition effect it is convenient to work with x/y ratios. Let χ= x/y denote the relative supply of X. Solving (9) and (10) for x and y and dividing yields

$$\frac{X}{Y} = C^{Y}{}_{w}\, k - C^{Y}{}_{r} / C^{x}{}_{r} - C^{x}{}_{w}\, k \equiv \chi\ (k,\tilde{p}) \tag{15}$$

where k = K/L is the economy's capital labor ratio. Note that χ is increasing in k and p~ ; and therefore increasing in p and decreasing in τ. We will refer to any change in the economy that alters $\chi(k,\tilde{p})$ as creating a composition effect. To define the pollution tax as technique effect We can use from 13.

The pollution tax depends on population size, real per capita income, and consumer tastes. Now we can write the pollution model:

$$\hat{Z} = \gamma_1 \hat{S} + \gamma_2 \hat{k} - \gamma_3 \hat{I} - \gamma_4 \hat{N} - \gamma_5 \hat{\sigma} \tag{16}$$

The first term in (16) is the scale effect, as before. The second term measures the effect on pollution of an increase in the capital/labor ratio. This is a composition effect. Since the polluting industry is capital intensive, a more capital abundant country generates more pollution, all else equal. The remaining terms all reflect the effects of changes in pollution policy; we will refer to them as technique effects. An increase in the level of per capita income increases the demand for environmental quality, and leads to stricter pollution policy $\varepsilon_{\varphi,I} > 0$); an increase in the number of people exposed ($\hat{N} >$ 0) leads to stricter pollution policy via the Samuelson rule; and an increase in the marginal disutility of pollution ($\hat{\sigma} > 0$, which may arise from increased knowledge about pollution) will also increase the demand for environmental quality and increase the pollution tax. Finally it is worthwhile to note the strength of these last three technique effects depends on ε_{T,τ^*}, which indexes the government responsiveness to the preferences of the representative agent. Pollution rises with the scale of the economy and capital abundance.

Increases in income, the marginal disutility of pollution, and the number of people exposed to pollution lead to a tightening of policy and a reduction in pollution. Equation (16) is not a suitable basis for estimation however because we have held both world and domestic prices fixed in its derivation. To examine the consequences of increased openness on pollution levels, suppose transport costs or other frictions act as a barrier to trade. Given a common world price pw, the domestic price in any country can be written,

$p = \beta p^w$

where β measures the importance of trade frictions. If we now allow for both trade frictions and world prices to change we have

$P\hat{}= \beta\hat{}+ pw\hat{}$

Amending (16) yields:

$$Z\hat{} = \gamma_1 S\hat{}+ \gamma_2 k\hat{} - \gamma_3 I\hat{} - \gamma_4 N\hat{} - \gamma_5 \sigma\hat{}+ \gamma_6 \beta\hat{}+ \gamma_7 pw\hat{} \quad (17)$$

As before, pollution varies with scale, capital abundance, income levels, etc. but as well, pollution now also varies with world prices and trade frictions. We should not expect to find openness per se related in any systematic way to pollution. This follows because β rises with freer trade for an exporter of the polluting good and β falls for an importer. While the coefficient of β ^ is positive, an increase in openness yields β ^ > 0 for a country with a comparative advantage in dirty goods, and β ^ < 0 for a country with a comparative advantage in clean goods. We summarize these results in the next part. When β ^ > 0 (or when p^ w > 0) the relative price of the pollution intensive good rises. Holding the abatement intensity constant, an increase in the relative price of X stimulates the output of X, and hence increases pollution via this composition effect. Second, for given levels of the pollution tax, an increase in the price of X increases the cost of abatement activity and this also increases pollution. When β ^ < 0 (or when p^ w <0) just the opposite occurs. While all countries in our sample will respond similarly to a change in world prices, their response to a change in trade frictions depends on their comparative advantage. This feature of our theory provides a method for identifying the composition effect created by freer trade. It suggests that some of the variation in our pollution data could be explained by a country's openness, but only after we have conditioned on those country characteristics that determine comparative advantage. In our model, comparative advantage is determined by the interplay of relative factor endowments and differences in pollution policy, (which are mainly due to differences in per capita income). To investigate the determinants of comparative advantage we solve for autarky relative prices. Pollution policy in turn is influenced by income.

To show how each of these factors affect comparative advantage let us consider them separately. Standard factor endowment theories predict that capital abundant countries should export capital intensive goods. In our model this need not be true because pollution policy can potentially reverse the pattern of trade. Nevertheless, capital abundance is still one of the key determinants of comparative advantage in our model. Because X is relatively capital intensive, an increase in k, holding all else constant, increases Home's relative supply of X, and lowers Home's autarky relative price of X. All else equal, an increase in the relative abundance of the factor used relatively intensively in the pollution intensive sector should increase the likelihood that a country will be an exporter of pollution intensive goods. More concretely, we can show that if the country is sufficiently capital abundant, it must export the capital intensive (polluting) good: An alternative theory of trade patterns is the pollution haven hypothesis.

According to this view, poor countries have a comparative advantage in dirty goods because they have relatively lax pollution policy, and rich countries have a comparative advantage in clean goods because of their stringent pollution policy. This result can be obtained as a special case of our model: if all countries have the same relative factor endowments, but differ in per capita incomes, then indeed richer countries will have stricter pollution policy and this will lead to a comparative advantage in clean goods. When countries differ in factor endowments as well, then we can obtain a weaker result: if a country is sufficiently rich, holding all else constant, then it will export the clean good. In autarky, the relative price of the pollution intensive good rises with per capita income if we control for relative factor abundance. Hence high income, all else equal, tends to generate a comparative disadvantage in pollution intensive goods. More concretely, we can show that if the country is sufficiently rich, it must export the labor intensive (clean) good.

Proposition 1 tells us that international trade has an impact on environmental quality that varies with the comparative advantage of a country. If we compare countries with similar incomes and scale, we expect to find openness associated with higher pollution in countries with a comparative advantage in the polluting good, and openness associated with lower pollution in countries with a comparative advantage in the clean good. This observation suggests that conditioning on country characteristics is important if we are to isolate trade's composition effect. Even though comparative advantage is set by the complex interplay of income differences and relative factor abundance, these results indicate that if a country is sufficiently rich then the pollution haven motive for trade will eventually outweigh factor endowment considerations and this country will export the clean good in trade. Similarly, if a country is sufficiently capital abundant then the factor endowment basis for trade will eventually outweigh any pollution haven motive for trade and this country will export the dirty good. The theory is perhaps at its weakest here because it does not provide a simple definition of either sufficiently rich or sufficiently capital abundant. But it should be recognized that these definitions would have to be functions of the entire distribution of both factor abundance and per-capita income in the world as a whole.

4- Empirical Model

To derive an estimating equation, assume measured concentrations at any observation site are a function of the country specific economic determinants of emissions and the other factors are as a unmeasured determinants of pollution and will be in error factor. Now, by following of the Antweiler et al. (2001) framework, we will have:

$$Z_{it}=\alpha_0+\alpha_1 GDP_{it}+\alpha_2 KL_{it}+ \alpha_3(KL_{it})^2+ \alpha_4 I_{it-1}+ \alpha_5(I_{it-1})^2+ \alpha_6 O_{it}+ \alpha_7 O_{it}*KL_{it}+ \alpha_8 O_{it}*(KL_{it})^2+ \alpha_9 O_{it}*I_{it-1}+ \alpha_{10} O_{it}(I_{it-1})^2+u_{it} \quad (18)$$

where GDP is country-specific GDP per capita, KL is measured by the capital to labor ratio, I is gross national income per capita (GNi), O is measured by the ratio of exports and imports to GDP, O(KL) and $O(KL)^2$ are interactions of openness with country's relative capital to labor ratio and its square, and O(I) and $O(I)^2$ are interactions of openness with country's income per capita and its square. And u_{it} is unmeasured variables.

In our model $\mathbf{Z_{it}}$ includes CO_2 emission

$\mathbf{GDPC_{it}}$: GDP per capita is the *scale effect.* ACT separate scale effect by measuring the former using GDP/km^2. Since we estimate national pollution emissions, the use of GDP/km^2 is no longer meaningful as a measure of scale. We use GDP per capita as proxy for scale effect. It measures the increase in pollution that would be generated if the economy were simply scaled up, holding constant the mix of goods produced and production techniques. Trade and growth both increase real income, and therefore both increase the economy's scale.

$\mathbf{KL_{it}}$, $\mathbf{(KL_{it})^2}$: A nation's capital to labor ratio captured to the *composition effect.* In our estimations we will include both a country's capital to labor ratio and its square. This non-linearity is appealing because theory suggests capital accumulation should have a diminishing effect at the margin.

The composition effect is captured by the changes in the share of the dirty good in national income. If we hold the scale of the economy and emissions intensities constant, then an economy that devotes more of its resources to producing the polluting good will pollute more. An increase in the supply of capital will increase the output of the capital-intensive industry, and reduce the output of the labor-intensive industry. An increase in the supply of labor stimulates of the labor-intensive industry and contracts of the capital-intensive industry.

The composition effect is critical in determining the effects of trade liberalization. Moreover, the sign of the composition effect is ultimately determined by a country's comparative advantage. If a country has a comparative advantage in clean industries, then clean industries expand with trade; and conversely, if it has a comparative advantage in polluting industries, then dirty industries expand with trade.

$\mathbf{I_{t-1}}$, $\mathbf{I^2_{t-1}}$: One lagged Gross national income per capita is the *technique effect.* Because we believe the transmission of income gains into policy is slow and reflects one period lagged, we use one period lagged Gross national income as our proxy for our technique effect. We have also allowed the technique effect to have a diminishing impact at the margin by entering both the level and the square of lagged Gross national income in all of our regressions.

This use of lagged gross national income and its squared to capture technique effects is consistent with the environmental Kuznets curve literature. This literature is the inverted-U-shaped relationship between per capita income and pollution: increased incomes are associated with an increase in pollution in poor countries, but a decline in pollution in rich countries.

If environmental quality is a normal good, increases in income brought about by trade or growth will both increase the demand for environmental quality and increase the ability of governments to afford costly investments in environmental protection. As income rises, the willingness to pay for environmental quality rises and increasingly large sacrifices in consumption are made to provide greater environmental benefits.

Oit: We include trade intensity (the ratio of imports+exports to GDP) as a measure of trade frictions.

OKLit, OKL2 it: trade intensity is interacted with a country's relative capital–labor ratio to capture the role of endowments.

OIit, OI2 it: Trade intensity is interacted with a country's income per capita to capture the pollution haven hypothesis.

The effects of trade liberalization on the environment depend on the environmental policy regime. Trade may encourage a relocation of polluting industries from countries with strict environmental policy to those with less stringent policy. We call this a *pollution haven hypothesis*. The pollution haven hypothesis is the stringency of pollution regulations does affect plant location and trade flows. This hypothesis has strong theoretical support. The pattern of trade depends on which of these effects is stronger.[1]

An increase in the stringency of environmental regulation accompanies higher per capita incomes. Because environmental quality is a normal good, the country with higher income chooses a higher pollution tax for any given goods price and these differences in environmental policy create an incentive to trade. Moreover, comparative advantage is determined jointly by

1- The interaction between income differences and relative factor endowments in determining the pattern of trade is analyzed in Copeland and Taylor (1997, 2003), Richelle (1996), and Antweiler, Copeland and Taylor (2001).

differences in pollution policy and other influences, such as differences in factor endowments.

Rich Northern countries are likely to be both capital abundant *and* have stricter pollution policy than poorer Southern countries. North's strict pollution policy will tend to make it a dirty good importer, but its capital abundance tends to make it a dirty good exporter.

The predictions of this simple pollution haven model are consistent with some criticisms of freer trade. North gains from trade by offloading some of its polluting production onto the South. Moreover, because the dirtiest industry is shifted to the parts of the world with weaker environmental policy this "global composition effect" tends to raise world pollution in short term. That is, if industry migrates to countries with relatively weak environmental policy, then concerns about the effects of environmental regulation on international competitiveness could lead governments in rich countries to weaken their environmental policy.

5- Empirical Results

The equation is estimated by the Panel Data methods. The time period covered in the estimations is 1991-2007 across Selected Countries in East Asia (China, Japan, Korea, Russia), Middle Asia (Turkey, Egypt, Cyprus, Jordan, Pakistan) and OECD countries (Australia, Belgium, France, Germany, Italy, Spain). Data are obtained from the World Bank's 2011 World Development Indicators' (WDI's) CD-Rom and on-line WDI 2011 (http://publications.worldbank.org/wdi) and Penn World Table (http://pwt.econ.upenn.edu/php_site/pwt63/pwt63_form.php).

Panel data analyses offer different ways to deal with the possibility of country-specific variables. Fixed Effect (FE) model is a suitable estimation approach that treats the level effects as constants, whereas Random Effect (RE) model is suitable to capture the level effect. It should be mentioned that RE model treats the level effects as uncorrelated with other variables, while FE model does not. In this analysis we estimate both FE and RE models in which the empirical results have been reported in Tables (1), (2) and (3). Based on our theoretical considerations, we estimate the following equation using fixed and/or random effects of panel data specification.

According to the Hausman test, in the first block, we use random effect and in the second and third blocks we accept fixed effect.

The first environmental effect is scale effect that is represented by GDP per capita. It measures the increase in pollution that would be generated if the economy were simply scaled up, holding constant the mix of goods produced and production techniques. In the first and second areas, positive coefficient of scale effect indicates a positive effect of increasing GDP on pollution. For example in the first area, Our estimation shows, if trade liberalization raises GDP per capita by 1%, then pollution concentrations rise by about 0.0007133% and in the second area, the pollution concentrations rise by about 0.0002%. Thus in the case of CO_2, in the first and second blocks, free trade is bad for the environment.

However the negative coefficient of GDP per capita in the third area, indicate a negative effect of GDP per capita on pollution.

The technique effect is represented by the lagged per capita income variable and the lagged per capita income squared. Because we believe the transmission of income gains into policy is slow and reflects one period lagged, we use one period lagged Gross national income as our proxy for our technique effect. Regression estimates just for the first area there is a negative relationship between income per capita and CO_2 emissions. In the first chart, a 1 unit increase in income level leads to a 0/002 percent decrease in CO_2 emissions level, while in the second and third blocks, it leads to a positive relationship between income per capita and CO_2 emissions, holding other factors constant. The coefficient estimates for the quadratic term of lagged per capita income in these areas are not statistically significant. The positive coefficient of technique effect has shown that Iran could not benefit from its trading earnings from Middle East and OECD through inter industry trade.

The sign of the composition effect is ultimately determined by a country's comparative advantage. If a country has a comparative advantage in clean industries, then clean industries expand with trade; and conversely, if it has a comparative advantage in polluting industries, then dirty industries expand with trade. The positive coefficient of composition effect that is represented by capital intensity has shown that Iran has comparative advantage in dirty goods in the third area. This result indicates strong evidence to suggest that a 1 unit increase in capital intensity leads to a 0.00061 percent increase in CO_2 emissions.

6- Conclusion

The aim of this paper was to evaluate the effect of inter-industry trade on the Iran’s environmental quality arising from its trade relations with the selected countries in East Asia, Middle East and OECD over the period 1991-2007. This paper focused firstly on theoretical discussion and then on development of a trade-environment framework that showed the explicit decomposition of the impact of trade on pollution levels. The framework developed by Antweiler et al. (2001), based on the Heckscher-Ohlin type trade model, provided an explicit description of the environmental impact of inter-industry trade. An important contribution of the Antweiler et al. (2001) framework has been the formal decomposition of the environmental impact of inter-industry trade into the scale, technique and composition effects. We finally specified the empirical equations for the econometric analysis on the relationship between bilateral trade and environmental quality, while we found a positive relationship between the scale of economic activity as measured by GDP and concentrations.

In addition, the empirical results indicated that an increase in the capital labor ratio raised emissions so that high-income countries have tighter standards in place, and this in turn implies the pollution consequences of capital accumulation should fall as development proceeds. In the case of Iran, the country does not benefit from its inter-trade relationship with the countries located for instance in the Middle East. This implies a better environmental quality a higher rate of bilateral intra-trade relations is needed.

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Table (1): The Effect of Inter Industry Trade on Environmental Quality in the First Area

Variables (1)	Random Effect (2)	Fixed Effect (3)
Constant	α_0 = - 0.542544	α_0 = 2.994373
GDP per capita	α_1 =0.0007133 z = 4.32 P > |z| = 0.000	α_1 = -0.0000488 t = -0.85 P >|t|= 0.398
KL	α_2 =0.0028242 z = 1.61 P > |z| = 0.108	α_2= -0.0005359 t = -1.11 P >|t|= 0.272
$(KL)^2$	α_3= -1.06e-07 z = -1.94 P > |z| = 0.052	α_3 = 2.46e-08 t = 1.66 P >|t|= 0.102
I_{t-1}	α_4 = -0.0021184 z = -2.10 P > |z| = 0.036	α_4 = 0.0003185 t = 0.88 P >|t|= 0.383
$(I_{t-1})^2$	α_5 = 3.99e-08 z = 2.38 P > |z| = 0.017	α_5= -4.66e-09 t = -0.79 P >|t|= 0.434
O	α_6 = 6.571504 z = 2.17 P > |z| = 0.030	α_6 = 2.983839 t = 2.82 P >|t|= 0.007
O(KL)	α_7 = -0.0084295 z = -2.56 P > |z| = 0.010	α_7 = 0.0027024 t = 2.84 P >|t|= 0.006
$O(KL)^2$	α_8 = 3.64e-07 z = 2.74 P > |z| = 0.006	α_8 = -1.31e-07 t = -3.18 P >|t|= 0.002
OI_{t-1}	α_9 = 0.0047836 z = 2.76 P > |z| = 0.006	α_9 = -0.0005124 t = -0.93 P >|t|= 0.355
$O(I_{t-1})^2$	α_{10} = -1.32e-07 z = -3.62 P > |z| = 0.0000	α_{10} = 8.21e-09 t = 0.67 P >|t|= 0.503
Diagnostic Tests	R^2 = 0.4760 Wald = 160/78 H: χ^2 = 50/02 Prob. > χ^2 = 0.0000	R^2 = 0.7855 F = 22.34 Prob. > F = 0.0000

Source: Authors

Table (2): The Effect of Inter Industry Trade on Environmental Quality in the Second Area

Variables (1)	Random Effect (2)	Fixed Effect (3)
Constant	α0 = -1.658681	α0 = 1.161409
GDP per capita	α1 = 0.0006234 z = 9.77 P > |z| = 0.000	α1 = 0.0002002 t = 9.55 P >|t|= 0.000
KL	α 2 =0.0000588 z = 0.16 P > |z| = 0.874	α 2 = -0.0001244 t = -1.44 P >|t|= 0.153
(KL)2	α 3 = -5.21e-09 z = -0.13 P > |z| = 0.898	α 3 = 1.53e-08 t = 1.60 P >|t|= 0.114
It-1	α 4=.0006579 z = 1.78 P > |z| = 0.075	α 4 = 0.0006056 t = 3.33 P >|t|= 0.001
(It-1)2	α5 = -8.44e-08 z = -2.16 P > |z| = 0.031	α5 = -3.55e-08 t = -2.46 P >|t|= 0.016
O	α 6 = 2.207383 z = 3.35 P > |z| = 0.001	α 6 = 1.566069 t = 3.96 P >|t|= 0.000
O(KL)	α 7= -0.0001376 z = -0.19 P > |z| = 0.846	α 7 = 0.0002503 t = 1.51 P >|t|= 0.136
O(KL)2	α 8 = 1.07e-08 z = 0.13 P > |z| = 0.897	α 8 = -3.10e-08 t = -1.60 P >|t|= 0.115
OIt-1	α 9 = -0.0005904 z = -1.28 P > |z| = 0.199	α 9 = -0.0006408 t = -2.90 P >|t|= 0.005
O(It-1)2	α 10 = 6.55e-08 z = 1.53 P > |z| = 0.125	α 10 = 3.49e-08 t = 2.24 P >|t|= 0.028
Diagnostic Tests	R2 = 0.7167 Wald = 0 H: χ2 = 2.48 Prob. > χ2 = 0.6478	R2 = 0.8342 F = 38.24 Prob. > F = 0.000

Source: Authors

Table (3): The Effect of Inter Industry Trade on Environmental Quality in the Third Area

Variables (1)	Random Effect (2)	Fixed Effect (3)
Constant	α0 = 8.478727	α0 = -0.3251513
GDP per capita	α1 = 0.00037 z = 2.91 P > |z| = 0.004	α1 = -0.0000791 t = -3.59 P >|t|= 0.001
KL	α 2 = -0.0056483 z = -2.31 P > |z| = 0.021	α 2 = 0.0006155 t = 2.32 P >|t|= 0.022
(KL)2	α 3 = 2.08e-07 z = 2.26 P > |z| = 0.024	α 3 = -1.63e-08 t = -1.57 P >|t|= 0.120
It-1	α 4 = 0.0026664 z = 2.15 P > |z| = 0.031	α 4 = 0.0005673 t = 4.04 P >|t|= 0.000
(It-1)2	α5 = -5.91e-08 z = -2.35 P > |z| = 0.019	α5 = -1.03e-08 t = -3.59 P >|t|= 0.001
O	α 6 = -9.577601 z = -0.86 P > |z| = 0.389	α 6 = 7.019707 t = 6.11 P >|t|= 0.000
O(KL)	α 7 = 0.0068375 z = 1.76 P > |z| = 0.078	α 7 = -0.0002019 t = -0.50 P >|t|= 0.616
O(KL)2	α 8 = -2.65e-07 z = -1.89 P > |z| = 0.059	α 8 = 3.65e-09 t = 0.25 P >|t|= 0.805
OIt-1	α 9 = -0.0029548 z = -1.49 P > |z| = 0.135	α 9 = -0.0003346 t = -1.63 P >|t|= 0.108
O(It-1)2	α 10 = 6.39e-08 z = 1.68 P > |z| = 0.093	α 10 = 5.85e-09 t = 1.45 P >|t|= 0.150
Diagnostic Tests	R2 = 0.0089 Wald = 38.64 H: χ2 = 5.53 Prob. > χ2 = 0.0631	R2 = 0.6874 F = 20.01 Prob. > F = 0.000

Source: Authors