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Trade liberalization and carbon dioxide diffusion

Maryam Lashkarizadeh and Puya Pourmoghaddam

Member of scientific board of Islamic Azad University, Firoozkough Branch.

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ABSTRACT

In this modern world, considering to the environmental problems is very important. The relationship between this topic and positive effects of free trade on the economic development and growth of the countries caused the importance of the topic is observed in international discussions more than ever. In this study, trade liberalization along with the factors affecting environment are considered in two groups of selected countries which are the member of Organization for Economic Development & Cooperation and developing countries such as Iran within 1995-2007 via dynamic panel data and static panel data. The relationships between the variables have been assessed by estimation to fixed and random effects method emphasizing on generalized moment method (GMM). The results indicated that the economic growth, population growth as well as value added of industrial sector resulted into the pollution intensification for both groups of selected countries. Degree of trade openness and trade of manufacturing products in the countries member of Organization for Economic Development & cooperation lead to pollution abatement and for developing countries leads to pollution expansion.

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Introduction

In the modern world, along with increasing development in the context of intellectual, technological, political and cultural mutations, trade liberalization has provided the appropriate requirements for opportunities and extensive risks for preserving the environment. Utilization of these opportunities and changing the risks to the opportunities for further upraising the environment quality in national, regional and international levels is dependent to the various factors that the power of the governments, political will, effectiveness and pressure of bioenvironmental actors and the position of a country in the international economics context are considered as the effective factors. Increasing the trade currents as the advanced economics' agenda and further consideration of developing countries to the implementation of ideas, thoughts, plans and green management is deemed as an effective step in this context. The century we are entering into shall be deemed as a new age of interaction between the nations and economics that the information and communications technology has passed the distances so non-descript and has exhibited a new geography.

The environment and preservation thereof in the countries development process is one of the new topics that has been considered within the several last decades by the different countries' policy makers and economic planers. Within the first decades after World War II, in the countries' economic and industrial development discussion, no considerable attention was paid to the environmental outcomes and consequences of developing activities. It caused many of actions the countries took in the framework of their economic and industrial development plans to incur irremediable harms on the environmental resources particularly nonrenewable resources. This status not only led the countries completely to the goal of economic development which was the improvement of welfare and quality of life of the citizens but on the other hand upon destroying the environment was follows the negative

outcomes. Expansion of environmental resources destroying actions and increasing its negative complications on the human life caused to the formation of sustainable development topic with the objective of human serving. The relationship between economic growth and development, trade liberalization and environment are important and complex issues so that the interaction quality between these sections is considered as the main axes of sustainable development of each country. In the recent decades, the environmental dangers and harms have been revealed more than ever. These harms have been resulted from the factors such as population growth, economic growth, energy consumption and industrial activities.

Positive effects of trade liberalization on the economics have been accepted by the most people and they are worry about its uneconomic effects. When the effect of trade liberalization on the environment is discussed, this question is propounded that if any relationship exists between the trade liberalization and environmental pollutions intensification?

According to the foregoing, in the second chapter, the circumstance of trade liberalization effect on the environment is discussed. In the third chapter, the applied studies in this context are reviewed and forth and fifth chapters is dealing with model assessment and presenting recommendations.

Literature Review

Grossman & Kruger (1991) have differentiated the effects of trade liberalization on the environment status to three scale effect, composition effect and technology effect. In this study, the scale effect explains the changes in size of economic activities, composition effect explains of changes in composition or portfolio of productive goods and technology effect explains the changes in production technology particularly changing towards clean technology. Therefore, following to the trade liberalization, the scale effect tends to environment destruction increasing and technology effect to the environment destruction reducing. The effect of composition is dependent to the type of

comparative advantage, so that considering the comparative advantage in a country, if a country is advantaged in polluter goods and achieve specialty in production of such goods, in such case the composition effect on account of changing the composition of state productive goods to the polluter goods apply negative impacts on the environment and if due to state comparative advantage in clean goods, the composition of that country's productive goods change to the clean goods, in such case composition effect have positive effect on the environment. Generally, following the trade liberalization if the technology effect comes over the scale effect and composition effect (in state status, with comparative advantage in polluter industries) or if the technology effect together with composition effect come over (in state status with comparative advantage in clean industries) the scale effect, in such case the trade liberalization will lead to positive environmental results (Barghioskouei & Yavari, 2007, p 4-5).

In this study, considering the presented model which has been described as follows, the variables of gross domestic product per capita indicates the scale effect, population and value added of industrial sector indicates the structural and trade openness degree refers to composition effect.

Theoretical Framework of the Study

Considering to the environment economics issues in the limits of growth theories of scholars such as Malts (1798) and Ricardo (1817) are observable. The environment is the dominant factor in these theories and human societies have been assumed somehow as defeated of this factor.

Promotion of technology and modern techniques in the last century has changed these theories so that the human activities have created a disorder in the process of this earth. Meanwhile, the trade as a lever for amplifying the economic development of the countries plays an important role. Researchers such as Pething (1976) and Siebert (1977) deem the environmental policies enforcing as an effective step towards production of sensitive goods in this context. Porter & Lind (1995) consider these policies as an effective step for applying innovation in environmental technologies in order to increase the competitive capability of the companies and the whole economics. In return, Tobey (1990) indicates an insignificant relationship between the environmental policies and trade model. This paradox causes to the subject sensitivity confronting pollution expansion issues in transnational dimensions.

Promotion of countries' trade activities along with considering the environmental issues in international dimensions in the last decades of 20th century indicates the significance of this topic. The theoretical literature exhibits the first step for repositioning the industries as industry flight hypothesis in the developed industrial countries. Then the pollution haven hypothesis (PHH) is emerged in developing countries. These hypotheses indicate indirectly the importance of environmental decisions in the macro issues of the countries.

Various studies have been applied on the relationship between trade volume and quality of environment that altogether a kind of non-convergence between the results, it caused the researchers to pursue the trend of this topic in most of their researches as two poles of the countries. The applied empirical studies on the trade and environment are limited to two group and case categories. In the group studies usually several countries according to the division as respect to the capital and technology factors, we encounter two groups of developed and developing countries. The developed countries which are

referred to as north countries in the theoretical literature, transfer the capital and technology. In return, the developed countries or south countries accept the capital or technology from the developed countries.

McCarney & Adamowics (2005) in 143 countries, Mangi (2006) in 115 countries, Zugravu et al (2009) in 22 countries, Lashlarizadeh & Nabavi (2008) in 6 countries and Barghioskouei (2008) in 98 countries have assessed in group the effects of trade liberalization on the environment with respect to the pollution diffusion.

In the case studies, the performance of trade liberalization on the environment has been applied on a particular country. This group of researches has been analyzed from aspects such as import, green taxes and performance of industry sector in the respective country. Studies such as Perooni & Wigle (1994) have been applied on relationship between export and quality of environment in Canada, Dessus & Bussolo (1998) on measuring the dependence between trade liberalization and environmental policies in Costa Rica, Antweiler et al (2001) on quality of export effect on the quality of environment in USA, Ten-Yang (2001) on the productive activities level and structure changes due to trade liberalization in Taiwan, Dean & Lovely (2002) on the effect of trade volume on the water pollution index in Chinese provinces, Frenkel & Rose (2005) on the effect of trade volume on the environmental quality indices such as carbon dioxide, nitrogen dioxide in USA, Jie He (2005) on the effect of trade volume on the environmental quality indices in China, Muthukumara & Jha (2006) on the effect of trade volume on the quality of environment in Vietnam, Khalil & Inam (2006) on the relationship between foreign trade and quality of environment in Pakistan, Shen (2008) on the good production and export factors for Chinese states, Dean & Lovely (2008) on the effect of trade growth on the air and water pollution indices in Chinese states, Bran (2008) on the relationship between trade and environment in Romania, Davis & Kahn (2010) on the trade liberalization status and removing the vehicle importing restrictions (2005) in Mexico, and local studies have been applied by Behboudi et al (2010) on the relationship between energy consumption, economic growth, trade liberalization and urban population on the carbon dioxide diffusion per capita as environment polluter index in Iran and study of Kazerouni & Afshari (2010) on the effect of industrial export on the environment of Iran.

The general result of the above studies on the relationship between two trade and environment topics indicate the positive relationship in the developing countries and negative relationship in most cases in the countries having high per capita income.

Empirical assessment

Introduction of pattern and data

In the extant paper, for studying the effects of trade liberalization on the environmental quality in two groups including 30 countries member of Organization for Economic Development & Cooperation and 26 developing countries such as Iran have been assessed within 1995-2000.

The applied model, according to the studies of Alam et al (2007) and Barghioskouei (2008) is as follows:

$$LCO_2 = \alpha_0 + \alpha_1 LGDP_{p_{it}} + \alpha_2 LPOP_{it} + \alpha_3 LIV_{it} + \alpha_4 LOPENS_{it} + \varepsilon_{it} \quad (1)$$

In which CO₂ refer to diffusion of carbon dioxide in terms of kiloton, GDP_p gross domestic product per capita to the fixed dollar rate for 2000, POP state population, IV value added of industrial sector as a fraction of gross domestic product, and

OPENS trade openness degree as a fraction of gross domestic product.

Whereas the productions of manufacturing products as respect to the environmental pollutions and importance of its economic importance is considerable, the following model has been added to the supplementary conclusion:

$$LCO_2 = \alpha_0 + \alpha_1 LGDPp_{it} + \alpha_2 LPOP_{it} + \alpha_3 LIV_{it} + \alpha_4 LOPENmn_{it} + \varepsilon_{it} \tag{2}$$

In equation 2 OPENmn refers to the share of manufacturing products from gross domestic product. Index I and t refers respectively to the country and time.

It is notable that the statistical references used from World Bank website (www.worldbank.org) refers to the years within 1995-2007 that have been separated and processed in two groups of selected developed countries (OECD) and developing countries via two above models.

Model assessment and analysis

Prior to performing the estimation, it is necessary to analyze the statics of model variables. Levin unit root test, Lin & Chu unit root test, Lin & Chu (LLC) study common unit root test for the combined data among the different equal levels. Im, Pesaran & Shin (IPS) test studied a common unit root process among the levels and heterogeneity among individual effects which is referred to as heterogeneous panel unit root test. The optimum lag has been selected according to the modified Schwartz formula. Hypothesis 0 in this test (unit root) is existence of unit root in time series. The results of two Levin, Lin & Chu (LLC) unit root test and Im, Pesaran & Shin (IPS) indicates non-statics of the level and first order statics of some variables. Consequently, at the next stage, cointegration tests have been used. In non-static mode of the variables, only in case of cointegrating relationship between the variables may trust to the results.

The cointegration test used in Pedroni methodology according to the hypothesis 0 shows non-cointegration. This test includes 7 statistics in two within dimension and between dimension categories. The statistics of within dimension test includes panel v and Raho statistic, Phillips- Perron (PP) panel statistic and augmented Dickey-Fuller (ADF) test. The statistics of between dimension includes Raho group statistic, Phillips-Perron group statistic and augmented Dickey-fuller (ADF). The results of these tests for the most test statistics in case of existence of intercept and the process of both selected countries group in two modes of within dimension and between dimension (considering the statistics of Philips Perron and augmented Dickey-Fuller) confirms the existence of co-integration vector and long-term relationship.

For achieving an acceptable explanation for estimating via panel data, selecting an appropriate test is necessary. Prior to providing the estimation for selecting between three common, fixed and random effects, F bound test and Hassman tests were used. The result of F bound test among two common and fixed effects methods, emphasize on the fixed effects method. For selecting one of fixed and random effects, Hassman test was used, and according to the results gained for the countries by OECD (Organization for Economic Cooperation & Development), the fixed effects are recommended. The models provided for the developing countries in case of trade openness, fixed effects test is recommended and in case of trading the manufacturing goods, random effects test is recommended according to the Hassman test.

Although Hassman test is important, we should memorize Johnston & Dinardo (1997) warning. About selecting among fixed and random effects, they believe that no simple rule exists in order to help the researcher for selecting one of them (Gajrati, 2008, p 1161).

Considering the foregoing about assessment of the said models in three fixed, random and generalized moment method (GMM) has been applied for reinforcing the results in order to study the effect of independent variables on the dependent ones.

Trade openness index model estimation

One of the indices discussed regarding the circumstance of the effect of trade and trade liberalization on the quality of environment is trade openness index. This index has been referred to as trade intensity and trade share of gross domestic product in the economic texts. Equation 1 has been indicated the relationship between this factor and carbon dioxide pollution diffusion.

Table 1- trade openness index model estimation in OECD countries (L CO₂dependent variable)

| estimation variable | OECD countries | | | | | |
|------------------------|----------------|------------|----------------|------------|-------------|------------|
| | Fixed effects | | Random effects | | GMM | |
| | Coefficient | Statistics | Coefficient | Statistics | Coefficient | Statistics |
| C | -13.70*** | -8.71 | -8.196*** | -10.79 | -1.66 | -1.42 |
| L CO ₂ (-1) | --- | --- | --- | --- | 0.625*** | 9.24 |
| L GPPp | 0.211*** | 5.57 | 0.250*** | 6.15 | 0.080** | 2.06 |
| L POP | 1.35*** | 13.62 | 1.024*** | 24.85 | 0.305*** | 3.68 |
| L IV | 0.325*** | 7.40 | 0.164*** | 3.17 | 0.077** | 2.16 |
| L OPENS | -0.151*** | -6.07 | -0.147*** | -4.34 | -0.063*** | -3.24 |
| N | 30 | | 30 | | 30 | |
| R ² | 0.999 | | 0.657 | | 0.999 | |
| F | 25858 | | 183 | | --- | |
| DW | 0.961 | | 0.751 | | 2 | |
| J-statistic | --- | | --- | | 323 | |

Note: Statistics are asymptotically distributed as normal. The variance ratio test is right-sided, while the others are left-sided.***, ** and *rejects the null of no co-integration at the 1%, 5% and 10% level, respectively. For the formulas used in the panel co-integration test statistics, it is described in details in Pedroni (1995, 2007)

The results of estimation are observed in table 1 for the OECD countries and table 2 for the developing countries. The variables of gross domestic product per capita, population and value added of industrial sector indicate in all three estimation methods and both selected group, the positive and significant relationship between carbon dioxide diffusion as the dependent variable. According to the applied estimation via generalized moment method (GMM), the lagged CO₂ variable has a positive and significant effect on the carbon dioxide diffusion growth.

Table 2- estimation of trade openness index model in the developing countries (L CO₂ dependent variable)

| estimation variable | Developing countries | | | | | |
|------------------------|----------------------|------------|----------------|------------|-------------|------------|
| | Fixed effects | | Random effects | | GMM | |
| | Coefficient | Statistics | Coefficient | Statistics | Coefficient | Statistics |
| C | -16.45*** | -10.93 | -9.77*** | -8.32 | -0.633*** | -41.9 |
| L CO ₂ (-1) | --- | --- | --- | --- | 0.976*** | 1411 |
| L GPPp | 0.124*** | 3.96 | 0.108** | 2.39 | 0.025*** | 33.34 |
| L POP | 1.51*** | 16.43 | 1.14*** | 16.95 | 0.035*** | 39.62 |
| L IV | 0.255*** | 4.65 | 0.201*** | 2.61 | 0.035*** | 3731 |
| L OPENS | 0.168*** | 5.74 | 0.302*** | 6.63 | 0.022*** | 26.89 |
| N | 26 | | 26 | | 26 | |
| R ² | 0.998 | | 0.607 | | 0.997 | |
| F | 9357 | | 128 | | --- | |
| DW | 0.719 | | 0.499 | | 1.96 | |
| J-statistic | --- | | --- | | 7.97 | |

As per F statistic, the whole model is significant in both fixed and random effects methods. But Durbin Watson statistic indicates the correlation between disturbed elements in estimation via static panel method.

For removing this problem and quantitative determination of model factors compatibility, dynamic panel method was used. Increasing of each unit of trade share of gross domestic product via GMM has significant relationship with pollution diffusion; so that in OECD countries, negative relationship is observed and in developing countries a positive relationship is observed between carbon dioxide.

Altogether the results obtained from three fixed, random and GMM is corresponding to the applied studies. Sargan statistic indicates that the used tools have required validity. The results obtained from generalized moment method in OECD countries group indicates the high value population variable 0.305 and gross domestic product per capita (0.08). Whilst in the developing population variable factor equal to 0.035 and then value added variable of industrial factor equal to 0.035 are observed. The positive effect of population growth on the pollution, in both groups of selected countries is exhibited and somehow show the dominance of structural effect on the scale effect in this study.

Estimation of manufacturing products index model

Considering the manufacturing products trade topic as the other index for trade liberalization that is important in environmental topics are applied frequently. In continue, model 2 has been added for complementary conclusion in order to achieve the effects of manufacturing products import and export on the carbon dioxide pollution diffusion, from the manufacturing products trade share of gross domestic product.

Table 3- estimation of manufacturing products trade indices model in the OECD countries (L CO₂ dependent variable)

| estimation variable | OECD countries | | | | | |
|------------------------|----------------|------------|----------------|------------|-------------|------------|
| | Fixed effects | | Random effects | | GMM | |
| | Coefficient | Statistics | Coefficient | Statistics | Coefficient | Statistics |
| C | -12.64*** | -8.52 | 8.35*** | -9.97 | -3.67** | -2.18 |
| L CO ₂ (-1) | --- | --- | --- | --- | 0.512*** | 9.74 |
| L GPPp | 0.197*** | 5.52 | 0.252*** | 6.30 | 0.185*** | 3.76 |
| L POP | 1.29*** | 13.48 | 1.01*** | 21.95 | 0.434*** | 3.41 |
| L IV | 0.355*** | 9.08 | 0.251*** | 3.90 | 0.112*** | 2.75 |
| L OPENS | -0.132*** | -6.21 | -0.153*** | -5.54 | -0.134*** | -4.03 |
| N | 30 | | 30 | | 30 | |
| R ² | 0.999 | | 0.662 | | 0.999 | |
| F | 25351 | | 185 | | --- | |
| DW | 1.01 | | 0.798 | | 1.88 | |
| J-statistic | --- | | --- | | 9.54 | |

Table 4- estimation of manufacturing products trade indices model in the developing countries (L CO₂ dependent variable)

| estimation variable | Developing countries | | | | | |
|------------------------|----------------------|------------|----------------|------------|-------------|------------|
| | Fixed effects | | Random effects | | GMM | |
| | Coefficient | Statistics | Coefficient | Statistics | Coefficient | Statistics |
| C | -14.78*** | -6.34 | -10.53*** | -8.57 | -0.617*** | -13.57 |
| L CO ₂ (-1) | --- | --- | --- | --- | 0.985*** | 487 |
| L GPPp | 0.180*** | 3.43 | 0.201*** | 4.13 | 0.032*** | 12.31 |
| L POP | 1.39*** | 9.87 | 1.13*** | 16.05 | .026*** | 11.29 |
| L IV | 0.232** | 2.56 | 0.280** | 3.18 | 0.043** | 10.7 |
| L OPENS | 0.138*** | 3.41 | 0.140*** | 3.60 | 0.04*** | 9.91 |
| N | 26 | | 26 | | 26 | |
| R ² | 0.996 | | 0.587 | | 0.997 | |
| F | 2910 | | 111 | | --- | |
| DW | 0.529 | | 0.484 | | 1.74 | |
| J-statistic | --- | | --- | | 7.54 | |

The results of estimation are observed in table 3 for the OECD countries and table 4 for the developing countries. As it is observed, estimation of the above model for both selected country group via static panel (fixed and random effects) demonstrates the positive and significant relationship between variables of gross domestic product per capita, population and value added of industrial sector and carbon dioxide diffusion logarithm as the dependent variable. The variable of manufacturing products trade share of gross domestic product in the OECD countries indicates a negative relationship and in the developing countries a positive relationship with CO₂ pollution diffusion for all three fixed, random and GMM methods.

The factor obtained from GMM in the OECD countries indicates the high value of population variable factor (0.434) and then gross domestic product per capita (0.185). Whilst in the developing countries population variable factor equal to 0.26 and industrial sector value added variable equal to 0.043 are observable and indicates the positive effect of population growth on the pollution in both selected countries groups.

Conclusion

Increasing the trade currents as the advanced economic agendas and consideration of the most developing countries to the ideas, thoughts, plans and green management realization is deemed as an effective step in this context. Therefore, in this study, after theoretical studies of the subject and presented assessments along with the analysis of the results for both selected countries groups mentioned in the previous chapters; the results indicate that the trade liberalization is not deemed as an anti-environment factor for increasing the environmental pollutions. In this study, the trade openness degree in the OECD countries indicates the negative relationship between trade and carbon dioxide diffusion as the environmental index. In the opposite point there are developing countries that have a positive relationship and it emphasized the pollution haven hypothesis. Altogether, the results of this study considering the propounded purposes indicates that the economic growth, population increasing as well as industrial sector value added increasing will lead to the pollution intensification. Upraising the trade openness degree and manufacturing products trading in the OECD countries resulted in pollution diffusion reduction and for the developing countries resulted in pollution diffusion increase which are compatible to the hypothesis.

Finally, it is notable that confronting the challenges and risks resulted from trade liberalization, effective utilization of available opportunities particularly in the developing countries requires the step by step and gradual strategies. Production topic was ever along with the environmental pollution intensify. Using the environmental tools and policies such as using clean technology and applying environmental taxes may be effective on the pollution reduction. As utilizing the industry as the growth and development lever is considered for compilation of countries macro strategies; upon considering the pollution generation in this chapter, local dispersion and analyzing the industrial sectors to the smaller sections along with applying required environmental standards seems to be necessary for improving the status quota. The population growth is one of the other effective factors on pollution diffusion. For improving the environmental pollution reducing, using modern civil services systems such as transportation and recycling together with the cultural promotion in this regard may be deemed as a positive.

According to the above results and the results obtained in the developed countries based concerning increasing the trade

factor towards reduction of environmental pollutions, for the developing countries, it is recommended that utilizing the trade besides establishment of new opportunities such as investment attraction for improvement of status quo seems to be common. Taking efforts for achieving the stability in pollution diffusion in these countries may be deemed as the first step towards progress of macro purposes with approach to the environment.

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