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Trade Openness and CO2 Emissions in Iran, 1971-2008

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Abstract

The increase of greenhouse gases (GHG) in which CO2 emissions constitute the principal component, is of major environmental problems of all societies. Economic growth impels intensive use of resources and as a result, more residues and wastes thrown in the nature that could lead to environmental degradation. This article tries to trace the eventual relationship between trade openness and environmental degradation in Iran. For this purpose, a multivarate model is employed in which economic growth and trade openness are related to CO2 emissions for the period of 1971-2006. By carring out the Granger causality test, there appeared a unidirectional relation from trade openness to CO2 emissions. To analyze the variables' relationships, the approach of GMM is applied. Results indicate that economic growth has a significant negative effect on carbon dioxcide emissions. But, the impact of trade openness on carbon dioxcide emissions is significantly positive.

Keywords: Trade openness, CO2 emissions, Granger causality, generalized method of moments (GMM).

JEL Classification: F18; O53; Q56

Introduction

The level of carbon dioxcide emissions from developing countries is being rapidly exceeding that of the developed countries. Therefore, greenhouse gases and related environmental challenges seem to be of major issues of the present century. The principal greenhouse gas is carbon dioxcide. The increasing volume of carbon dioxcide emissions is

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caused by expanding and widening of the process of industrialization and the consequent urbanizations all over the world are a determinant factor of the ascending greenhouse threats. So, the study and the survey of these aspects are of great importance for all societies from developing to developed countries.

Halting the ongoing process is of special importance. Specification of eventual relations between greenhouse gases carbon dioxcide emissions and the level of the growth of national revenue has a great traditional economic signification.

For this reason, climate change and greenhouse gases with their effects on flora, fauna, and hence on the ecosystems are of the challenging problems of the societies. This situation requires the stabilization in a first step, and then, the reduction of the global emissions. According to economic theories, we expect a direct relation between trade and economic growth. In other words, the expension of trade could increase production and income, and finally leads to more emissions. But, by virtue of trade theories there are no clear relationships between environmental quality and trade openness (Copeland and Taylor, 2005). Among several studies that have applied theoretical models and experimental framework for analysis of the relations between trade and environmental quality, we point to the following ones.

Copeland and Taylor (1994 and 1995) put forward three channels by way of which economic growth may affect the quality of environment and consequently alter the EKC shape. First channel, named scale effect, is pollution resulting from growth. Second channel, composition effect, ends in structural changes emmaning from trade liberalization. Finally, third channels named technique effects is caused by the usage and consumption of cleaner technique of production that goes with trade liberalization.

Wyckoff and Roop (1994) investigated the relationships between trade openness and global CO_2 emissions in OECD countries. They found that, on average, about 13% of the total CO_2 emissions of the six largest OECD countries were embodied in manufactured imports during 1984–1986(Yunfeng & Laike, 2010). Antweiler, Copeland, and Taylor (2001) studied the effect of trade openness on pollution emmaning from sulfur dioxide concentrations. The results showed that freer trade appears to be good for the environment (Yunfeng & Laike, opcit).

Yang, (2001) using the Taiwan's social accounting matrix of year 1996, examined the effect of trade on carbon dioxide emissions. The results showed that trade increases total carbon dioxide emissions. Cole, Elliott and Shimamoto (2006), used Japanese firm-level data identified the factors that influenced the environmental management of Japanese firms. Their results indicate that, there is seemingly positive effect of exports and Foreign Direct Investment (FDI) on environmental management. Shui and Harriss (2006) studied the quantity of CO2 emissions that embodied in US - China trade. Their estimation shows that 7% to 14% of China's current CO2 emissions are the results of producing goods for export to the USA. He (2008) using data set of provincial level production and sulfur dioxide emissions of 13 industrial sectors in China for the period of 1991-2001 studied the effects of trade openness on emissions. Using Divisia index decomposition method, He decomposed the determinants of emissions into scale, composition, and technique effects. He found an indirect impact of trade on pollution. Managi, Hibiki and Tsurumi (2009) by using the technique of instrumental variables, studied the relationships between trade openness and the environment quality in OECD and non-OECD countries. They found that beneficial effect of trade on the environment varies depending on the pollutant and the country. Trade has improved the environment quality in OECD countries. However, it has had a detrimental effect on sulfur dioxide (SO2) and carbon dioxide (CO2) emissions in non-OECD countries. Tamazian and Rao(2010), used the approach of standard reduced-form modeling to study 24 transition economies for the period of 1993–2004. Their results approved the EKC hypothesis while confirming the importance of both institutional quality and financial development for environmental performance. Also they found a positive relation between trade openness and environmental degradation. But this result is attenuated when interacted with institutional quality .Sunila Sharma(2011) studied the determinants of carbon dioxide emissions for a global panel consisting of 69 countries for the period of 1985–2005 using a dynamic panel data model. Based on level of income, she classified countries to a number of sub-panels that consisted of three income panels: high income, middle income, and low income panels. Results showed that in sub-panels countries trade openness has positive effects on CO2 emissions. But for the global panel, trade openness, has negative effects on the CO2 emissions.

Regarding Iranian official data, we constate that there is a considerable variation in the rate of growth of CO2 emissions and the rate of trade openness during the period of investigation. Fifure1 retrace the allure of the variables during 1971-2008.

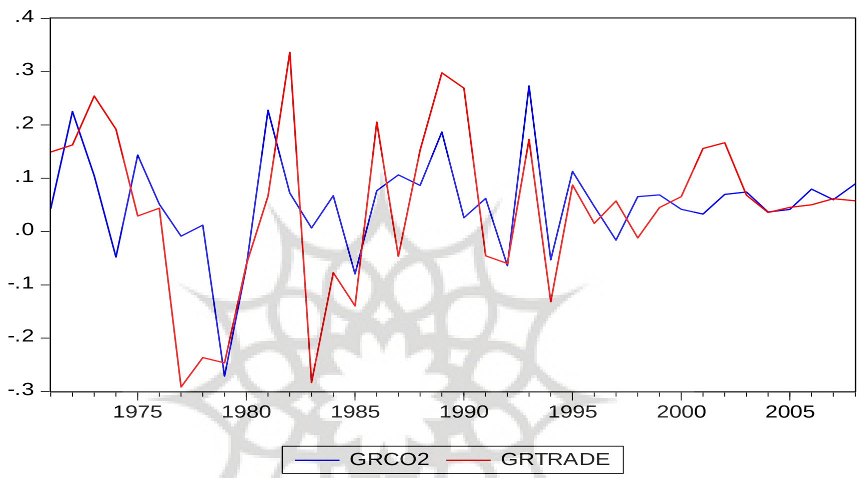

Fig.1- Rate of variation of trade openness and CO2 emissions of Iran, 1971-2008.

We can state that the variation of both variables, considering some lags, is simultaneously coordinated. Building on such stylized fact of Iranian economy, we are going to verify statistically our hypothesis on the relationships of the mentioned variables.

This paper investigates the relationship between the trade openness and the CO2 emissions of Iran. The sample covers the period of 1971to 2008. We use a model that relates CO2 emissions to economic growth, trade openness, labor force, capital stock, urban population, and energy consumption.

2-Methodology

The paper intends to analyze the relationships between trade openness and CO2 emissions of Iranian economy. We use a multivariate model in which CO2 emissions is a function of trade openness and other related explanatory variables.

$$E = f\,(GDP, TRADE, EC, UR, K, L) \quad (1)$$

Where, E, GDP, TRADE, EC, UR, K, and L stand respectively for CO2 emissions, gross domestic product, trade openness, energy consumption, urbanization, capital stock and labor force. Considering the logarithmic form of it, we can write:

$$lnE = ln\alpha + lnGDP + lnTRADE + lnEC + lnUR + lnK + lnL \quad (2)$$

The derivation of relation (2), gives

$$\Delta lnE = = \Delta lnGDP + \Delta lnTRADE + \Delta lnEC + \Delta lnUR + \Delta lnK + \Delta lnL \quad (3)$$

In relation (3) variables are defined as rate of growth. To estimate relation (3) we use equation (4):

$$\Delta lnE = = \beta_0 + \beta_1\Delta lnGDP + \beta_2\Delta lnTRADE + \beta_3\Delta lnEC + \beta_4\Delta lnUR + \beta_5\Delta lnK + \beta_6\Delta lnL + \epsilon \quad (4)$$

In equation (4), β_i show the coefficients and ϵ is a white noise.

Also, to analyze the effects of export and import on CO2 emissions, we consider equation (5):

$$\Delta lnE = = \beta_0 + \beta_1\Delta lnGDP + \beta_2\Delta lnEX + \beta_3\Delta lnIM + \beta_4\Delta ln\ EC + \beta_5\Delta lnUR + \beta_7\Delta lnL + \beta_6\Delta lnK + \xi \quad (5)$$

We estimate the equation (4) and (5) by generalized method of moments (GMM) technique.

3-Results and discussion

To study the impact of trade openness on CO2 emission, we have used the Iranian data of gross domestic production, capital stock, labor force, trade openness, energy consumption, and rate of urbanization for the period of 1971-2008. For the stationary analysis, we use two of the most influential unit root tests i.e. ADF and PP. Unit root test has been performed with intercept, trend, and intercept, and none. To calculate the Augmented Dickey-Fuller test, the required of lags are determined based on SIC. The table 1 shows the results of unit root test.

Table 1- Results of ADF and IPS unit root tests

Variable: DLGDP					
None		t-Statistic	None		t-Statistic
ADF test statistic:		-3.415672	IPS test statistic:		-3.476802
Test critical values:	1% level	-2.634731	Test critical values:	1% level	-2.634731
	5% level	-1.951000		5% level	-1.951000
	10% level	-1.610907		10% level	-1.610907
Variable: DLCO2					
None		t-Statistic	None		t-Statistic
ADF test statistic:		-5.18259721	IPS test statistic:		-5.2482943
Test critical values:	1% level	-2.634731	Test critical values:	1% level	-2.634731
	5% level	-1.951000		5% level	-1.951000
	10% level	-1.610907		10% level	-1.610907
Variable: DLTRADE					
None		t-Statistic	None		t-Statistic
ADF test statistic:		-3.981726	IPS test statistic:		-3.952964
Test critical values:	1% level	-2.634731	Test critical values:	1% level	-2.634731
	5% level	-1.951000		5% level	-1.951000
	10% level	-1.610907		10% level	-1.610907
Variable: DLK					
Trend & Intercept		t-Statistic	Trend & Intercept		t-Statistic
ADF test statistic:		-5.6274132	IPS test statistic:		-4.146276
Test critical values:	1% level	-4.252879	Test critical values:	1% level	-4.252879
	5% level	-3.548490		5% level	-3.548490
	10% level	-3.207094		10% level	-3.207094
Variable: DLEC					
Intercept		t-Statistic	Intercept		t-Statistic
ADF test statistic:		-6.969831	IPS test statistic:		-6.954765
Test critical values:	1% level	-3.639407	Test critical values:	1% level	-3.639407
	5% level	-2.951125		5% level	-2.951125
	10% level	-2.614300		10% level	-2.614300
Variable: DLLF					
Intercept		t-Statistic	Intercept		t-Statistic
ADF test statistic:		-4.954723	IPS test statistic:		-7.724259
Test critical values:	1% level	-3.639407	Test critical values:	1% level	-3.639407
	5% level	-2.951125		5% level	-2.951125
	10% level	-2.614300		10% level	-2.614300
Variable: DLPOP					
Trend & Intercept		t-Statistic	Trend & Intercept		t-Statistic
ADF test statistic:		-2.532918	IPS test statistic:		-2.5162951
Test critical values:	1% level	-4.252879	Test critical values:	1% level	-4.252879
	5% level	-3.548490		5% level	-3.548490
	10% level	-3.207094		10% level	-3.207094
First Difference		t-Statistic	First Difference		t-Statistic
ADF test statistic:		-6.327194	ADF test statistic:		-6.5619272
Test critical values:	1% level	-4.262735	Test critical values:	1% level	-4.262735
	5% level	-3.552973		5% level	-3.552973
	10% level	-3.209642		10% level	-3.209642

As table 1 summarizes, ADF and PS tests indicate that all variables - except growth rate of urbanization -are stationary at the level. The latter becomes stationary in the first difference. Engle and Granger (1987) argued that a linear combination of two or more non-stationary series may be stationary. So, we apply Johansen cointegration test. Table 2 shows the results of Johanson cointegration test.

Table 2- Results of Johanson cointegration test

Test	Max-Eigenvalue Test				Trace Test			
Hypothesized No. of CE(s)	Null Hypothesis	AGAINST Hypothesis	Eigenvalue Statistic	Critical Value	Null Hypothesis	AGAINST Hypothesis	Trace Statistic	Critical Value
None	0 = r	1 = r	69.65	48.54	0 = r	r ≥ 1	189.74	132.6
At most 1	r ≤ 1	2 = r	48.49	40.32	r ≤ 1	r ≥ 2	132.45	96.43
At most 2	r ≤ 2	3 = r	37.6	31.5	r ≤ 2	r ≥ 3	85.36	71.39
At most 3	r ≤ 3	4 = r	24.1	26.2	r ≤ 3	r ≥ 4	51.83	45.21
At most 4	r ≤ 4	5 = r	19.6	21.59	r ≤ 4	r ≥ 5	30.54	37.42
At most 5	r ≤ 5	6 = r	10.85	14.73	r ≤ 5	r ≥ 6	12.64	15.51

Trace test indicates no cointegration at the 0.05 level
Max-eigenvalue test indicates no cointegration at the 0.05 lev

Johansen cointegration test gives a stationary linear combination. At the 0.05 level, the trace test and Max-Eigenvalue test indicate respectively a five and a three cointegrating equations. The number of cointegration vectors in two tests is different. We employ eigenevalue test because it is more suitable test. So, there are at least three cointegration vectors that specify the long run relation between CO2 emissions and explanatory variables in the period of observation. Results of Johansen cointegration test indicate a long-run equilibrium relationship among the variables.

To distinguish the causality relationship between trade openness and CO2 emissions, Granger causality test is applied. As table 3 shows, there is a causality relation from trade openness growth to CO2 emissions growth.

Table 3- Pair wise Granger Causality tests between trade openness and CO2 emissions

Null Hypothesis	Obs	F-Statistic	Probability
DLTRAD does not Granger Cause DLCO2	37	7.4356	0.02314
DLCO2 does not Granger Cause DLTRAD	37	0.92731	0.67453

But, the inverse does not apply. So, increasing the Co2 emissions in Iran was caused by the increase of trade openness. To analyze relations between trade openness and CO2 emission we use equations 4. Table 4 summarizes results of equation's estimation.

Table 4- Estimation of equation 4, determining the trade openness and CO2 emissions relations

Variable	Coefficient	t-Statistic	Prob.
Intercept	0.353	8.1365	0.0002
Growth rate of capital stock log	3.357	7.1587	0.0011
Growth rate of labor force log	1.897	5.4829	0.0062
Growth rate of gross domestic production log	-1. 869	-8.3491	0.0000
Growth rate of energy consumption log	0.8962	6.2836	0.0031
Growth rate of trade openness	0.2371	8.1792	0.0002
Growth rate of (trade)^2	-1.2153	8.4297	0.0001
R^2 =0.754	Adj. R^2 =0.75	Durbin Watson Stat.=2.09	

Amount of t-statistics justify the significance of coefficients. Durbin Watson statistics indicate that there is no serial correlation problem. Low difference between R-squares and adjusted R-squares specifies the goodness of fit. Results state that, the growth rate of GDP has a negative impact on CO2 emissions growth. Moreover, elasticity of emission-growth is higher than unity. Othewise The coefficient of trade openness growth is less than unity and has a positive sign. Energy consumption, capital stock and labor force have positive impacts on CO2 emissions.

To analyze the impact of export and import separately on CO2 emissions, total trade is decomposed in its compounds, that is, in import and export. In this case, their causality relationships with CO2 emissions are examined in the first step. Then, using equation 5, their relationships is estimated. Table 5 indicates that there is a unidirectional Granger causality relationship from export to CO2 emissions. A significant impact of export on CO2 emissions is expected.

Table 5- Pair wise Granger causality tests between export and Co2 emissions

Null Hypothesis	Obs	F-Statistic	Probability
DLEX does not Granger Cause DLCO2	37	6.58391	0.01478
DLCO2 does not Granger Cause DLEX	37	0.498251	0.81983

On the other hand, results of Granger causality between import and CO2 emissions show that there is a unidirectional relationship from import to CO2 emissions. That is an increase in import might lead to an increase in CO2 emissions. Table 6 summarizes the results of pair wise Granger causality tests between two variables.

Table 6- Pair wise Granger causality tests between import and Co2 emissions

Null Hypothesis	Obs	F-Statistic	Probability
DLIM does not Granger Cause DLCO2	37	4.92718	0.02947
DLCO2 does not Granger Cause DLIM	37	1.08246	0.92819

For analyzing effects of export and import separately on CO2 emissions, the equation 5 is estimated. Table 7 summarizes results of this estimation.

Table 7- Estimation of equation 4, determing import and export on CO2 emission relations

Variable	Coefficient	t-Statistic	Prob.
Intercept	0.128	2.63	0.0312
Growth rate of capital stock	2.71	2.82	0.0361
Growth rate of labor force	2.93	2.97	0.0361
Growth rate of gross domestic production	-1.68	-2.73	0.0354
Growth rate of energy consumption	1.682	3.81	0.0276
Growth rate of export	0.417	3.94	0.0204
Growth rate of import	-0.438	- 2.74	0.0317
Growth rate of (export)^2	-1.61	-2.95	0.0372
Growth rate of (import)^2	-1.83	-2.32	0.0397
R^2 =0.751	Adj. R^2 =0.743	Durbin Watson Stat.=2.04	

In table7, t-statistics imply that coefficients of variables are significant. Also, r-square and adjusted r-square indicate that model explains more than 74 percent of relations of variables. Moreover, Durbin Watson statistic tells that the model is free from serial correlatin defect. Results of estimation indicate that export has a positive impact on CO2 emissions. But, estimation of quadric relations between this variable is negative. This means that the growth of export ultimately causes a diminution of CO2 emissions and consequently reduces the amount of greenhouse gases.That might be because of economic growth advantages such as amelioration of technologies induced by environmental regulations, polution taxes, and civil society's presures and so on.

On the other hand, import and its quadric have a negative effect on CO2 emissions. That is, the importation grosso modo conduct the economy to a less polluted situation. The reason is that the polutions are produced where the production is realised.

Figure2 shows respectively the fluctuations of import, CO2 emissions, and export.

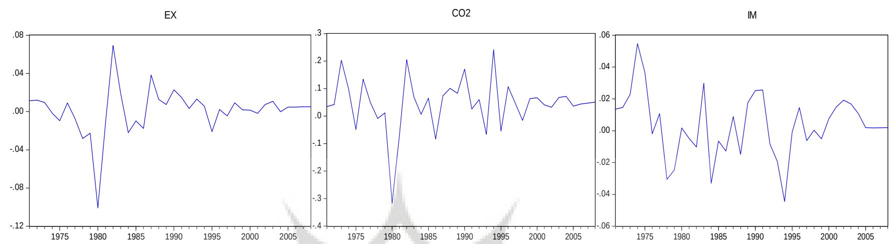

Figure 2- Variation of export, import, and CO2 emissions during 1971- 2008

It is to note that the fluctuations of CO2 emissions and export are pretty similar to each other. But, a low similarity is seen between CO2 emissions fluctuations and import fluctuations. Such a bahaviour could be commented as follow:

To satisfy both domestic and foreign commodity demand, Iran, like any other country, uses energy to produce goods and services. This process leads to more environmental pollution. Inversely, recoursing to imported goods, leads to less use of energy and consequently a diminished level of environmental degradation and prospective pollution.

4-Conclusion

Production of goods and services destined to satisfy domestic final demand and to make ready commodities for export demand are identified as the sources of total CO2 emissions. The main objective of this paper was to determine and to analyze the causal relationship between trade openness and CO2 emissions in Iran. For this purpose, a multivariate model including the economic growth, carbon emissions, trade openness, energy consumption, capital stock, labor force, and the rate of urbanization for the period of 1971-2008 was used. To analyze the relation between the trade openness and the CO2 emissions, the generalized method of moments approach had been applied.

The results indicate that economic growth has had a negative effect on CO2 emissions. Results also show that trade openness has had a significant positive impact on the CO2 emissions in the country. Moreover, the emission-trade elasticity is lower than unity; but the emission-growth (negative) elasticity is more than unity. It means that the economic growth reduces CO2 emissions more rapidly than trade openness increases it. Research findings also had demonstrated that there had been a one way causality relationship from both export and import to CO2 emissions.

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