INTERNATIONAL JOURNAL OF ACADEMIC RESEARCH IN BUSINESS & SOCIAL SCIENCES
Vol 4, Issue 11, (2014) E-ISSN: 2222-6990

The Causality between Quality environment, Income and Openness in Oil Exporting Countries: Panel Cointegration and Causality

Mohsen Mehrara[1], Abbas Rezazadeh Karsalari[2], Maysam Musai[3]
[1]Faculty of Economics, University of Tehran, Tehran, Iran, mmehrara@ut.ac.ir
[2]Department of Management, Islamic Azad University, Tafresh Branch, Tafresh, Iran, rezazadeh296@yahoo.com
[3]Faculty of Social Sciences, University of Tehran, mousai@ut.ac.ir

DOI Link: http://dx.doi.org/10.6007/IJARBSS/v4-i11/1319
Published Date: 30 November 2014

Abstract
This paper investigates the causal relationship between CO2 emissions and GDP in a panel of 11 selected oil exporting countries by using panel unit root tests and panel cointegration analysis for the period 1970-2011. A three-variable model is formulated with openness as the third variable. The results suggest that there is a long-run relationship between these variables. CO2 emissions have a positive long-run relationship with per capita income as well as openness, indicating economic growth tends to worsen environmental quality. The Granger Causality test indicates strong unidirectional effects from GDP and openness to CO2 emissions.

Keywords: Panel Unit Root, Panel Cointegration, Granger Causality, Environmental quality, Openness, Oil Exporting Countries

JEL classifications: Q00, F1, F18

1. Introduction

Globalisation is usually divided into globalisation of markets and globalisation of production (Hill 2005). According to Levitt (1983), market globalisation implies a standardization of products across the world as national barriers become less and less relevant. Nevertheless, this type of globalisation appears less of a reality as national markets still present significant differences, marketing strategies continue to have country-specific traits and customer needs differ across countries (Douglas & Wind 1987). Instead, production globalisation appears more of a reality. Globalisation of production refers to the sourcing of goods and services to take advantage of a difference in the factors of production. Globalisation of production continues to suffer from trade barriers, costs of transportation, economic, social and political risks and others (Hill 2005). While trade barriers have been significantly lowered since World War II, formal and informal barriers continue to survive.

Globalization does impact the ecologies and environments of nations, requiring safeguards that mitigate the negative effects rather than exploiting without regard to such concerns. Global warming negatively impacts all life on earth. Unfettered industrialization and pollution by the economically advanced nations needs to be curtailed for the benefit of all humanity, especially in the developing world nations. Burning fields or tropical rain forests in poor countries can cause ill health elsewhere, especially by the greenhouse effect. Some critics claim that the introduction of free trade will increase social and environmental problems in particularly harming the poorest countries. If fair trade is not offered to the developing world in the form of industry protection and gradual liberalization while the developed countries are forced to eliminate their trade barriers, it will once again be the elite that is to gain most from trade liberalization and developing countries become the losers. A critical scenario reflecting the present status of international trade. In spite of the potential gains of free trade, governments of rich and poor countries continue to apply protectionist policies and intervene in markets, which may be economically as well as politically grounded. The challenge is therefore not only to convince governments of the economic benefits, which are rather obvious, but also to discover politically attractive ways to phase-out tariffs and subsidies.

The focus of the paper is, therefore, to examine the relationship between CO2 emmisions, economic growth and openness in petroleum exporting countries for the period 1970-2011. The direction of causality between these variables is examined by utilizing a cointegration and error correction modeling framework. The paper is organized in four sections. Section 2 discusses the methodology, data and empirical results of the study. Section 3 concludes.

2. Literature Review

During the last 20 years the degree of openness to trade increased by 50 percent worldwide (World Bank, 2008). This unprecedented increase in international trade is expected to affect the EKC. Trade affects the environment through the interaction of three elements: the composition effect, the technique impact, and the scale effect. The composition impact refers to economies changing their emphasis from agricultural to industrial activities and from industrial activities to services. The composition effect for developing countries is likely to raise pollution, but for developed countries the expected result is the opposite. Thus, the process of development creates a structural shift from polluting industries to less polluting processes and service activities. The technique impact is a result of higher income populations' looking for a better environment and cleaner production leading both to the enforcement of higher environmental standards and regulations and to the adoption of cleaner technologies. The scale effect has a positive correlation with pollution since more production implies a greater emission of pollutants. It is also true that the scale effect is associated with growth. With growth comes a greater willingness to pay for a cleaner environment, which in the end results in less environmental deterioration. For the EKC inverted U-shape to occur the technique effect should more than neutralize the composition and scale effects. Panayotou (1993) and Vukina et al. (1999) point out that at initial stages of economic growth the negative impact on the environment prevails due to scale effects, the EKC hypothesis suggests that eventually the scale effect will be outweighed by the positive reduced emission levels impact of the composition and technique effects.

Environmental impacts of economic growth and globalization can be understood in terms of scale, income, technique, and composition effects. Scale effects refer to increased pollution and natural resource depletion due to increased economic activity and greater consumption. Income or wealth effects appear when greater financial capacity results in greater investment in environmental protection and new demands for attention to environmental quality. With higher income, we observe two other, related phenomena – technique and composition effects. Technique effects arise from tendencies towards cleaner production processes as wealth increases and, as trade intensifies, better access to economic base evolves towards a less pollution intensive high-tech and services-based set of activities(Williams, 2001). For physical reasons, more output means more pollution, other things equal. But other things are usually not equal. Trade and growth can shift the composition of output, for example, among the agricultural, manufacturing, and service sectors. Because environmental damage per unit of output varies across these sectors, the aggregate can shift. Often the same commodity can be produced through a variety of different techniques, some cleaner than others. Electric power, for example, can be generated by a very wide range of fuels and techniques. To the extent trade or growth involves the adoption of cleaner techniques; pollution per unit of GDP will fall (Jeffrey, 2003). A policy of trade liberalization is often suggested as a means of stimulating economic growth in developing countries. Given the potential benefits of trade liberalization policies, it is important to examine whether such policies are in fact in conflict with the environment as they accelerate economic growth (Mukhopadhyay and Chakraborty, 2003).

Grossman and Krueger (1991), World Bank (1992) and Selden and Song (1994) found an inverted U-shape relationship between per capita income and environmental quality known as the Environmental Kuznets Curve. The EKC hypothesis suggests that during the initial stages of economic growth, environmental quality will deteriorate; then, after reaching a peak, it will improve as the economy grows. It also suggests that as countries develop and increase their per capita income, the composition of their production results in cleaner technologies and service activities. Grossman and Krueger (1991) found that environment quality deteriorates with growth until middle income is attained. Roca et al. (2001) and Magnani (2001) suggested that this is true for a select set of pollutants and not for environmental quality in general.

3. Data and empirical results

We apply a three variable model to examine the causal relationship between CO2 emissions, GDP and openness. The data were obtained from world development indicators. Data used in the analysis are panel of annual time series during the period 1970-2010 on the openness, defined as the ratio of the value of total trade to GDP (OPEN), (logarithm of) real GDP per capita (GDP) in constant 2000 prices in local currency units and logarithm of Per capita carbon dioxide (CO2) for the 11 oil exporting countries. The choice of the starting period was constrained by the availability of data.

To test the nature of association between the variables while avoiding any spurious correlation, the empirical investigation in this paper follows the three steps: We begin by testing for non-stationarity in the three variables of CO2, GDP and OPEN. Prompted by the existence of unit roots in the time series, we test for long run cointegrating relation between three variables at the second step of estimation using the panel cointegration technique developed by Pedroni (1995, 1999). Granted the long run relationship, we explore the causal link between the variables by testing for granger causality at the final step.

2.1. Panel Unit Roots Results

The panel data technique referred above has appealed to the researchers because of its weak restrictions. It captures country specific effects and allows for heterogeneity in the direction and magnitude of the parameters across the panel. In addition, it provides a great degree of flexibility in model selection. Following the methodology used in earlier works in the literature we test for trend stationarity of the three variables of CO2, GDP and OPEN. With a null of non-stationary, the test is a residual based test that explores the performance of four different statistics. Together, these four statistics reflect a combination of the tests used by Levin-Lin (1993) and Im, Pesaran and Shin (1997). While the first two statistics are non-parametric rho-statistics, the last two are parametric ADF t-statistics. Sets of these four statistics have been reported in Table 1.

The first three rows report the panel unit root statistics for CO2, GDP and OPEN at the levels. As we can see in the table, we cannot reject the unit-root hypothesis when the variables are taken in levels and thus any causal inferences from the three series in levels are invalid. The last three rows report the panel unit root statistics for first differences of CO2, GDP and OPEN. The large negative values for the statistics indicate rejection of the null of non-stationary at 1% level for all variables. It may, therefore be concluded that the three variables of CO2, GDP and OPEN are unit root variables of order one, or, I (1) for short.

Table 1: Test of Unit Roots for CO2, GDP and OPEN

variables	Levin-Lin Rho-stat	Levin-Lin t-Rho-stat	Levin-Lin ADF stat	IPS ADF stat
CO2	0.73	-0.56	-0.98	-1.22
GDP	-1.33	-1.56	-1.43	-0.87
OPEN	-0.79	-1.19	-0.22	-0.91
ΔCO2	-12.00***	-7.9***	-5.81***	-11.73***
ΔGDP	-10.02***	-6.91***	-7.51***	-14.77***
ΔOPEN	-8.77***	-8.11***	-10.91***	-.12.65***

***significant at 1%

2.2. Panel Cointegration Results

At the second step of our estimation, we look for a long run relationship among CO2, GDP and OPEN using the panel cointegration technique developed by Pedroni (1995, 1999). This technique is a significant improvement over conventional cointegration tests applied on a single country series. While pooling data to determine the common long run relationship, it allows the cointegrating vectors to vary across the members of the panel. The cointegration relationship we estimate is specified as follows:

$$CO2_{it} = \alpha_i + \delta_t + \beta_i GDP_{it} + \gamma_i OPEN_{it} + \varepsilon_{it} \quad (1)$$

Where α_i refers to country effects and δ_t refers to trend effects. ε_{it} is the estimated residual indicating deviations from the long run relationship. With a null of no cointegration, the panel cointegration test is essentially a test of unit roots in the estimated residuals of the panel. Pedroni (1999) refers to seven different statistics for this test. Of these seven statistics, the first four are known as panel cointegration statistics; the last three are group mean panel cointegration statistics. In the presence of a cointegrating relation, the residuals are expected to be stationary. These tests reject the null of no cointegration when they have large negative values except for the panel-v test which reject the null of cointegration when it has a large positive value. All of these seven statistics under different model specifications are reported in Table 2. The statistics for all different model specifications suggest rejection of the null of no cointegration for all tests except the panel and group $\rho-$tests. However, according to Perdroni (2004), ρ and PP tests tend to under-reject the null in the case of small samples. We, therefore, conclude that the three unit root variables CO2, GDP and OPEN are cointegrated in the long run.

Table 2: Results of Panel Cointegration test

Statistics	
Panel v-stat	6.81***
Panel Rho-stat	-0.81
Panel PP-stat	-5.72***
Panel ADF-stat	-2.83**
Group Rho-stat	-0.69
Group PP-stat	-8.81***
Group ADF-stat	-7.94***

***significant at 1%
** Significant at 5%

The estimated long run relationship is of the form:

$$CO2 = 1.12 + 1.92GDP + 0.64OPEN - 0.006trend$$

$$t \qquad (6.72)(4.71) \qquad (6.63) \qquad (7.49)$$

The results show a positive long-run relationship between CO2 emissions and per capita income, suggesting that pollution levels tend to increase as a country's economy grows. Also, the findings indicate a positive long-run relationship between CO2 emissions and openness, implying that air pollution tends to increase as the oil revenues and exposure to international markets increases.

2.3. Panel Causality Results

Cointegration implies that causality exists between the series but it does not indicate the direction of the causal relationship. With an affirmation of a long run relationship among CO2, GDP and OPEN, we test for Granger causality in the long run relationship at the third and final step of estimation. Granger causality itself is a two-step procedure. The first step relates to the estimation of the residual from the long run relationship. Incorporating the residual as a right hand side variable, the short run error correction model is estimated at the second step. Defining the error term from equation (1) to be ECT_{it}, the dynamic error correction model of our interest by focusing on CO2 emissions and GDP is specified as follows:

$$\Delta GDP_{it} = \alpha_{yi} + \beta_{yi} ECT_{i\ t-1} + \gamma_{y1i}\Delta CO2_{i\ t-1} + \gamma_{y2i}\Delta CO2_{i\ t-2} + \delta_{y1i}\Delta GDP_{i\ t-1} + \delta_{y2i}\Delta GDP_{i\ t-1} + \lambda_{y1i}\Delta OPEN_{i\ t-1} + \lambda_{y2i}\Delta OPEN_{i\ t-2} + \varepsilon_{yit} \quad (2)$$

$$\Delta CO2_{it} = \alpha_{ci} + \beta_{ci} ECT_{i\ t-1} + \gamma_{c1i}\Delta CO2_{i\ t-1} + \gamma_{c2i}\Delta CO2_{i\ t-2} + \delta_{c1i}\Delta GDP_{i\ t-1} + \delta_{c2i}\Delta GDP_{i\ t-1} + \lambda_{c1i}\Delta OPEN_{i\ t-1} + \lambda_{c2i}\Delta OPEN_{i\ t-2} + \varepsilon_{cit} \quad (3)$$

Where Δ is a difference operator; ECT is the lagged error-correction term derived from the long-run cointegrating relationship; the β_y and β_c are adjustment coefficients and the ε_{yit} and ε_{cit} are disturbance terms assumed to be uncorrelated with mean zero.

Sources of causation can be identified by testing for significance of the coefficients on the lagged variables in Eqs (2) and (3). First, by testing $H_0 : \gamma_{y1i} = \gamma_{y2i} = 0$ for all i in Eq. (2) or $H_0 : \delta_{c1i} = \delta_{c2i} = 0$ for all i in Eq. (3), we evaluate Granger weak causality. Masih and Masih (1996) and Asafu-Adjaye (2000) interpreted the weak Granger causality as 'short run' causality in the sense that the dependent variable responds only to short-term shocks to the stochastic environment.

Another possible source of causation is the ECT in Eqs. (2) and (3). In other words, through the ECT, an error correction model offers an alternative test of causality (or weak exogeneity of the dependent variable). The coefficients on the ECTs represent how fast deviations from the long run equilibrium are eliminated following changes in each variable. If, for example, β_{yi} is zero, then CO2 does not respond to a deviation from the long run equilibrium in the previous period. Indeed $\beta_{yi} = 0$ or $\beta_{ci} = 0$ for all i is equivalent to both the Granger non-causality in the long run and the weak exogeneity (Hatanaka, 1996).

It is also desirable to check whether the two sources of causation are jointly significant, in order to test Granger causality. This can be done by testing the joint hypotheses $H_0 : \beta_{yi} = 0$ and $\gamma_{y1i} = \gamma_{y2i} = 0$ for all i in Eq. (2) or $H_0 : \beta_{ci} = 0$ and $\delta_{c1i} = \delta_{c2i} = 0$ for all i in Eq. (3). This is referred to as a strong Granger causality test. The joint test indicates which variable(s) bear the burden of short run adjustment to re-establish long run equilibrium, following a shock to the system (Asafu-Adjaye, 2000).

The results of the F test for both long run and short run causality are reported in Table 3. As is apparent from the Table, the coefficients of the ECT, GDP and OPEN are significant in the CO2 equation which indicates that long-run and short-run causality run from GDP and OPEN to CO2. So, GDP and OPEN strongly Granger-causes CO2 emissions. OPEN does Granger cause GDP at short run at 1% level, without any significant effect on output in long run. Weak exogeneity of GDP and OPEN indicate that this variable does not adjust towards long-run equilibrium.

Moreover, the interaction terms in the CO2 equation are significant at 1% level. These results imply that, there is Granger causality running from GDP and OPEN to CO2 in the long-run and short run, while CO2 have a neutral effect on GDP and openness in both the short- and long-run. In other words, openness is strongly exogenous and whenever a shock occurs in the system, CO2 would make short-run adjustments to restore long-run equilibrium.

Table 3:Result of Panel causality tests

	Source of causation(independent variable)						
Dependent Variable	Short-run			Long-run	Joint (short-run/long-run)		
	ΔGDP	ΔCO2	ΔOPEN	ECT(-1)	ΔGDP, ECT(-1)	ΔCO2, ECT(-1)	ΔOPEN, ECT(-1)
ΔGDP	-	F=0.87	F=6.93***	F=0.39	-	F=0.71	F=5.81***

ΔCO2	$F=6.23^{***}$	-	$F=4.91^{***}$	$F=7.99^{***}$	$F=8.34^{***}$	-	$F=9.23^{***}$
ΔOPEN	F=0.92	F=0.51	-	F=0.61	F=0.62	F=0.80	-

***significant at 1%

3. Conclusion

The objective of this study is to examine Granger causality between CO2 emissions, income and trade for oil-exporting developing countries over the period 1970-2011. The panel integration and cointegration techniques are employed to investigate the relationship between the three variables: CO2 emissions, GDP, and openness. The empirical results indicate that we cannot find enough evidence against the null hypothesis of unit root. However, for the first difference of the variables, we rejected the null hypothesis of unit root. It means that the variables are I(1). The results show a positive long-run relationship between CO2 emissions and per capita income, suggesting that pollution levels tend to increase as a country's economy grows. Also, the findings indicate a positive long-run relationship between CO2 emissions and openness, implying that air pollution tends to increase as the oil revenues and exposure to international markets increases. Utilizing Granger Causality within the framework of a panel cointegration model, the results suggest that there is strong causality running from GDP and openness to CO2 emissions with no feedback effects from CO2 to GDP and openness for oil exporting countries. It means that it is the openness and GDP that drives CO2 in mentioned countries, not vice versa. So the findings of this paper support the point of view that it is higher trade and economic growth that leads to higher CO2.

Acknowledgements

The authors would like to acknowledge the financial support of University of Tehran for this research under grant number 4401012/1/26

REFERENCES

[1] Asafu-Adjaye, J., (2000), the Relationship between Energy Consumption, Energy Prices and Economic Growth: Time Series Evidence from Asian Developing Countries, Energy Economics 22: 615–625.

[2] Douglas, Susan P. and Yoram Wind (1987), "The Myths of Globalization," Columbia Journal of World Business, 22(4), 19-29.

[3] Granger, C. W. J., 1969. Investigating Causal Relations by Econometric Models and Cross-spectral Methods, Econometrica 37 (3): 424-438.

[4] Granger, C. W. J., 1988. Some Recent Developments in a Concept of Causality, Journal of Econometrics 39: 199–211.

[5] Grossman, Gene M., and Alan B. Krueger. 1991. "Environmental impact of the North American Free Trade Agreement". National Bureau of Economic Research. Working paper 3914.

[6] Hatanaka, M., 1996. Time-Series-Based Econometrics: Unit Roots and Co-integration. Oxford University Press, Oxford.

[7] Hill, C. (2005) International Business, 5ed., New York, Mc Graw Hill Irwin.

[8] Im, K. S., Pesaran, M. H., and Shin, Y., 1997. Testing for Unit Roots in Heterogeneous Panels, University of Cambridge, Department of Applied Economics.

[9] Im, K. S., Pesaran, M. H., and Shin, Y., 2003. Testing for Unit Roots in Heterogeneous Panels, Journal of Econometrics 115: 53–74.

[10] Jeffrey. F. A., and Andrew A. Rose. 2005. “Is trade Good or Bad for the Environment? Sorting out the Causality” Review of Economics and Statistics 87(1): 85-91.

[11] Levin, A., Lin, C.F., 1992. Unit Root Tests in Panel Data: Asymptotic and Finite Sample Properties.Department of Economics, University of California at San Diego, Working Paper 92–23.

[12] Levin, A., Lin. C. F., 1993. Unit Root Test in Panel Data: New Results. Department of Economics, University of California, San Diego, Working paper 93-56.

[13] Levin, A., Lin, C. F., and Chu, C. S. J. 2002. Unit Root Test in Panel Data: Asymptotic and Finite Sample Properties. Journal of Econometrics 108: 1-24.

[14] Levitt, T. (1983) ‘The Globalization of Markets’, Harvard Business Review, 61(3) pp92-102.

[15] Magnani, Elisabetta. 2001. “The Environmental Kuznets Curve: development path or policy result?” Environmental Modeling & Software, 16(2): 157-165.

[16] Masih, A.M.M., Masih, R., 1996. Energy consumption, real income and temporal causality: results from a multi-country study based on cointegration and error-correction modeling techniques. Energy Economics 18:165–183.

[17] Mukhopadhyay. K Chakraborty D (2003), IS LIBERALIZATION OF TRADE GOOD FOR THE ENVIRONMENT? EVIDENCE FROM INDIA, Asia-Pacific Development Journal, Vol. 12, No. 1, June 2005.

[18] Panayotou, Theodore. 1993. “Demystifying the Environmental Kuznets Curve: Turning a Black Box into a Policy Tool” Environmental and Development Economics 2: 465-84.

[19] Pedroni, P., 1995,Panel Cointegration: Asymptotic and Finite Sample Properties of Pooled Time Series Tests, with an Application to the PPP Hypothesis. Indiana University, Working Papers in Economics, No. 95-013.

[20] Pedroni, P., 1997, Panel Cointegration: Asymptotic and Finite Sample Properties of Pooled Time Series Tests, with an Application to the PPP Hypothesis: New results, India University, Working Papers in Economics.

[21] Pedroni, P., 1999. Critical Values for Cointegration Tests in Heterogeneous Panels with Multiple Regressors. Oxford Bulletin of Economics and Statistics 61 (4): 5–49.

[22] Pedroni, P., 2004. Panel Cointegration: Asymptotic and Finite Sample Properties of Pooled Time Series Tests with an Application to the PPP Hypothesis: New Results. Econometric Theory 20 (3): 597–627.

[23] Pesaran, M. H., Shin Y., 1997. An Autogressive Distributed Lag Modelling Approach to Cointegration Analysis, Working Paper Trinity College, Cambridge.

[24] Roca, Jordi, Emilio Padilla, Mariona Farre, and Vittorio Galletto. 2001. “Economic growth and atmospheric pollution in Spain: discussing the environmental Kuznets curve hypothesis”. Ecological Economics, 39(1): 85-99.

[25] Selden, Thomas, and Daqing Song, 1994, “Environmental Quality and Development: Is There a Kuznets Curve for Air Pollution Emissions,” Journal of Environmental Economics and Management 27, 147-162.

[26] Vukina Tomislav, Beghin John C., Solakoglu Ebru G. 1999. “Transition to markets and the environment: effects of the change in the composition of manufacturing output. Environment and Development Economics, 4: 582–598.

[27] Williams, M. (2001), ‘Trade and Environment in the World Trading System: A decade of stalemate?’, Global Environmental Politics, 1(4), 1-9.

[28] World Bank,1992 /2008, World Development Indicators, Washington D.C.: World Bank.