

Relationship between Economic Growth, Trade and Environment: Evidence from D8 Countries

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Abstract This paper investigates the causal relationship between environmental quality, economic growth and trade in D8 countries by using panel unit root tests and panel cointegration analysis for the period 1970-2011. The results suggest that there is a long-run relationship between these variables. Emissions have a positive long-run relationship with per capita income and trade. Moreover, the results show a unidirectional strong causality from economic growth to environment in these countries. We also find no causality between emissions and trade.

Key words Unit root, Cointegration, Granger Causality, Environmental quality, Trade, Economic Growth

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1. Introduction

Since the 1980s, we have witnessed affected changes in the international marketplace. Liberalization of world trade and capital markets led by globalization has created a new and challenging competitive ground for all firms (Nolan and Zhang, 2003). With the trend towards more interdependence among nations, several changes in the business environment have appeared. There has been an appearance of global markets for goods, services, labor and financial capital (Deardorff and Stern, 2002; Hansen, 2002). Globalization can make environmental conservation compatible with development. International economic competition partly gets in the way of resolving environmental problems. Companies balk at spending money on environmental efforts, which means losing arena in this competition. Developing countries reflect that developed countries are the main offenders and view the environmental efforts they are being asked to make as a means for the more advanced countries to maintain their economic head start. Thus environmental solutions should include international market mechanisms (Huwart, 2013). Occasionally a country's growth is first bad for the environment and later good. On the one hand, when GDP rises, the greater scale of production leads directly to more pollution and other environmental degradation. On the other hand, there tend to be favorable moves in the configuration of output and in the techniques of production. The question is whether the latter two impacts can outweigh the first. A look at data across countries or across time allows several rough generalizations as to the usual outcome of these conflicting impacts. For several vital environmental measures, a U-shaped relationship appears: at relatively low levels of income per capita, growth leads to greater environmental damage, until it levels off at an intermediate level of income, after which further growth leads to improvements in the environment. This empirical relationship is known as the Environmental Kuznets Curve. The label is by analogy with the original Kuznets curve, which was a U-shaped relationship between average income and inequality (Jeffrey, 2003).

The focus of the paper is, therefore, to examine the relationship between economic growth, trade and environmental quality in D8 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 reviews the relevant literature. Section 3 discusses the methodology, data and empirical results of the study. Section 4 concludes.

2. Literature Review

Global collaboration through formal or informal institutions provides an increasingly vital mechanism to ensure the proper treatment of global problems, including those stemming from globalization. Through such global cooperation it must be possible to confirm equity and stability in a globalized world, leading to economic growth for all, the transition to a market economy for former socialist states, and economic development for the poorer nations. Such collaboration is also the way to treat the noneconomic problems of globalization, including those of environmental and health protection on a worldwide basis, freedom from political crises or instability, and global peace and security for the planet. The challenge will be to develop new ways of cooperation and new institutions to deal with the challenges of globalization (Michael, 2003).

The optimists see globalization as a process that fosters economic growth and increases per capita incomes, both essential to generate the funds and political will for global environmental management. Optimists see other environmental benefits from globalization as well. It is encouraging global integration and cooperation as well as common environmental norms and standards, which are enhancing the capacity of a system of sovereign states to manage problems like ozone depletion and climate change. It is pushing states to liberalize trade and foreign investment, promote specialization, and eliminate subsidies, which in the past have contributed to market failures and sub-optimal economic and environmental results. It is improving the capacity of developing states for environmental management through the transfer of technologies, knowledge, and development assistance and it is contributing to a host of domestic reforms to policies—such as better environmental laws, stronger institutions, and more secure property rights (Peter, 2005). The environmental impact of exports and foreign direct investment the reorganization of resources that took place in most of the region's countries as a result of the economic reforms of newly has in several cases boosted investment, production and exports of natural resource-intensive products. In fact, the increasing competitiveness of world exports is raising the opportunity expenditure of leaving natural resources unexploited at faster rates than their natural regeneration. This has led to the emergence of strong economic forces that are driving several of countries to exploit their natural resources (Jones *et al.*, 1995).

Ecologists believe that economic growth and the wide increase of economic activity in the past newly are core causes of environmental degradation. On the other hand, economists fully undermine this reason, claiming that economic growth is in fact the solution for most environmental concerns. The ecologist reason is based on immediate consequences of economic growth. So, one may argue that economic growth and associated development usually results in increased levels of environmental degradation. Although, that is not to say that an unavoidable consequential link exists between these trends. It seems evident that developing countries pursuing rapid growth under the premises of neoliberalism disregard environmental anxieties. Due to a strong commitment to neoliberal policies, developing countries tend to prioritize economic development goals above all conditions, consequently generating an increase in environmental degradation (Carvalho, 2012). It is important to highlight that not only does globalization effect the environment, but the environment effects the pace, direction and quality of globalization. At least, this happens because environmental resources provide the fuel for economic globalization, but also because our social and policy responses to global environmental challenges constrain and influence the context in which globalization happens. This happens, for example, through the governance structures we establish and through the constellation of stakeholders and stakeholder interests that construct key policy debates. It also happens through the transfer of social norms, aspirations and ideas that criss-cross the globe to formulate extant and emergent social movements, including global environmentalism. In short, not only are the environment and globalization intrinsically linked, they are so deeply welded together that we simply cannot address the global environmental challenges facing us unless we are able to understand and harness the dynamics of globalization that influence them. By the same token, those who wish to capitalize on the potential of

globalization will not be able to do so unless they are able to understand and address the great environmental challenges of our time, which are part of the context within which globalization takes place (Najam, 2007).

Frankel and Rose (2005) similarly test whether the impacts of openness on the environment are stronger when a country has a capital-labor ratio that is above the global average or per capita income that is below average. They test the impact of openness on concentrations of NO₂, SO₂ and Particulate Matter (PM), CO₂ emissions, deforestation, energy depletion and rural clean water access. Their approach is distinct from earlier assessments in that they use instrumental variables to account for the endogeneity of trade volumes and income levels; because there is little variation in their instrument for trade volumes, they restrict their attention to cross-sectional data. They include an interaction term between relative capital abundance and openness to see whether capital-abundant countries have a comparative advantage in dirty goods, and find the signs are mixed and the large standard errors render the interaction term statistically insignificant. Lucas *et al.* (1992) investigate the influence of trade openness on the growth rate of toxic intensity of output. They find that a high degree of restrictive trade policies tends to increase pollution intensity in fast-growing economies. Gale and Mendez (1998) analyze the relationship between trade, growth and the environment, and find that an increase in income has a detrimental effect on environmental quality, but trade effect on pollution is not significant. Dean (2002) examines the effect of trade liberalization on environmental damage. She finds that increased openness to international markets aggravates environmental damage through the terms of trade, but mitigates it through income growth. More recently, Wu *et al.* (2012) studied the effect of a country's governance environment on its propensity to trade. They examined how different governance types affect trade patterns among 44 countries representing 89% of world trade. A large positive effect on trade flows exists between two highly rule-based countries and between two relation-based countries. Any trade relationship involving a family-based country negatively affects trade flows, even between two family-based countries.

3. Data and empirical results

We apply a three variable model to examine the causal relationship between environment quality, GDP and trade. Environment quality is proxied by CO₂ and SO₂ emissions per capita. We apply the principle component approach to merge the proxies into one measurement (E). The data were obtained from world development indicators. Data used in the analysis are panel of annual time series during the period 1970-2011 on the proxy of quality environment, real GDP per capita (GDP) and trade, defined as the ratio of the value of total trade to GDP (T) for D8 countries: Bangladesh, Egypt, Indonesia, Iran, Malaysia, Nigeria, Pakistan, and Turkey. 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 E, GDP and T. 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.

3.1. 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 E, GDP and T. 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 E, GDP and T 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 E, GDP and T. 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 E, GDP and T are unit root variables of order one, or, I (1) for short.

Table 1. Test of Unit Roots for E, GDP and T

variables	Levin-Lin Rho-stat	Levin-Lin t-Rho-stat	Levin-Lin ADF stat	IPS ADF stat
EMI	0.23	-0.72	-0.91	-1.11
GDP	-1.81	-1.28	-1.49	-1.42
T	-0.15	-1.97	-1.52	-1.19
ΔEMI	-9.62 ^{***}	-9.71 ^{***}	-11.92 ^{***}	-10.83 ^{***}
ΔGDP	-11.53 ^{***}	-8.93 ^{***}	-11.65 ^{***}	-11.73 ^{***}
ΔT	-9.81 ^{***}	-10.82 ^{***}	-10.02 ^{***}	-10.93 ^{***}

***significant at 1%

3.2. Panel Cointegration Results

At the second step of our estimation, we look for a long run relationship among EMI, GDP and T 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:

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

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 ρ -tests. However, according to Pedroni (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 E, GDP and T are cointegrated in the long run.

Table 2. Results of Panel Cointegration test

Statistics	
Panel v-stat	6.91 ^{***}
Panel Rho-stat	-2.01
Panel PP-stat	-8.62 ^{***}
Panel ADF-stat	-5.71 ^{***}
Group Rho-stat	-0.72
Group PP-stat	-7.71 ^{***}
Group ADF-stat	-10.72 ^{***}

***significant at 1%

The estimated long run relationship is of the form:

$$E_t = 1.53 GDP_t + 0.92 T_t \quad (6.62) \quad (3.62)$$

The results show a positive long-run relationship between emissions and per capita income, suggesting that environmental quality get worse as the income increases. Also, the findings indicate a positive long-run relationship between emissions and trade, implying that air pollution tends to increase as the trade and exposure to international markets increases

3.3. 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 EMI, GDP and T, 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 emissions (EMI) and GDP is specified as follows:

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

$$\Delta E_{it} = \alpha_{ei} + \beta_{ei} ECT_{i,t-1} + \gamma_{e1i} \Delta E_{i,t-1} + \gamma_{e2i} \Delta E_{i,t-2} + \delta_{e1i} \Delta GDP_{i,t-1} + \delta_{e2i} \Delta GDP_{i,t-1} + \lambda_{e1i} \Delta T_{i,t-1} + \lambda_{e2i} \Delta T_{i,t-2} + \varepsilon_{eit} \quad (3)$$

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_e are adjustment coefficients and the ε_{yit} and ε_{hit} 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 $H_0 : \delta_{e1i} = \delta_{e2i} = 0$ 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 GDP does not respond to a deviation from the long run equilibrium in the previous period. Indeed $\beta_{yi} = 0$ or $\beta_{ei} = 0$ 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 $H_0 : \beta_{ei} = 0$ and $\delta_{e1i} = \delta_{e2i} = 0$ 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 T are significant in the emissions equation which indicates that long-run and short-run causality run from GDP and trade to emissions So, GDP and trade strongly Granger-causes emissions without any feedback effects from trade and emissions to GDP. Moreover,

there is no causality between trade and GDP. Exogeneity of GDP and trade indicate that this variable does not adjust towards long-run equilibrium.

Moreover, the interaction terms in the emissions equation are significant at 1% level. These results imply that, there is Granger causality running from GDP and T to emissions in the long-run and short run, while emissions have a neutral effect on GDP and trade in both the short- and long-run.

Table 3. Result of Panel causality tests

Dependent Variable	Source of causation(independent variable)						
	Short-run		Long-run		Joint (short-run/long-run)		
	Δ GDP	Δ E	Δ T	ECT(-1)	Δ GDP, ECT(-1)	Δ E, ECT(-1)	Δ T, ECT(-1)
Δ GDP	-	F=1.41	F=0.41	F=0.19	-	F=1.71	F=1.51
Δ E	F=7.61***	-	F=1.03	F=4.71***	F=9.82***	-	F=4.29***
Δ T	F=1.91	F=0.92	-	F=0.51	F=0.24	F=1.51***	-

***significant at 1%

4. Conclusion

The objective of this study is to examine Granger causality between emissions, income and trade for D8 countries over the period 1970-2011. The panel integration and cointegration techniques are employed to investigate the relationship between the three variables: emissions, GDP, and trade. 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 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 emissions and trade, 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 trade to emissions with no feedback effects from emissions to GDP and trade for D8 countries. It means that it is the trade and GDP that drives emissions in mentioned countries, not vice versa.

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