THE RELATIONSHIP BETWEEN ECONOMIC GROWTH AND ENVIRONMENT AND TRADE IN DEVELOPING COUNTRIES

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ABSTRACT

This paper investigates the causal relationship between environmental quality, economic growth and tradein developing 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 bidirectional strong causality between economic growth and environment in these countries. We also find bidirectional causalitybetween emissions and trade.

JEL classifications: Q00, F1, F18

Keywords: Unit root, Cointegration, Granger Causality, Environmental quality, Trade, Economic Growth

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1. INTRODUCTION

Liberalized trade can have both positive and negative effects on the environment. It may exacerbate environmental problems as well as provide new means for addressing them (Anderson, Cavanagh, and Lee 1999; Jobes 2003; Speth 2003). Environmental choices can also shape the path of globalization as national regulatory choices can act as barriers to liberalized trade or trigger a convergence toward higher international standards. As economies open up, more people become involved in the processes of knowledge integration and the deepening of non-market connections, including flows of information, ideology, technology and culture. New technologies may solve old problems, but they can also make new ones. Technologies of environmental care can move across boundaries quicker, but so can technologies of environmental extraction. Information flows can connect citizens across boundaries and oceans,but they can also threaten social and economic networks at the local level. Environmentalism as a norm has become truly global, but so has mass consumerism (Najam, 2007).

Globalisation, which is partly synonymous with rising international trade, has fostered the fast production, trade and consumption of material goods in extraordinary quantities. This has weighted the ecological footprint of human activities around the world. While it's still difficult to assess the effect of globalization on the environment, it's quite obvious in some areas.Globalisation promotes CO2 emissions from transport. As critical drivers of globalisation, transport systems have multiplied alongside international trade. Emissions from road transport are of course very high, but more so within national borders. But the opening of some regional areas has given a strong boost to road freight transport. Despite some encouraging recent alternatives such as piggy-backing, transnational road transport is an important source of CO2 emissions.

The focus of the paper is, therefore, to examine the relationship between environmental quality, income and trade for 101 developing countries during 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

Trade liberalization further complicates matters in that the globalisation of political norms, such as democracy and human rights, has been accompanied by, and some believe has been dependent upon, the advancement of economic globalisation, which, to date, has had an adverse effect on the global environment. If this is the case, then, as globalisation increasingly undermines global ecological integrity, environmental issues will come to be an element of the immediate fears relating to human security, rather than an issue that can be deferred. In fact, this is already the case for a substantial number of the global poor who live on land that is polluted, desalted, or on flood plains. For these people, environmental problems are already a threat to human security (Kerri, 2007).Economic growth and expanded trade can be broken down into four categories. Scale effects refer to increased pollution and natural resource depletion due to increased economic activity and greater consumption. Technique effects arise from the tendency toward cleaner production processes as wealth increases, and trade expands access to better technologies and environmental "best practices." Income or wealth effects appear when greater financial capacity results in more resources being invested in environmental protection and creates demands for greater attention to environmental excellence. Composition effects arise as the economic base evolves toward a high-tech and services-based economy involving a move in preferences toward cleaner goods. The overall environmental effect of economic growth depends on the net result of these four effects. If the technique, income, and composition effects overwhelm the negative scale effect of expanded activity, then the overarching effect will be positive (Grossman and Krueger 1995; Selden and Song 1994; Shafik 1994; Antweiler et al., 2001). For some problem and some levels of development the gains look to outweigh the losses.

One thing that is indisputable, as the scientific evidence makes clear, is that the growing and cumulative scale of human activities has produced environmental effects of a global nature that are not reflected in the markets but that affect global common interests transcending national perspectives. There has clearly been an increase in environmental interdependence and vulnerability among countries, whatever their degree of development. This gives a singular character to the third phase of globalization, which took place in the last quarter of the twentieth century.A range of comparative advantages could emerge in the countries of the region, with widely varying environmental effects. These advantages include those deriving from access to cheap energy sources, those associated with lower transport costs because of proximity to natural resources, those of location offered by lax environmental or health legislation and those represented by the opportunity to benefit from local environmental or climatic conditions or components. In ecological terms, this shifting mosaic of comparative advantages in the region's countries could pose the risks of increased pressure on fragile or remote areas or ecosystems with little human intervention, the sudden increase in the value of particular ecological elements or functions and the introduction of new biological forms or even exotic ecosystems in the region. In the absence of social regulation, these developments may lead to overexploitation and degradation of regional ecosystems, but if well managed they could generate new sustainable sources of prosperity and lead to a positive redefinition of comparative advantages in the global context (Jose, 2000).

Jones and Rodolfo (1995) and Lee and Roland-Holst (1997) point out that overall trade is expected to improve environmental quality, but it has contradictory effect on the environment, since it increases pollution but also motivates its reduction. Grossman and Krueger (1991) identify three possible effectsof an increase in economic activity due to a reduction in trade barriers and consequently an increase in trade. The first factor adversely affects the environment through an expansion of economic activities. The second entails a structural change of the current production, which will not result in pollution reduction everywhere, and the third factor results in changes in the production techniques. The composition and the technique effects have to offset the effect of the expansion of the economic activity for the possibility of an Environmental Kuznets Curve (EKC) relationship. Industrial value added and agricultural value added reflect the level of industrial-agricultural development and are key indicators of sustainable development. Both industrial value added and agricultural value added have mixed effecton the environment. They increase pollution as they expand but are also expected to motivate its reduction through per capita income and adoption of newer, cleaner technology.

3. DATA AND EMPIRICAL RESULT

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 101 developing countries. The choice of the starting period was constrained by the availability of data (For the names of countries, see the appendix).

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	0.79	-0.50	-0.83	-1.62
GDP	-1.51	-1.20	-1.19	-1.72
T	-0.59	-1.51	-1.10	-1.49
ΔEMI	-11.54***	-10.61***	-10.62***	-11.61***
ΔGDP	-10.19***	-7.39***	-10.18***	-12.95***
ΔT	-9.41***	-11.41***	-14.61***	-11.62***

***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:

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

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 E, GDP and T are cointegrated in the long run.

Table 2: Results of Panel Cointegration test

Statistics	
Panel v-stat	7.61***
Panel Rho-stat	-1.28
Panel PP-stat	-7.51***
Panel ADF-stat	-4.51***
Group Rho-stat	-1.05
Group PP-stat	-6.20***
Group ADF-stat	-9.19***

***significant at 1%

The estimated long run relationship is of the form:

$$E = 2.92GDP + 0.71T$$
$$t \quad (4.95) \qquad (4.11)$$

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 openness, 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:

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

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

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 E equation which indicates that long-run and short-run causality run from GDP and T to environmental quality. So, GDP and trade strongly Granger-cause environmental quality. Moreover, emissions Granger cause GDP and trade in the short-run without any significant effect on them in the long run.

Moreover, the interaction terms in the E equation are significant at 1% level. These results imply that, there is bidirectional Granger-Causality between GDP and emissions as well as trade and emissions in the short run. In other words, GDP and trade are weakly exogenous and whenever a shock occurs in the system, environmental quality 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	ΔE	ΔT	ECT(-1)	ΔGDP, ECT(-1)	ΔE, ECT(-1)	ΔT, ECT(-1)
ΔGDP	-	F=7.54***	F=1.54	F=0.61	-	F=6.91***	F=7.81***
ΔE	F=8.71***	-	F=8.91***	F=8.61***	F=10.27***	-	F=10.19***
ΔT	F=1.91	F=8.41***	-	F=0.33	F=0.61	F=7.91***	-

***significant at 1%

4. CONCLUSION

The objective of this study is to examine Granger causality between environmental quality (measured by CO2 and SO2 emissions), GDP and trade for 101 developing 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 environmental quality deteriorate when 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. 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 short run feedback effects from emissions to GDP and openness for developing countries.

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Appendix: Sample Countries

Algeria	Korea, rep
Argentina	Lesotho
Azerbaijan	Liberia
Bangladesh	Lithuania
Barbados	Madagascar
Belize	Malawi
Benin	Malaysia
Bolivia	Mali
brazil	Mauritania
Bulgaria	Mauritius
Burundi	Mexico
Cambodia	morocco
Cameroon	Mozambique
cape Verde	Namibia
central African rep	Nepal
Chad	Nicaragua
Chile	Niger
China	Nigeria
Colombia	Pakistan
Comoros	panama
Congo, Dem. Rep.	Papua new guinea
Congo, rep	Paraguay
Costa Rica	Peru
cote d'lvoire	Philippines
Cyprus	Poland
Dominica	Portugal
Dominican republic	Romania
Ecuador	Rwanda
Egypt	Sao tome
Elsalvador	Senegal
equatorial guinea	Seychelles
Estonia	sierra Leone
Ethiopia	Solomon islands
Gabon	South Africa
Gambia	Sri lanka
Ghana	St. Lucia
Grenada	St. Vincent and the Grenadines
Guatemala	Sudan
guinea	Tanzania
guinea-Bissau	Thailand
Guyana	Togo
Haiti	Trinidad
Honduras	Tunisia
Hungary	Turkey
India	Uganda
Indonesia	Uruguay
Iran	Uzbekistan
Jamaica	Venezuela
Jordan	Zambia
Kazakhstan	Zimbabwe
Kenya	