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The Causality between Environmental Quality, Economic Growth and Openness in Asian Countries: Panel Co integration and Causality

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Abstract

This paper investigates the causal relationship between environmental quality, economic growth and openness in 40 Asian 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 openness. Moreover, the results show a strong causality from openness and economic growth to environment in these countries. Yet, CO2 and SO2 emissions do not have any significant effects on income and trade in short- and long-run. So the findings of this paper support the point of view that it is higher trade and economic growth that leads to higher emissions.

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

Introduction

Globalization is national economies integrate into the international economy through trade; foreign direct investment; short-term capital flows; international program of workers and people in general; and currents of technology. This has created new Opportunity for many

people and countries; but not for all. It has also placed pressures on the natural resources and global environment, straining the capacity of the environment to sustain itself and exposing human dependence on environment. A globalized economy may also produce globalized externalities and increase global inequities. Local environmental and economic choices can contribute to global solutions and prosperity, but the environmental costs, as well as the economic ramifications of our actions, can be externalized to places and people who are so far away as to seem invisible. Globalization is altering the global environment (Najam, 2007). Several observe the net ecological impact of globalization as positive, as a force of progress and better lives. It fosters economic growth and cooperative institutions, both necessary in the long run to manage the global environment. Others see the net effect as negative, as a force sinking the globe into a bog of ecological decay. It is hastening the destructive process of too several people consuming too many natural resources without any concern for equality or justice. Both the pro- and anti-globalization camps present persuasive data and arguments. Globalization involves multiple and complex sets of overlapping processes. Certainly, there will be various and at times cross-cutting effects on the global environment.It is vital to highlight that not only does globalization impact the environment, but the environment impacts the pace, direction and quality of globalization. At least, this happens because environmental resources provide the fuel for economic globalization, because our social and policy responses to global environmental challenges constrain and influence the context in which globalization happens. There are potential and very important non-economic effects of globalization involving great risks and potential expenditures, even the possibility for catastrophe. One is that of security, where the negative effects of globalization could lead to conflicts. In fact, the very process of globalization leading to integration of markets could make conflicts escalate beyond a particular region or raise the stakes of conflict, for example, from conventional weapons to weapons of mass destruction. A second non-economic area in which globalization could lead to disastrous outcomes is that of political crises, that could escalate from local to large-scale challenges. A third such area is that of the environment and health, where the greater interconnectedness stemming from globalization could lead again to catastrophic outcomes, such as global warming and pandemics (Michael, 2003).

The focus of the paper is, therefore, to examine the relationship between environmental quality, income and openness in 40 Asian countries for the period 1970-2011. The direction of causality between these three 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.

Literature Review

The environmental impacts of productive and technological restructuring may be direct or indirect. The environmental implications of globalization are different from the economic ones, in both time and space. The environmental penalties are generally longer-term, with dynamic, cumulative characteristics that are difficult to measure because they are associated in several cases with qualitative parameters. Moreover, many of these inferences are not necessarily reflected in markets. Some examples of such implications are cross-border pollution, impacts on global Commodity, effects on landscape and the loss of scenic beauty, the extinction of species and the loss of biodiversity. Direct environmental effects are generated by the use of new technologies for agriculture industry and energy, by the exploitation of hitherto untapped renewable and non-renewable natural resources, by the

creation and Scattering of new biological forms and by the release of new substances into the environment. Indirect environmental impacts are generated by the social, political, economic and demographic adjustments driven by the wave of new technology, which has resulted in changes in prices and demand, the social organization of work, production systems, the international division of labour, employment, services and the location and nature of human activities and settlements (Jose, 2000).

The critics of economic globalization and neoliberalism argue that "Globalization is not a natural, evolutionary, or inevitable phenomenon, as is often argued. Globalization is a political process that has been forced on the weak by the powerful." On the other hand, economists Affected by neoliberal thought, claim that globalization is remarkably beneficial for poor countries. The belief of free market advocates is that global welfare is maximized by the liberalization of trade, finance, and investment, and by the restructuring of national economies to offer an enabling environment for capital. Moreover, neoliberal economists see a clear benefit of the alliance of the global economy and believe that those who fight against these processes are suffering from global phobia. Their reasoning is that, firstly, the more global the economy, more manufactures of products in a given country can take advantage of commodities, production processes, and markets in other countries. Secondly, globalization encourages the diffusion of knowledge and technology, which increases the chances for economic growth worldwide. Thirdly, the rich countries and corporations in the global North have capital that they will lend to developing states for economic growth if these states accept the rules of the neoliberal economic system. Fourth and finally, if trade barriers are minimal and government takes a minor role in trying to manage the economy, the chances for government corruption and political interference are greatly reduced. However, most critics cast doubt on economic globalization benefits and more precisely, on the neoliberal argument that a truly global economy is beneficial for the poor. According to critics, economic globalization has dramatically increased inequality between and within nations, and far from this circle of prosperity widening, as the neoliberal argument entails, the opposite is actually happening: the gap between rich and poor is widening fast, and economic globalization is to blame (Carvalho, 2012).

The inverted U relationship derives its name from Simon Kuznets (1955), who postulated the relationship between income distribution and economic growth. This curve was later adapted for environmental research by Grossman and Krueger (1991), who suggested that the Kuznets Curve could be applied to the environment, postulating the relationship between per-capita pollution and per-capita income. When applied to environmental issues, pollution grows rapidly in the first stages of development as society is poor and more interested in jobs and income than in the consequences of environmental pollution. Dasgupta (1997) found that as income rises, individuals give greater value to a cleaner environment and implement institutional reforms and regulations designed to decrease pollution.

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 openness, defined as the ratio of the value of total trade to GDP (O) for 40 Asian countries. All variables are in terms of logarithm. The choice of the

starting period was constrained by the availability of data. The countries considered in this study are Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyz Republic, Pakistan, Tajikistan, Turkmenistan, Uzbekistan, China People's Rep. of, Hong Kong; China, Korea Rep. of, Mongolia, Bangladesh, Bhutan, India, Maldives, Nepal, Sri Lanka, Brunei Darussalam, Cambodia, Indonesia, Lao PDR, Malaysia, Philippines, Singapore, Thailand, Viet Nam, Fiji Islands, Kiribati, Marshall Islands, Palau, Papua New Guinea, Samoa, Solomon Islands, Tonga, Vanuatu, Australia, Japan, New Zealand

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.

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 O. 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 O 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 O. 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 O are unit root variables of order one, or, I (1) for short.

Table 1:
Test of Unit Roots for E, GDP and O

variables	Levin-Lin Rho-stat	Levin-Lin t-Rho-stat	Levin-Lin ADF stat	IPS ADF stat
EMI	0.73	-0.80	-0.40	-1.20
GDP	-1.65	-1.91	-1.88	-0.87
O	-0.16	-0.59	-0.39	-1.89
ΔEMI	-10.81***	-11.99***	-9.03***	-10.33***
ΔGDP	-11.42***	-6.84***	-11.72***	-14.66***
ΔO	-11.18***	-10.36***	-8.39***	-12.51***

***significant at 1%

Panel Cointegration Results

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

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

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 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 O are cointegrated in the long run.

Table 2:
Results of Panel Cointegration test

Statistics	
Panel v-stat	8.26***
Panel Rho-stat	-1.81
Panel PP-stat	-8.81***
Panel ADF-stat	-3.61***
Group Rho-stat	-0.91
Group PP-stat	-7.12***
Group ADF-stat	-10.51***

***significant at 1%

The estimated long run relationship is of the form:

$$E = 2.5\,GDP + 0.3\,O$$
$$t \quad (5.7) \qquad (8.7)$$

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

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:

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

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

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_{hi} 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 O are significant in the E equation which indicates that long-run and short-run causality run from GDP and O to environmental quality. So, GDP and openness are strongly Granger-cause environmental quality. Openness does Granger cause GDP at short run at 1% level, without any significant

effect on output in long run. Weak exogeneity of GDP and openness indicate that this variable does not adjust towards long-run equilibrium.

Moreover, the interaction terms in the E equation are significant at 1% level. These results imply that, there is Granger causality running from GDP and openness to environmental quality in the long-run and short run, while environmental quality have a neutral effect on GDP and openness in both the short- and long-run. In other words, GDP and openness 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	ΔO	ECT(-1)	ΔGDP, ECT(-1)	ΔE, ECT(-1)	ΔO, ECT(-1)
ΔGDP	-	F=0.91	F=12.81***	F=0.61	-	F=0.91	F=7.81***
ΔE	F=8.71**	-	F=8.91**	F=8.61**	F=10.27***	-	F=10.19***
ΔO	F=1.91	F=0.73	-	F=0.33	F=0.61	F=0.91	-

***significant at 1%

Conclusion

The objective of this study is to examine Granger causality between environmental quality (measured by CO2 and SO2 emissions), GDP and openness for 40 Asian 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 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 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 openness, 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 openness to emissions with no feedback effects from emissions to GDP and openness for Asian countries. It means that it is the openness and GDP that drives emissions 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 emissions.

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