Granger Causality Relationship between Export Growth and GDP Growth in Developing Countries: Panel Cointegration Approach

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Abstract

In this research, Granger causality relationship between nonoil export and economic growth is investigated based on panel cointegration analysis for 73 developing countries during the period 1970-2007. Sample countries are categorized into two groups of oil dependent countries and nonoil developing countries. Also, for evaluating the causality direction, bi-variate and tri-variate specifications are applied. The results show that in both bi- and tri-variate models, there is bidirectional long-run causality between export and GDP growth for both groups of countries. Also, bivariate model, there is bidirectional short-run causality between export and GDP growth for nonoil developing countries, however, for oil countries, there is no short run causality relationship between the variables, in any of the two models.

Key words: export growth, economic growth, Granger causality, Cointegration, Error Correction Model (ECM)

1. Introduction

From the early 1960, policy makers and researchers had a great interest in relationship between export and economic growth. Their main reason and motivation is that they want to know if a country should increase its export to lead to a more economic growth or they should stimulate economic growth from the outset to lead to more export. Regarding the relationship between export and economic growth, four possibilities could be recognized: Some analysts believe that the causality direction is from export to economic growth which expressed as Export-Led Growth (ELG) hypothesis (Balassa 1978, Bahagwati 1978, Edwarards 1998). The export development and free entry and exit are considered as the key causes of economic growth. For example, firms can take advantage of more efficient allocation of resources, scale economies and encouraging creativity and innovation caused by foreign competition (Helpman and Krugman 1985). Moreover, export can cause more import of intermediate goods which leads to increase of capital accumulation and output growth.

Also, there are various studies which support Growth Led Export (GLE) in a way that the causality direction is from economic growth to export growth. Regarding to the Growth Led Export hypothesis, export development is set off through benefits of efficiency caused by increase in interior work force's skill levels and technology advancement (Krugman, 1984, Bhagwati 1988). Two above approaches do not overlap. Therefore the third possibility is that there is a feedback relationship between export and economic growth. At last (as the fourth possibility) it is possible that there is no relationship or just a simple contemporaneous relation between these two variables. In this study, by using panel Cointegration approach and panel Vector Error Correction Model (VECM) in reduced form, the causality direction between export growth rate and the rate of GDP growth of 1970-2007 period for 73 developing countries including two groups of oil rich countries and non oil developing countries is investigated. In the second section of this paper, we briefly investigate the theoretical and empirical literature regarding to the effect of trade and openness on the economic growth. The econometric methodology and empirical results are discussed in the third section of this paper. First, the integration order of variable would be examined, based on panel unit-root tests. Second, we test the long-run relationship between level variables by panel cointegration tests. Third, by using panel VECM approach we would empirically evaluate the causality direction among the variables. The forth section concludes.

2. Review of Literature

There are three main approaches concerning the relationship between trade policies and economic growth which can briefly be classified as neoclassical, endogenous growth and institutional ones.

The neoclassical approach emphasizes the importance of competitive advantages in international trade. Each country maximizes its welfare through the activities which are the most efficient regarding resource and production factors scarcity in of economy. In this case, the benefits of the trade are static and trade liberation and openness can't lead to increase in long run growth rate, but it influences income level (Duncan and Quang 2001). According to the traditional theory and analysis of Hechscher-Ohlin-Samuelson, it is expected that trade would influence on economy through impact on level and composition of the product without influencing on long run growth. Trade specialization and optimal allocation of resources can lead to the static benefits based on neoclassical approach. In sum, it can be said that classical and neo-classical models of trade keep silence about the effect of trade and openness of business on growth (Stensens, 2006).

Dynamic gain caused by trade liberation has a close relation to the endogenous growth theory which has been developed from the mid-1980. The endogenous growth theories discuss that trade policies might have some influences both on level and long run economic growth rate. These impacts include scale effect, allocation, spillover and redundancy. In fact, endogenous growth model develop theories connecting foreign trade and economic growth. Since the potential market is expanded, the economies of scale in production can be reaped and thus the production of final goods and intermediate goods are concentrated in the most efficient sites. Allocation affects results from re-allocation of the resources. Spillover effect is caused by spreading of new technologies which results from trade. Also, open trade leads to reduction of unnecessary duplication and reproduction of researches, hence eliminating redundancy in R&D (Duncan and Quang 2000). The fundamental basics of endogenous growth theories were developed by Romer(1986) and Locus(1988) and extended by Grossman and Helpman (1990) and Acemogla and Ventura (2002) which evaluate the international trade effect on growth. From Grossman and Helpman (1991) point of view, trade and openness lead to facilitation of availability to intermediate goods and capital equipment, hence increasing efficiency of other resources. Trade makes it possible for developing countries to import high technologies and capital goods from developed countries. Trade also increases the efficiency of production; hence increase consumption and production level.

In other words, the openness increases the market for local producers and improves the economic efficiency. Then, it causes the specializing of country in knowledge- oriented and research-based production (Harisson 1996). In institutional approach, the role and effect of institution elements on economic growth, is emphasized. North (1990), Olson (1996), De Soto (2000) emphasized the high importance of property rights and fair implementation of contracts as basic components of economic growth and discussed that institutions have great importance for improving the economic performance in market- based economies. Therefore, if these institutions are not established in countries, the impact of trade reforms and openness policies on growth and income level are not clear. In other words, the institutionalists believe that trade liberation influences economic growth under the conditions of good institutions. Trade liberation influences economic performance not only through changing relative prices but also through institutions. In other words the positive long-run impact of trade and openness on growth exist only when the openness come along with appropriate institutional frames and policies which encourage the investment, improve institutional quality and develop human capital accumulation. Therefore, countries with the low institutional quality, weak financial systems and instability in government's policies can't enjoy the benefits caused by openness. According to these groups of economists, an increase in economic growth is expected to lead to export growth.

Also, various empirical studies investigated the relationship between openness of business and economic growth and different results are obtained. Frankel and Romer (1999) indicate that despite many attempts which are done for studying this issue, there is little convincing evidence that strongly confirm the trade impact on growth. Hence, there are different degrees of uncertainty about this issue. In other words, the issue that trade has always a positive impact on countries 'economic growth is not an imminent matter. In fact, some economists have criticized the issue and don't agree that international trade can really influence long-run economic growth. Some studies between countries emphasized on positive relations between these two elements or the positive impact of openness of business on economic growth. Barro (1991), Dollar(1992), Edwards(1993,1998), Saches and Warner(1995), Sala-i-Martin(1997), Frankel and Romer(1999), Dollar and Kraay(2002), Wacziarg and Welch(2003), Mayor-Foulkes(2005), Freund and Bolaky(2004) indicate that trade is a facilitator and catalyst for economic growth. Some also conclude that the positive relationship between openness of business and growth is not only clear but even in some cases negative. Levin and Runlet (2003), Harrison (1996), Harrison and Hanson (1999), O'Rourke(2000), Rodriguez and Roderick (1999) and Yannikkaya (2003) are among them.

Hence, and in empirical sense Depending on the kind of used variables for measuring the degree of openness, the type of data and used samples, econometrics technique and model specification, the effect of trade liberalization and openness on growth is different and can be positive or negative.

3. Data, Methodology and Empirical Results

3-1. Data

In this study, we use panel data for 73 selected developing countries during the period 1970-2007. The countries are categorize into two groups of oil-rich countries, and non oil countries. oil countries include: Venezuela, United Arab Emirates, Saudi Arabia, Nigeria, Kuwait, Iran , Algeria and Ecuador. Non oil developing countries include: Belarus, Albania, Argentina, Azerbaijan, Bangladesh, Bolivia, Bosnia and Herzegovina, Brazil, Bulgaria, Cameroon, Cambodia, Chad, Chile, Colombia, Costa Rica, Cote d'Ivoire, Czech Republic, Egypt Arab Rep, El Salvador, Estonia, Finland, Ghana, Guatemala, Honduras, Hong Kong, China, Iceland, India, Indonesia, Kazakhstan, Kenya, Kyrgyz Republic, Luxembourg, Madagascar, Mali, Mexico, Moldova, Mozambique, Nicaragua, Oman, Pakistan, Paraguay, Peru, Philippine, Malaysia, Sri Lanka, Sudan, Tajikistan, Tanzania, Thailand, Trinidad and Tobago, Uganda, Turkmenistan, Turkey, Ukraine, Uruguay, Zimbabwe, Zambia, Uzbekistan, Yemen, Sweden, Senegal, Slovenia, Romani and Georgia.

The variable of this research are log of Gross Domestic Production (LGDP), log of non-oil Exports (LX) in 2000 constant dollar and log of degree of openness (LOPEN). The openness is defined as the ratio of the total non-oil Exports and Imports to GDP in real terms. All data are obtained from the WDI (2008). To test the nature of association between the two 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 *LGDP*, *LX and LOPEN*. Prompted by the existence of unit roots in the time series, we test for long run cointegrating relation between 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.

3-2. Unit root test

Following the methodology used in earlier works in the literature we test for both trend stationarity and mean stationarity for the two variables of *LGDP*, *LX* and LOPEN. Also, we control for time effects common to all countries (t= 1971-2002) within each model. The test is a residual based one that explores the performance of different statistics.we apply the panel unit root tests proposed by Levin, Lin and chu(2002), Breitung(2000), Im, Pesaran and Shin(2003) and Fisher-type tests using ADF and PP tests (Maddala and Wu(1999) and Choi(2001)). The Levin, Lin, and Chu(LLC), Breitung, and Hadri tests assume that the autoregressive parameters are common across cross-section. Alternatively, the Im, Pesaran, and Shin (IPS), and Fisher-ADF and fisher-PP tests allow autoregressive parameters to vary freely across cross-sections. Results for panel unit root tests are reported in Table 1 and Table 2. The results of all these tests for oil-rich countries as well as non oil countries are presented in Tables 1 (for levels) and Table 2 (for first difference). It can be seen that variables are in all cases non stationary, with their first difference being stationary or I (0). So, the results strongly indicate the presence of a unit root in model variables for the panel of oil exporting countries and non oil ones.

Table 1: Panel unit root tests for level variables

Non oil developing countries			**Rich oil countries**			**Test method**
LOPEN	*LX*	*LGDP*	*LOPEN*	*LX*	*LGDP*	
2.82 (0.99)	4.33 (1.00)	2.33 (0.99)	0.9 (0.82)	1.36 (0.87)	0.58 (0.72)	Levin, Lin Rho-Stat
-0.41 (0.35)	-0.63 (0.23)	1.32 (0.52)	-0.21 (0.41)	-4.7 (0.32)	2.12 (0.98)	Breitung t-test
3.13 (0.99)	4.8 (1.00)	5.7 (1.00)	2.49 (0.72)	0.56 (0.71)	-0.39 (0.34)	Im,Pesaran and Wtest
120.6 (0.71)	57/9 (1.00)	131.3 (0.45)	24.09 (0.63)	14.64 (0.54)	19.43 (0.25)	ADF-Fisher chi-Square
96.48 (0.98)	59.6 (1.00)	109.6 (0.90)	43.48 (0.16)	86.16 (0.39)	14.66 (0.55)	PP-Fisher chi-Square

Notes: The numbers in parenthesis are p-value

Table 2: Panel unit root tests for variables in first difference

Non oil developing countries			**Rich oil countries**			**Test method**
$DLOPEN$	DLX	$DLGDP$	$DLOPEN$	DLX	$DLGDP$	
-32.39 (0.00)	-31.47 (0.00)	-0.922 (0.00)	-11.69 (0.00)	-10.81 (0.00)	-9.67 (0.00)	Levin, Lin Rho-Stat
-18.76 (0.00)	-23.48 (0.00)	-21.74 (0.00)	-8.54 (0.00)	-6.83 (0.00)	-8.69 (0.00)	Breitung t-test
-29.25 (0.00)	-30.59 (0.00)	-15.72 (0.00)	-19.92 (0.00)	-4.05 (0.00)	-9.46 (0.00)	Im, Pesaran and Wtest
1141.02 (0.00)	1089.86 (0.00)	746.12 (0.00)	132.72 (0.00)	98.2 (0.00)	110.07 (0.00)	ADF-Fisher chi-Square
1718.27 (0.00)	1530.64 (0.00)	1158.98 (0.00)	157.76 (0.00)	142.03 (0.00)	116.55 (0.00)	PP-Fisher chi-Square

Notes: The numbers in parenthesis are p-value

3-3. Cointegration test

At the second step of our estimation, we look for a long run relationship among model variables 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. With a null of no cointegration, the panel cointegration test is essentially a test of unit roots in the estimated residuals of the panel. 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. Table 3 reports four different statistics suggested by Pedroni (1999) for bi-variate specification including LGDP and LX.

Table (3): Pedroni cointegrated test results for Bivariate specification

Non oil developing countries			Rich oil countries			statistics
Test result		Value of statistics	Test result		Value of statistics	
H_0hypothesis is rejected	No cointegration	-8.65 (0.00)	H_0hypothesis is rejected	No cointegration	-3.33 (0.00)	Group rho-Statistic
H_0hypothesis is rejected	No cointegration	-6.69 (0.00)	H_0hypothesis is rejected	No cointegration	-2.37 (0.02)	PANEL rho-Statistic
H_0hypothesis is rejected	No cointegration	-6.90 (0.00)	H_0hypothesis is rejected	No cointegration	-2.74 (0.01)	PANEL pp-Statistic
H_0hypothesis is rejected	No cointegration	-5.31 (0.00)	H_0hypothesis is rejected	No cointegration	-2.27 (0.03)	PANEL ADF-Statistic

Notes: The number inside the parenthesis represents P-value.

All of these four statistics suggest rejection of the null of no cointegration for both groups of countries. We, therefore, conclude that the two unit root variables LGDP and LX are cointegrated in the long run. Similar results are obtained for trivariate specification (includind LGDP, Lx and LOPEN) in Table 4. So, the existence of long-run equilibrium relationships among model variables are accepted in both bi- and tri-variate specifications. These results show that there are strong long run relationships among the variables in the developing countries.

Table (4): Pedroni contigrated test results for trivariate specification

Non oil developing countries			Rich oil countries			Test method
Test result		test	Test result		test	
H_0 hypothesis is rejected	No cointegration	10.25 (0.00)	H_0 hypothesis is rejected	No cointegration	4.16 (0.001)	**Group rho-Statistic**
H_0 hypothesis is rejected	No cointegration	7.29 (0.00)	H_0 hypothesis is rejected	No cointegration	3.09 (0.0034)	**PANEL rho-Statistic**
H_0 hypothesis is rejected	No cointegration	-6.28 (0.0022)	H_0 hypothesis is rejected	No cointegration	-4.17 (0.001)	**PANEL pp-Statistic**
H_0 hypothesis is rejected	No cointegration	8/75 (0.00)	H_0 hypothesis is rejected	No cointegration	-7.11 (0.00)	**PANEL ADF-Statistic**

Notes: The number inside the parenthesis represents P-value.

3-4. Panel Causality Results

Cointegration implies that causality exists between the two series but it does not indicate the direction of the causal relationship. With an affirmation of a long run relationship between LGDP and LX in bi-variate model and among LGDP, LX and LOPEN in tri-variate we test for Granger causality in long and short run. 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 to be ECT_{it}, the cointegrating equation and the dynamic error correction model in bi-variate form are specified as follows:

$$LGDP_{it} = \alpha + \beta LX_{it} + ECT_{it} \quad (1)$$

$$\Delta LGDP_{it} = \alpha_{yi} + \beta_{yi} ECT_{i\ t-1} + \gamma_{y1i} \Delta LX_{i\ t-1} + \delta_{y1i} \Delta LGDP_{i\ t-1} + \varepsilon_{yit} \quad (2)$$

$$\Delta LX_{it} = \alpha_{Xi} + \beta_{Xi} ECT_{i\ t-1} + \gamma_{X1i} \Delta LX_{i\ t-1} + \delta_{X1i} \Delta LGDP_{i\ t-1} + \varepsilon_{Xit} \quad (3)$$

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_X are adjustment coefficients and the ε_{yit} and ε_{xit} are disturbance terms assumed to be uncorrelated with mean zero. The lag length is determined by Schwarz criterion (SC). 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 $H_0 : \gamma_{y1i} = 0$ for all *i* in Eq. (2) or $H_0 : \delta_{X1i} = 0$ 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-run 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 *LGDP* does not respond to a deviation from the long run equilibrium in the previous period. Indeed $\beta_{yi} = 0$ or $\beta_{Xi} = 0$ 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 $\gamma_{y1i} = 0$ for all *i* in Eq. (2) or $H_0 : \beta_{Xi} = 0$ and $\delta_{X1i} = 0$ 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). If there is no causality in either direction, the 'neutrality hypothesis' holds. The same methodology is applied to the tri-variate specification. The results of estimation of cointegrating equations by panel dynamic OLS for two groups of countries, i.e. oil-rich countries and developing non oil countries in bi-variate form is reported in the Tables 5. As it can be seen from table (5), LX_t coefficient is significant and equal to 0.15 in oil-rich countries. This coefficient for non oil developing countries is 0.38 and highly significant. Therefore, a strong long-run equilibrium relationship exists between export and GDP in both mentioned groups of countries for bi-variate case.

The results of the tests for both long run and short run causality in bi-variate model are reported in Table 6.

Table (5): cointegrating equations in bi-variate form(dependent variable: LGDP)

	Oil-rich countries		non oil developing countries	
	coefficient	t-test	coefficient	t-test
intercept	20.69	45.97 (0.00)	15.08	77.14 (0.00)
LX	0.15	8.02 (0.00)	0.38	42.57 (0.00)
R^2		0.99		0.98
F-test		442.73 (0.00)		1879.07 (0.00)

Notes: The number inside the parenthesis represents P-value.

Table (6): Panel Granger Causality in bi-variate Model

Dependent variable	Countries	Short-run causality t-test dLX(−1)	Short-run causality t-test dLGDP(−1)	long-run causality t-test ECT(-1)	Joint causality F-test
DLGDP	Oil contries	0.04 (1.45)		-0.32** (-6.23)	3.15*
	Non oil countries	0.07** (15.35)		-0.04** (-7.05)	8.48**
DLX	Oil contries		0.26 (0.95)	-0.32* (-2.43)	3.29*
	Non oil countries		0.42* (7.18)	-0.06** (3.72)	3.37*

Notes: The number inside the parenthesis represents t ratios. **and * respectively show the significance in 1% and 10% levels

As is apparent from the Table, the coefficients of the *ECT* in GDP equation for both oil- rich as well as non oil developing countries(-0.32 and -0.04 respectively) are significant. So, there are long-run Granger causality running from export growth to GDP growth for both groups of developing countries. The coefficient of DLX(-1) in GDP equation has unexpected sign(-0.04) and statistically insignificant in oil exporting countries but significant for non oil developing countries, with the coefficient of 0.07. Then, for bi-variate model, there is no short-run causality from export growth to GDP growth in oil exporting countries but for non oil developing countries, export growth is short-run Granger causality for GDP growth. The results for export equation in Table 6 indicate that for oil exporting countries, GDP growth granger cause export growth just in long run, but for non oil developing countries there is strongly Granger causality running from export to GDP. Overall, F tests for short-and long-run ,joint causality, show bidirectional causality relationship between export and GDP in both group of developing countries. The estimation results of cointegrating equation by panel dynamic OLS for tri-variate model are reported in the table 7. As it can be seen from the table, the coefficients of export and openness are 0.34 and -0.38 respectively and statistically significant in oil exporting countries. These coefficients for non oil developing countries have the same sign (0.63 and -0.95 respectively), being statistically significant too.

Table (7): cointegrating equations in tri-variate form(dependent variable: LGDP)

	Oil-rich countries		non oil developing countries	
variables	coefficient	t-test	coefficient	t-test
intercept	16.14	30.59 (0.00)	9.2	41.79 (0.00)
LX	0.34	15.48 (0.00)	0.63	64.85 (0.00)
LOPEN	-0.38	-11.42 (0.00)	-0.52	-37.13 (0.00)
R^2		0.9954		0.9937
F-test		15.73 (0.00)		30.67 (0.00)

Notes: The number inside the parenthesis represents P-value.

Table (8): Panel Granger Causality in tri-variate Model

		Short-run causality t-test		long-run causality t-test	Joint causality F-test
Dependent variable	Countries	DLX(-1)	DLGDP(-1)	ECT(-1)	
DLGDP	Oil countries	0.025 (0.63)		-0.31** (-5.61)	3.09*
	Non oil countries	0.01 (1.06)		-0.05** (-6.95)	8.3**
DLX	Oil countries		0.24 (0.85)	-0.26** (-2.31)	2.45**
	Non oil countries		0.48** (7.97)	-0.06** (-3.68)	3.51*

Notes: The number inside the parenthesis represents t ratios. **and * respectively show the significance in 1% and 10% levels

The results of the tests on panel causality for tri-variate model are presented in Table8. The coefficients of the *ECT* are significant in the GDP equations for both oil exporting and non oil developing countries which indicates that long-run causality runs from export to GDP. The coefficient of DLX(-1) is not significant for both groups of developing countries. Therefore, there is not any short-run causality from export growth to GDP in these countries. For export equations, the coefficient of ECT is significant for both groups, implying that GDP growth Granger-causes exports growth in long run for both groups of countries. Moreover, GDP has no effect on export in short run in oil-rich countries but the reverse is true for non oil developing countries. Moreover, the interaction terms (*ECT* and *LGDP* or LX) are significant, indicating that a bidirectional joint causality relationship exist between export growth and GDP for both groups of countries in Trivariate form as in Bivariate one.

4. Conclusion

The purpose of this study was to test for panel Granger causality between export and GDP growth for 73 developing countries during the period 1970-2007. The co-integration and Granger's causality tests are applied to investigate the relationship between the export, GDP and openness. The granger causalities are tested in bi-variate model (including export and GDP) and tri-variate one(including export, GDP and openness). The results indicate that there are long-run equilibrium relationships between export and GDP in both groups of oil and non oil developing countries in bi- and tri-variate models. Also, we found strong evidence of bidirectional long-run causality between export and GDP growth in both groups of countries and models. Although, it is shown that there is no short-run causality relationship between export growth and economic growth in oil-rich countries in any bi- and tri- variate models. But for non oil developing countries, the results show a bidirectional short-run causality between export and GDP growth in bi-variate model. Overall, the joint F-statistics for the short- and long- sun causalities implies bidirectional causality between export and GDP for sample developing countries. In summary, export-based growth theory where, export growth is one of the fundamental reasons for economic growth in developing countries is accepted at least in long run. Moreover, GDP growth through improvement of human capital, labor force skills and technology development prepares required institutional backgrounds for more export.

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