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COINTEGRATION AND ERROR-CORRECTION MODELS IN ESTIMATING CAUSALITY BETWEEN EXPORTS AND ECONOMIC GROWTH IN BANGLADESH

Md. Abdul WADUD*

The long-run relationship between exports and economic growth in Bangladesh is examined applying cointegration and Granger causality tests from error-correction mechanisms. Different techniques are utilized to estimate and test the hypotheses about random walk, the cointegration space and error-correction models of the variables: Exports and Gross Domestic Product (GDP). The results confirm that there is a single cointegrating vector and a significant unidirectional and positive Granger-causal relationship between exports and GDP running from exports to economic growth.

I. Introduction

Development economists have shown increased interests in the association between exports and economic growth in the less developed countries. A number of recent empirical studies have applied Granger causality tests based on Vector Autoregressive (VAR) models to determine the nature and the direction of causality. However, the statistical techniques used in these studies allow an estimation of short-run dynamics, and most of these studies have not been supportive of a positive causal relationship running from exports to economic growth. Jung and Marshall (1985) got evidence of unidirectional causality from exports to growth for only 4 countries out of 37. Hsiao (1987) found evidence of no causality for 4 Asian economies, except Hong Kong, where unidirectional causality from GDP to exports was found. Ahmed and Kwan (1991) found no causal relationship. Chow (1987) re-

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I. Introduction

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ported bidirectional causality for 6 countries out of 8 NIEs, unidirectional export-to-growth causality is found for one and no causal relation for others. Kwan and Cotsomotis (1991) reported bidirectional causality in China for 1952-1988 and no causality for the sub-period 1952-1978. Most recently, Ahmed and Harnhirun (1995) found no causality between exports and economic growth for 4 out of 5 ASEAN countries and bidirectional causality for one (Singapore). Thornton (1996) reported that Granger tests from error-correction models confirmed unidirectional causality running from exports to economic growth in Mexico. Abhayaratne (1996) got no evidence to suggest any causal relationship between foreign trade and GDP growth in Sri Lanka. Ghatak, et al., (1997) found evidence to confirm unidirectional Granger causality from exports to GDP growth in Malaysia. For development strategies of Bangladesh the achievement of a causal relationship has significant policy implications. The export-led growth strategy is appropriate for this country if export growth causes economic growth (exports $\rightarrow$ GDP), if economic growth causes exports growth (GDP $\rightarrow$ exports) a certain level of economic growth may be a prerequisite to extend its exports [Chow (1987), Moschos (1989)], because economic growth may help achieve efficient allocation of resources according to comparative advantage and realization of economies of scale which lower the costs of exportables, and make exports more competitive in international markets while a bidirectional causality can reinforce each other.

The principal goal of this study is to examine the causal relationship between exports and economic growth in Bangladesh during the period 1972-98 in terms of the application of 'good practice' of Johansen's multivariate cointegration technique because none of the previous studies is specific to Bangladesh. In order to achieve this goal, this study applies the multivariate cointegration technique proposed by Johansen (1988) and (1991), and Johansen and Juselius (1990), (1992) and (1994), which estimates all the (possible) cointegrating vectors that prevail within a vector of variables, provides a test statistic for the number of cointegrating vectors, permits hypothesis tests on the coefficients penetrating the cointegrating vectors and provides a test statistic that is more cogent in its efficiency to reject a false null hypothesis. This cointegration methodology is applied in this study to test the long-run equilibrium relationship between exports and economic growth also and the error correction model in a multivariate framework is employed to examine the short-run dynamics by which exports converge on equilibrium long-run values. This research sheds light on the dynamic structure of the model which is important to draw meaningful conclusions on the speed of adjustment as well. The second section explains the export performance and development of Bangladesh, the third and fourth sections describe the econometric methodology and empirical findings, respectively, and the last section provides some conclusions and policy implications.

II. Bangladesh Export Performance and Development

Bangladesh's export earnings have been increasing with a real growth rate of 16 per cent in the 1980s compared to around 5.5 per cent in the 1990s [Hassan and Tufte, (1998)]. The earnings of non-traditional exports have contributed to this surge of export increase. The share of export earnings of non-traditional sectors in total export earnings has increased from 31 per cent in 1983 to 73 per cent in 1995 while the share of traditional sectors' export earnings in total export earnings has gone down sharply to 13 per cent in 1995 [Export Promotion Bureau, (1997)]. In contrast, the import growth of Bangladesh, only 4.4 per cent in 1995, is less robust in spite of improvement in import liberalization. The Gross Domestic Product (GDP) growth rate and industrial growth rate at 1994-95 constant prices, is not so robust, and was only 5.4 and 8.6 per cent, respectively, in 1995. The share of exports in Bangladesh's national income and that of exports of manufactured goods in total export earnings were about 10.56 and 75.78 per cent, respectively, in 1995 [Annual Export Receipts, (1994-95)].

National savings and investment rates reached 15.2 and 16.6 per cent of GDP, respectively, in 1994-95. To attain macroeconomic stability and higher economic growth, policy programs have been implemented directly towards achieving external competitiveness of the economy through trade reform policies including the reduction of tariffs, quotas, liberalization of trade and other restrictions on trade from the early 1980s. Bangladesh has achieved a significant improvement in liberalizing what had been one of the most restrictive trade regimes in Asia. In the June 1995-96 budget Bangladesh declared further liberalization of trade accelerating tariff reform by compressing customs duty rates to a range of 7.5 – 50 per cent for most products over the next year. These trade liberalization policies like other policies, had a favourable impact on exports which showed a steady increase in the 1990s. This is followed by only 2.5 per cent 'advance income tax' to be abolished to make customs duty the only protective instrument for most imports. Bangladesh also reinstated an import sales tax with a trade-neutral VAT [Export Promotion Bureau, (1996)]. Duty free import facilities through bonded warehouses are introduced for the 100 per cent export-oriented manufacturers. The trade weighted average import tax rate declined to 43 per cent in 1994 from 59 per cent in 1992. A number of products were released from the restriction of import ban during 1994, and import processes have been further streamlined. The 1998-99 budget proposes to further liberalize trade by lowering tariffs on imports of nearly 2500 items. The main thrust of trade policy is to increase exports at a higher rate than the increase in imports so as to reduce the export-import gap which has been always negative.

The Export Processing Zones (EPZs) offer a number of benefits in harmony with trade liberaliztion including the duty-free import of capital machinery, ware-

house facilities, tax breaks, a relatively secure power source, union-free labour, and other benefits to all export-oriented industries. Under the Export Subsidy Policy, Bangladesh encourages ready made garment producers by bonded warehousing and back-to-back letter of credit facilities and also permits exporters to 100 per cent of their foreign currency earnings through any authorized dealer. Interest rate subsidies to exporters were decreased in 1991 and further declined over 1993-94. Special trade provisions, like counter-trade for import, have been encouraged for many years as a means to upgrade exports while conserving foreign exchange. Revaluation of the currency based on weighted index, followed a semi-flexible exchange rate policy and has announced the taka to be fully convertible for current account transactions and full convertibility of taka for capital account transactions in December 1994. All of these attempts and policy programs were undertaken to generate foreign exchange to recover balance of payment deficits, import capital goods and boost the national economy. As a result the export growth rate went up to 13 and 16 per cent in 1997 and 1998 respectively. But still Bangladesh has been confronting a considerable amount of balance of payments deficit over the years. Therefore, it might be worthwhile to examine whether export growth can enhance economic growth to help reduce the balance of payment deficits, and if there is a causal relationship between exports and economic growth in Bangladesh.

III. Econometric Methodology

An econometric model can be set out to test the long-run relationship and Granger causality between the variables. Most of the macroeconomics time series are characterized by a random walk so that their first differences are stationary [Engle and Granger, (1987); Nelson and Plosser, (1982)]. If statistical tests, like cointegration, establish co-movements in these time series, the residuals from the regression can be used as error correction terms in the dynamic first-difference equation [Ahmed and Harnhirun, (1995)]. Therefore, for two integrated I(1) and cointegrated time series, there must exist Granger causality in at least one direction in the I(0) variables [Engle and Granger, (1987)] and hence a VAR model can be prepared with an error correction term for two cointegrated I(1) time series to capture the short-run dynamics and to decrease the chance of observing 'spurious regression' in terms of the levels of data or their first differences. After checking the stationary and cointegration properties of the variables we shall test the Granger causality with the error-correction model between exports growth and economic growth (in terms of GDP growth) of the country.

The first step of our methodology is to test the order of integration, i.e., the stationarity, of the natural logarithm of the levels of the exports (LnEx) and GDP (LnGDP). Two approaches are used in practical applications to test stationarity allowing the chance of autocorrelation: 'augmented Dickey-Fuller' (ADF) test

[Dickey and Fuller, (1981)] and nonparametric adjustment Phillip-Perron test [Phillip and Perron, (1988)]. The Augmented Dickey-Fuller test requires the following regression as:

$$\Delta Y_t = \alpha + \beta t + \delta Y_{t-1} + \theta_i \sum_{i=1}^{n} \Delta Y_{t-1} + \varepsilon_t$$

where ε_t are assumed to be identically, independently distributed random variable. This ADF test statistic checks the null hypothesis that the time series has a unit root, i.e., $\delta=0$, under the alternative hypothesis of stationary time series. The second step is to test for cointegration applying Johansen's maximum likelihood estimation approach [Johansen, (1988); Johansen and Juselius, (1990); and Johansen, (1991)]. Johansen's test for the multivariate cointegration approach is based on the following econometric model of the VAR process:

$$\Delta y_t = \beta_{0y} + \beta_{1y} t - \Pi_y x_{t-1} + \sum_{i=1}^{p-1} \Gamma_{iy} \Delta x_{t-i} + \Phi_y w_t + \varepsilon_t$$

where $x_t = (y_t, z_t)$, y_t is an $m_y \times 1$ vector of jointly determined endogenous I(1) variables, x_t is an $m_t \times 1$ vector of exogenous I(1) variables

$$\Delta z_t = \beta_{0z} + \sum_{i=1}^{p-1} \Gamma_{iz} \Delta x_{t-i} + \Phi_z w_t + v_t,$$

w_t is a $q \times 1$ vector of I(0) variables exeluding the intercepts and trends, the disturbance vectors ε_t and v_t fulfil

$$u_t = \begin{bmatrix} \varepsilon_t \\ v_t \end{bmatrix} \sim iid(0, \Omega),$$

where Ω is a symmetric positive-definite matrix, the disturbances u_t are distributed independently of w_t: $E(u_t/w_t) = 0$, the intercept and trend coefficients, β_{0y} and β_{1y} are $m_y \times 1$ vectors: Π_y is the $m_y \times m$ long-run multiplier matrix, $m = m_x + m_y$, Γ_{1y}, Γ_{2y}, ..., $\Gamma_{(p-1)y}$ are $m_y \times m$ coefficient matrices capturing the short-run dynamic effects and Φ_y is the $m_y \times q$ matrix of coefficients on the I(0) exogenous variables. Engle-Granger test, augmented Engle-Granger test [Engle and Granger, (1987)] and Cointegrating Regression Durbin-Watson (CRDW) test [Sargan and Bhargava, (1983)] can also be applied for testing the order of integration of the cointegrating regression error term. If cointegration is established, then Granger causality, either unidirectional or bidirectional, must exist in at least the I(0) variables. In other words, cointegration indicates causal effects [Engle and Granger, (1987)].

The third step involves testing whether there exists causality between exports and GDP growth. The Granger Representation Theorem states if two time

series are both I(1) and are cointegrated, then a dynamic error-correction representation would prevail and vice versa. Therefore assuming the integration of order I(1) and cointegration between the logarithm of the levels of exports and GDP, the following ECM, according to Engle and Granger (1987), is formulated to carry out a standard Granger causality test:

$$\Delta \ln GDP_t = \alpha_0 + \sum_{i=1}^{n} \alpha_i \Delta \ln GDP_{t-i} + \sum_{i=1}^{m} \rho_j \Delta \ln Ex_{t-j} + \gamma ECT_{t-1} + \xi_t \qquad (1)$$

$$\Delta \ln Ex_t = \beta_0 + \sum_{i=1}^{q} \beta_i \Delta \ln GDP_{t-i} + \sum_{i=1}^{p} \lambda_i \Delta \ln Ex_{t-j} + \tau ECT_{t-1} + \zeta_t \qquad (2)$$

where Δ indicates the difference operator, ξ_t and ζ_t imply non-zero, serially independent random error terms and ECT_{t-1} is the error-correction term obtained from the long-run cointegrating regression. The short-run dynamics which are inevitable to achieve the long-run equilibrium can be provided by the causal relationship between the variables [Granger, (1988)]. For example, considering equation (1), exports are said to Granger cause economic growth not only if the ρ_i's are jointly significant but also if γ is significant. The ECM approach also permits distinction between 'short-run' and 'long-run' Granger causality. In the short-term, when variables are cointegrated, divergences from the long-run equilibrium will feed back on the variations in the dependent variable in order to force the movement towards the long-run equilibrium; if the dependent variable is driven directly by this long-run equilibrium error, then it is responding to this feedback and if not, it is responding only to short-term shocks to the stochastic environments [Hassan and Tufte, (1998)]. The short-run adjustment coefficient, derived by estimating the coefficient of the lagged error-correction term, represents the ratio by which the long-run disequilibrium in the dependent variable is being corrected in each short-run period. The 'short-run' causal effects are indicated through the significance of the F-tests of the 'differenced' independent variables whereas the significance of the t-tests of the lagged error-correction terms provides the long-run causal relationship. This paper adopts the Akai Final Prediction Error (FPE) criterion to determine the optimal lag of the explanatory variables.

IV. Data and Analysis of Empirical Findings

We now check the stationary and the cointegrating properties of the variables involved in the light of the econometric methodology. The data used in this study are annual time-series data for the 1972-98 period and are collected from the World Bank, World Table 1995, Asian Development Bank database 1998 and Bangladesh Statistical Year Book 1999.[1] The ADF test and Phillip-Perron tests for unit root as

[1] After the liberation of Bangladesh in 1971, only available data are from 1972 to 1998.

formal tests are applied to check stationary property of the variables. The ADF test results for the logarithms of levels and first differences of all the variables are presented in Table 1.

The results show that the null hypothesis of non-stationarity is not rejected at the 5 per cent level of significance for the logarithms of levels of the variables but the null hypothesis of non-stationarity is rejected for the first differences at the 5 per cent level of significance. Hence we can draw the conclusion that the first differences of GDP and exports are stationary. Therefore the results confirm that all variables are integrated of order one in levels but integrated of order zero in first differences, that is, LnEx~ I(1), LnGDP~I(1), DLnEx~I(0) and DLnGDP~I(0). The results of the Phillip-Perron test are shown in Table 2.

The results support the results obtained using the ADF test. Therefore we proceed now to test for cointegration. Johansen's maximum likelihood approach is applied to the test for cointegration. Table 3 reports the cointegration LR test based on maximal eigenvalue and trace of the stochastic matrix, which are complementary versions of the same test to determine the cointegration rank, r. Both test statistics,

TABLE 1

Augmented Dickey-Fuller Tests for Unit Roots

Variable	Test Statistic	
	Levels	First Differences
LnGDP	-2.9540	-4.0861
LnEx	-1.4790	-4.1396

Note: The 5 per cent critical value for the ADF statisticsis approximately -3.6746 for levels and -3.6921 for first differences. These critical values are computed from MacKinnon (1991).

TABLE 2

Phillips-Perron Tests for Unit Roots

Variable	Test Statistic	
	Levels	First Differences
LnGDP	-1.8840	-3.9861
LnEx	-2.1790	-4.8896

Note: The 5 per cent critical value for Phillips-Perron statistic is approximately -3.6746 for levels and -3.6921 for first differences. These critical values are computed from MacKinnon (1991).

maximal eigenvalue and trace, are well above both the corresponding 95 per cent critical values for which it is possible to reject the null of no cointegration.

Therefore the results ensure the variables are cointegrated and confirm a single cointegrating vector as well as support stable genuine long-run relationship between exports and GDP growth.

Results in Table 4 suggest that the coefficient of the error-correction term for equation (1) is statistically significant with the negative sign, and the F-statistic shows the significance at the 5 per cent level for equation (1) as well. Therefore export growth Granger causes economic growth, that is, there is a unidirectional causality running from exports to economic growth, and thus the results support the export-led growth strategy hypothesis, that is, export growth leads to output growth. This does not necessarily imply that exports cannot be the driving force behind growth. In fact, the contribution of exports is rather crucial in obtaining machineries and other materials for industrialization and modernization. Hence the result that causality running from exports to GDP growth, is usual. The findings are also supported by Jung and Marshall (1985), Thornton (1996) and Ghatak, et al., (1997). The estimated coefficients for the ECT, –0.1032 and –0.3676, represent the ratios by which

TABLE 3

Results of Johansen's Cointegration Tests

Hypothesis		Maximum Eigenvalue Test		Trace Test	
Null	Alternative	Statistic	Critical value (at 5%)	Statistic	Critical value (at 5%)
r = 0	r = 1	18.4089	15.8700	25.3348	20.1800
r < = 1	r = 2	6.9259	9.1600	6.9259	9.1600

TABLE 4

Granger Causality Test from Error-Correction Model (ECM)

Dependent Variable	Coefficients for ECT	t-statistic for ECT_{t-1}	F-statistic for $\sum_{j=1}^{m} \Delta \ln Ex_{t-j}$
ΔLnGDP	-0.10318	-2.1709*	4.3787*
ΔLnEx	-0.36756	-1.8770	1.2574

*Means significant at the 5 per cent level.

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