Exports, Growth and Causality:
An Application of Co-integration
and Error-correction Modelling

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1. INTRODUCTION

The relationship between export expansion and economic growth has been examined extensively during the last two decades in the context of the suitability of the alternative development strategies. The decade of the 1970s witnessed an emerging consensus in favour of export promotion as development strategy. Such a consensus was based on the following facts. First, higher export earnings working through alleviating foreign exchange constraints may enhance the ability of a developing country to import more industrial raw materials and capital goods, which, in turn, may expand its productive capacity. Secondly, the competition in export markets abroad may lead to the exploitation of economies of scale, greater capacity utilisation, efficient resource allocation, and an acceleration of technical progress in production. Thirdly, given the theoretical arguments mentioned above, the observed strong correlation between exports and economic growth was interpreted as empirical evidence in favour of export promotion as a development strategy.

The empirical evidence in favour of export promotion rests on the general approach where real growth is regressed on contemporaneous real export, growth and the significance of the export growth coefficient supports the proposition that export growth causes output growth. Balassa (1978); Feder (1982); Fosu (1990); Kavoussi (1984); Tyler (1981) and Ram (1985) have followed such an approach.[1] Khan and Saqib (1993), on the other hand, examined the relationship between exports and economic growth by constructing a simultaneous equation model comprising equations for exports and economic growth. They found a strong association between export performance and GDP growth for Pakistan, and that more than 90 percent of the contribution of exports on economic growth was indirect in nature.

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[1]Michaely (1977) and Balassa (1978) used simple Spearman rank correlation to measure the relationship between exports and economic growth.

The above studies contribute significantly to explaining the relationship between exports expansion and economic growth, but it would be inappropriate to characterise the finding as one in which export promotion has induced growth.[2] Such an answer can be found by examining the direction of causation between exports and economic growth. Discovering the direction of causation has important policy implications for development strategies. If a definite unidirectional causality running from exports expansion to economic growth is found, then it will lend credence to the export-led growth strategy. If the direction of causation is running from economic growth to exports, then it would imply that a higher level of economic activity is a pre-requisite for developing countries to expand their exports. If the causation is of the bi-directional nature, then it would imply that exports and economic growth have a reciprocal relationship. Finally, if there is no causality between exports and economic growth, then alternative strategies rather than export promotion may be needed to structurally transform the developing countries.[3]

Because of its direct relevance to the choice of alternative development strategies, Jung and Marshall (1985); Chow (1987); Hsiao (1987) and Bahmani-Oskooee *et al.* (1991) have investigated, using the Granger or Sims procedure, the direction of causation between exports and economic growth for many developing countries as well as developed countries of the Far East region. Their findings have been mixed, ranging from one-way causality from exports growth to output growth to no causality. These studies suffer from two major shortcomings. Firstly, none of these studies have examined the co-integrating properties of the variables involved. The standard Granger or Sims tests are valid if the original time series are not co-integrated. If the time series are co-integrated, then any causal inferences are invalid.[4] It is, therefore, essential to check for the co-integrating properties of the original time series before subjecting them to a test for causality. Secondly, most economic time series exhibit non-stationary tendencies and regression of one against the other is likely to lead to spurious regression results. To remedy this problem, the co-integration and error-correction modelling are recommended by Engle and Granger (1987). To the best of our knowledge, Bahmani-Oskooee and Alse (1993) have examined the relationship between exports growth and economic growth for less developed countries by using the Granger approach, taking into account the two major shortcomings just discussed above.

The present study examines the direction of causation between exports growth and economic growth in Pakistan, using the Granger causality approach, and it takes

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[2]Jung and Marshall (1985) have pointed out that by specifying a structural model, which contains all of the posited theoretical relationships, one can obtain structural estimates of the various effects which will be more akin to discovering the direction of causation between exports and economic growth. Khan and Saqib (1993), to some extent, come closer to this viewpoint.

[3]See Chow (1987).

[4]See Granger (1986).

into account the non-stationarity as well as the co-integrating properties of the two series. To enrich our analysis, we divide total exports into primary and manufactured exports and then examine the direction of causation of these two categories of exports with economic growth separately. This study uses quarterly time-series data covering the period from 1972:II to 1994:II. As is well-known, the quarterly series for the GDP are not available, therefore these were calculated from the annual data by utilising the methodology given in Khan and Raza (1989). The quarterly data for exports were taken from the various issues of the International Financial Statistics of the IMF.

The rest of the paper is organised as follows. The methodology and results are discussed in Section 2. The final section contains concluding remarks.

2. METHODOLOGY AND RESULTS

The traditional practice in testing the direction of causation between the two variables has been to utilise the standard Granger (1969) framework. The standard Granger causality test consists of estimating the following equations:

$$Y_t = \beta_0 + \sum_{J=1}^{m} \beta_j Y_{t-j} + \sum_{i=1}^{n} \alpha_i X_{t-i} + U_t \qquad \ldots \qquad \ldots \qquad \ldots \qquad (1)$$

$$X_t = \gamma_0 + \sum_{J=1}^{m} \gamma_j X_{t-j} + \sum_{i=1}^{n} \delta_i Y_{t-i} + V_t \qquad \ldots \qquad \ldots \qquad \ldots \qquad (2)$$

where U and V are mutually uncorrelated white noise series and t denotes the time period. Causality may be determined by estimating Equations (1) and (2), and testing the null hypothesis that $\alpha_i = \delta_i = 0$ for all i's against the alternative hypothesis that $\alpha_i \neq 0$ and $\delta_i \neq 0$ 1for atleast some i's. If the coefficients α_i's are statistically significant but δ_i's are not, then Y is said to have been caused by X. The reverse causality holds if δ_i's are statistically significant while α_i's are not. But if both α_i and δ_i are significant, then causality runs both ways.

As stated at the outset, the standard Granger causality test suffers from major shortcomings by not taking stationary properties of the series into account. The present paper takes into account these shortcomings and uses the amended Granger causality test to detect the direction of causation between the two variables. The amended Granger causality test allows for a causal linkage between two variables stemming from a common trend. Such a linkage characterises the long-run equilibrium alignment that persists beyond the short-run adjustments. The standard test may report one-way, reverse, or two-way causality or no causality; however, the amended test rules out the possibility of no causality when the variables share a common trend, i.e., they are co-integrated.

The estimation of the amended Granger causality test involves four steps. Step I includes the determination of the order of integration of the variables under

consideration. Co-integration regression is estimated with the help of the Ordinary Least Squares (OLS) method in step II, using variables having the same order of integration. In Step III, the stationarity of residuals (Z_t) is tested and the residual so obtained is used as error-correction term in Step IV when the amended Granger causality equations are estimated.

Step I: Testing for the Order of Integration

The first step towards estimation of the amended Granger causality equations is to determine the order of integration of the variables under consideration. Two prominent procedures to determine the order of integration are: (a) Dickey-Fuller (DF) test and (b) Augmented Dickey-Fuller (ADF) test. The DF test is based on the regression: $\Delta X_i = \mu + \beta X_{t-1} + \varepsilon_t$, where X_t denotes the variable of interest and D denotes the difference operator; m and b are parameters to be estimated. The null hypothesis (H_o) is: X_t is not I(O). The ADF test is based on the regression: $\Delta X_t = \mu +$ $\beta X_{t-1} + \sum\limits_{i=1}^{\tau} \gamma_i \, \Delta X_{t-i} + \varepsilon_t 2$ where τ is selected such that e_t is white noise; μ, β and γ_i are parameters to be estimated. The cumulative distribution of the DF and the ADF statistics are provided by Fuller (1976). The DF and the ADF statistics are calculated by dividing the estimates of β by its standard error. If the calculated DF and ADF statistics are less than their critical values from Fuller's table, then the null hypothesis (Ho) is rejected and the series are stationary or integrated of order one, i.e., I(1).

The degree of integration of each variable involved in our analysis is determined using both the DF and the ADF class of unit root tests. The results are reported in Table 1. In the level form, both the DF and the ADF test statistics present mixed results and as such nothing definite can be said about the stationary properties of the variables involved in the analysis. However, both the DF and the ADF test statistics reject the null hypothesis of non-stationarity for all the variables to be used in the amended Granger causality test at the 5 percent level only when the first differenced variables are used. This indicates that all the series are stationary in the first difference and are integrated of order 1, i.e. I(1).

Step II: Co-integration Regression

In the second step, we   estimate   co-inte-gration regression using variables having the same order of integration. Co-integration regression for two variables X_t and Y_t is given as

$$X_t = \psi + \delta \, Y_t + Z_t \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad (3)$$

$$Y_t = \alpha + \beta \, X_t + Z_t \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad (4)$$

Table 1

Test for the Order of Integration

Variables	Dickey-Fuller (DF)		Augmented Dickey-Fuller (ADF)	
	Without Trend	With Trend	Without Trend	With Trend
Log Y	0.05	–1.81	0.05 [1]	–1.84 [1]
Log X	–3.62	–6.49	–3.08 [1]	–6.90 [1]
Log PX	–5.10	–5.85	–3.27 [1]	–3.60 [1]
Log MX	–1.99	–7.65*	–0.81 [1]	–4.21 [1]*
(1–L) Log Y	–9.14*	–9.09*	–6.42 [1]*	–6.38 [1]*
(1–L) Log X	–10.88*	–10.82*	–10.51 [1]*	–10.44 [1]*
(1–L) Log PX	–15.92*	–15.87*	–8.92 [1]*	–8.97 [1]*
(1–L) Log MX	–18.08*	–17.98*	–8.02 [1]*	–7.98 [1]*

Note:　Y　=　GNP in real terms.
　　　　X　=　Total exports in real terms.
　　　　PX　=　Primary exports in real terms.
　　　　MX　=　Manufactured exports in real terms.
　　　　–　　Critical value of DF and ADF statistics from Fuller's tables are –2.89 and –3.46 respectively at the 5 percent level of significance.
　　　　–　　Figures in parenthesis are the number of Lags used in the ADF test.
　　　　*　　Significance at the 5 percent level.

where ψ and α are constants and δ and β and are co-integrating parameters. Equations (3) and (4) are estimated with the help of the OLS method and the results are reported in Table 2.

The calculated DF or ADF statistic for all the residuals except one is less than its critical value at the 5 percent level. Therefore, with the exception of the equation where real income is regressed against primary exports, all the series are co-integrated, which suggests that there exists a two-way stable long-run equilibrium relationship between exports (and manufactured exports) and economic activity. However, in the case of primary exports, a one-way, stable, long-run equilibrium relation from economic activity to primary exports is found.

There is yet another way to check the stationarity of the residuals from the co-integration equations. For the residuals to be stationary, the CRDW must be significantly different from zero. If it approaches zero, the residuals are non-stationary. Table 2 shows that all the CRDW statistics are higher than the critical values at the 5 percent level with the exception of one.[5] Thus, the CRDW test confirms the stationarity

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[5]The critical value of the CRDW statistic in the vicinity of 50 observations is 0.78 at the 5 percent level. See Engle and Yoo (1987), Table 4, for such statistics.

of the residuals consistent with the DF and the ADF test. The positive signs of all the slope coefficients suggest that exports and the GDP are positively related with each other. An increase in exports stimulates output which, in turn, increases exports. Because of the long-run stable relations that exist between these two variables, the policy suggestion that stems from it is that export promotion policies should contribute to higher economic growth in Pakistan.

Table 2
Test for Co-integration

Co-integration Equation	Slope	*t*-statistics of Slop	R^2	CRDW	DF	ADF
Log X = f(log Y)	1.34	11.22	0.59	1.32	–6.51*	–6.87 [1]*
Log Y = f(log X)	0.44	11.22	0.59	0.79	–4.65*	–4.57 [1]*
Log PX = f(log Y)	0.72	5.57	0.26	0.97	–5.81*	–3.56 [1]*
Log Y = f(log PX)	0.37	5.57	0.26	0.26	–2.21	–1.07 [1]
Log MX = f (log Y)	1.88	25.58	0.88	1.55	–7.38*	–4.00 [1]*
Log Y = f(log MX)	0.47	25.58	0.88	1.37	–6.70*	–3.66 [1]*

Note:
Y = Real GNP.
X = Total Real Exports.
PX = Real Primary Exports.
MX = Real Manufactured Exports.
– The critical values at the 5 percent level of significance for the DF and the ADF statistics from Fuller's Tables are –2.84 and –3.41 respectively.
* Indicates the existence of the co-integration relationship.

Step III: Testing Stationarity of the Residuals (Z_t)

The residuals from the co-integration equations are recovered to perform the stationarity test based on the following equations:

$$(DF) \quad \Delta\varepsilon = \phi_0 + \phi_1 \varepsilon_{t-1} + V_t \qquad \ldots \qquad \ldots \qquad \ldots \qquad (5)$$

$$(ADF) \quad \Delta\varepsilon = \phi_0 + \phi_1 \varepsilon_{t-1} + \sum_{t=1}^{K} \phi_j \Delta \varepsilon_{t-i} + V_t \quad \ldots \qquad \ldots \qquad (6)$$

where ε_t is the residual (Z_t) from the co-integration regressions (3) and (4). The null hypothesis of non-stationarity stands rejected if ϕ is negative and the calculated DF or ADF statistics are less than the critical value from Fuller's table. In other words, the existence of a long-run stable equilibrium relationship between the two variables is

confirmed. The results of this exercise are also reported in Table 2,and explained above in relation to the stationarity of the residuals.

Step IV: The Amended Granger Causality Test

After establishing the fact that the two variables are co-integrated, the question as to which variable causes the other can be taken up. In this connection, the standard Granger causality test is amended to incorporate the error-correction terms, which are derived from the co-integration regressions. The amended Granger causality test is given as follows:

$$(1-L)X_t = a_0 + b_0\mu_{t-1} + \sum_{i-1}^{m} C_{0i}(1-L)X_{t-i} + \sum_{i-1}^{n} d_{0i}(1-L)Y_{t-i} + e_t \quad \ldots \quad (7)$$

$$(1-L)Y_t = \alpha_1 + b_1\mu'_{t-1} + \sum_{i-1}^{m} C_{li}(1-L)Y_{t-i} + \sum_{i-1}^{n} d_{li}(1-L)X_{t-i} + e'_t \quad \ldots \quad (8)$$

where L is the lag operator and the error-correction terms μ and $\mu'3$ and are the stationary residuals from co-integration Equations (3) and (4) respectively. The error-correction terms in Equations (7) and (8) introduce an additional channel through which causality can be detected. For example, in Equation (7), Y is said to cause X not only if the d_{oi}'s are jointly significant, but also if b_o (the coefficient of error-correction term) is significant. Thus, in contrast to the standard Granger test, the amended Granger causality test allows for the result that Y causes X, as long as the error-correction term bears a significant coefficient even if the d_{oi}'s are not jointly significant.[6]

It is important to note that Granger causality test is highly sensitive to the choice of lag-length. In most cases, such lag lengths are arbitrarily assigned. We have determined the optimum lag length with the help of Akaike's Final Prediction Error (FPE).[7] The optimum lag length for each variable is reported in the square bracket of Table 3.

Using the optimum lag structure, the amended Granger causality test is conducted and the relevant statistics are reported in Table 3. A Cursory look at Table 3 is sufficient to see that bi-directional causality between exports growth and economic growth is found through both channels. What this result suggest is the fact that an increase in output growth will increase exports growth, which, in turn, will increase output growth. Similar results are found in the case of manufactured exports growth
and output growth. In the case of primary exports, though bi-directional causality is

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[6]See Granger (1988).

[7]The FPE is defined as

$$FPE\,(n) = [(T + n + 1) / (T - n - 1] \, [\,SSR/T\,]1$$

where T is the number of observations, SSR is the sum of squared residuals, and n is the number of lags. If $FPE\,(n+1) > FPE(n)$, then the $n+1$ lag is dropped from the model.

Table 3

Results of Amended Granger Causality Test

Equations	Dependent Variable	t–statis. for EC_{t-1}	F–statis. for $\Sigma(1-L)\log X_{t-1}$	F–statis. For $\Sigma(1-L)\log PX_{t-i}$	F–statistics for $\Sigma(1-L)\log MX_{t-i}$	F–statistics for $\Sigma(1-L)\log Y_{t-i}$	Direction of Causation
$TEXP_t = f(TEXP_{t-i}, GNP_{t-i}, EC_{t-1})$	$(1-L)\log X_t$	–0.74 (–3.99)*	3.23 [3]*			2.22 [4]*	Y ⇄ X
$GNP_t = f(GNP_{t-i}, TEXP_{t-i}, EC_{t-1})$	$(1-L)\log Y_t$	–0.64 (–2.89)*	3.16 [4]*			4.50 [3]*	X ⇄ Y
$PEXP_t = f(PEXP_{t-i}, GNP_{t-i}, EC_{t-1})$	$(1-L)\log PX_t$	–0.20 (1.90)*		3.82 [4]*		5.77 [5]*	Y ⇄ PX
$GNP_t = f(GNP_{t-i}, PEXP_{t-i}, EC_{t-1})$	$(1-L)\log Y_t$	–0.0014 (–0.51)		0.39 [5]		2.62 [4]*	PX ← Y
$MEXP_t = f(MEXP_{t-i}, GNP_{t-i}, EC_{t-1})$	$(1-L)\log MX_t$	–0.53 (2.80)*			4.18 [7]*	5.53 [5]*	Y ⇄ MX
$GNP_t = f(GNP_{t-i}, MEXP_{t-i}, EC_{t-1})$	$(1-L)\log Y_t$	–0.61 (2.69)*			5.04 [8]*	4.85 [4]*	MX ⇄ Y

Note: EC denotes the error-correction term and the numbers inside the parentheses are *t*–statistics.

The numbers in square-brackets are the number of lags.

*Significant at the 5 percent level.

TEXP   =   Total Exports (X).
PEXP   =   Primary Exports (PX).
MEXP   =   Manufactured Exports (MX).
GNP   =   Gross National Product (Y).

found through Equation (3) the result is not as strong as in the cases of the total and manufactured exports. Thus, a strong bi-directional causality between exports growth and economic growth is found in the case of Pakistan. We also found from Table 2 that there exists a long-run, stable, positive relationship between real exports and real GDP in both directions. The most important policy implications that stem from our analysis are that the export promotion policy must be vigorously pursued and that more emphasis should be given to manufactured exports to increase economic (output) growth in the country. These findings and policy implications are consistent with Khan and Saqib (1993) and Khan and Khanum (1994).

3. CONCLUDING REMARKS

The purpose of this paper has been to investigate the direction of causation between exports growth and economic growth. This issue has been widely investigated in the past in the context of the suitability of export promotion versus import substitution as development strategies. The traditional practice has been to utilise the Granger causality test to examine the direction of causality. Recent developments in econometric techniques have highlighted at least two shortcomings in the application of the standard Granger causality test. These include the stationary properties of the series and the co-integration of variables included in the analysis.

The present paper, while investigating the direction of causation between exports growth and economic growth and using the Granger causality test, has taken into account these two shortcomings. The paper finds a stable, long-run two-way relationship between exports (as well as manufactured exports) and output, but a one-way stable relationship between output and primary exports. Furthermore, the paper also finds a bi-directional causation between exports (both primary and manufactured) growth and economic growth. Based on these findings, it is recommended that export promotion policy with a major emphasis on manufactured exports must be vigorously pursued to achieve a higher rate of economic growth.

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Comments

A number of empirical studies have been undertaken to test the export-led growth hypothesis for LDCs. The studies are based on time-series as well as cross-section data. While cross-section studies have, however, failed to provide a uniform support, the Granger or Sims procedure has been employed in these time-series studies in order to investigate the possible feedback relationship between exports growth and economic growth.

Bahamani-Oskooee and Alse (1993) pointed out three major shortcomings associated with such time-series studies, as also mentioned by the authors of this paper. First, these studies did not check for co-integrating properties of the time-series involved. Second, to avoid a spurious regression result because of non-stationarity tendencies of most economic time-series, they use rates of change instead of levels, which filters out low frequency (long-run) information. Third and final, these studies use annual data because of the unavailability of quarterly or monthly observations. So the lack of causation could be the result of temporal aggregation.

Taking into account these shortcomings, Bahmani-Oskooee and Alse (1993) re-examined the causal relationship between export growth and economic growth for LDCs including Pakistan. They found a feedback relationship for all LDCs in the sample including Pakistan.

The paper under review has extended the analysis for Pakistan by disaggregating total exports into primary and manufactured exports. The analysis should also have considered semi-manufactured exports. These three major categories of exports have shown different trends from 1976 to 1994. The share of manufactured exports in the total has increased from 44 percent in 1970 to 67 percent in 1994. While the share of the semi-manufactured remains around 22 percent, the share of primary exports has declined from 33 percent to 11 percent. These trends are reflected in the findings of the paper. Feedback relationship was found between manufactured exports and economic growth. This relationship, however, did not turn out to be stronger in the case of primary exports. The authors, therefore, recommend that efforts should be made to promote manufactured exports. This recommendation is based on a critical assumption that the demand for our manufactured exports in inelastic.

An empirical study like this is certainly useful specially when Pakistan needs to frame long-run policies to face the cut-throat competition posed by the emerging new World Trade Organisation (WTO)

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