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Exports and Economic Growth in Asian Developing Countries: Cointegration and Error-Correction Models

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This paper uses cointegration and error-correction models to analyze the causal relationship between export growth and economic growth in eight Asian developing countries using annual data from 1960 to 1997. While conventional wisdom suggests that export growth contribute positively to economic growth, this study also provides strong evidence supporting the export-led growth hypothesis. The empirical results show that bi-directional causality exists between export growth and economic growth in India, Indonesia, Korea, Pakistan, Philippines, Sri Lanka and Thailand. There is also evidence for export-led growth in Malaysia. Furthermore, there is evidence for short-run Granger causality running from economic growth to export growth in all cases except Sri Lanka. However, there is no strong evidence for short-run causality running from export growth to economic growth.

I. Introduction

The relationship between export growth and economic growth in developing countries has been of continuing interest both in theoretical and empirical literature. A large number of empirical studies have been conducted during the last two decades to investigate the role of exports on economic growth or the export-led growth hypothesis,[1] using either time-series or cross-section data. These studies have been conducted along a number of divergent lines. The early studies on this issue examined the simple correlation coefficient between export growth and economic growth.[2] These studies generally concluded that there is strong evidence in favor of export-led growth hypothesis based on the fact that export growth and economic growth are highly correlated. The main weakness of this group of studies is that a high degree of positive correlation between the two variables was used as evidence supporting the export-led growth hypothesis.

The second group of studies took the approach of whether or not exports are driving output by estimating output growth regression equations based on the neoclassical growth accounting techniques of production function analysis, including exports or export

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1. The hypothesis that exports growth causes economic growth is referred to in development economics literature as the export-led growth hypothesis.
2. See, for example, Michaely (1977), Balassa (1978), Heller and Porter (1978), Tyler (1981), and Kormendi and Mequire (1985).

growth as an explanatory variable.[3] This group of studies used a highly significant positive value of the coefficient of export growth variable in the growth accounting equation and a significant improvement in the coefficient of determination with the inclusion of the export growth variable in the regression equation as evidence for the export-led growth hypothesis. This group of models is subject to the criticism based on a methodological issue. They, generally, make *a priori* assumption that export growth causes output growth and do not consider the direction of the causal relation between the two variables.

A third group of, relatively recent, studies have their emphasis on causality between export growth and economic growth. This approach has been taken in a number of recent studies designed to assess whether or not individual countries exhibit evidence for export-led growth hypothesis using Granger or Sims causality tests.[4] The major shortcoming of these causality test results is that the Granger or Sims tests used in these studies are only valid if the original time series are cointegrated. Therefore, one must check for cointegrating properties of original export and output series before using Granger or Sims tests.

Finally, there has been relatively new studies which involve the application of techniques of cointegration and error-correction models (see Kugler (1991), Serletis (1992), Oxley (1993), Bahmani-Oskooee and Alse (1993), Dutt and Ghosh (1994, 1996), Ghatak, Milner and Utkulu (1997), Rahman and Mustafa (1998) and Islam (1998)). This relatively new methodology does not suffer from the shortcomings found in methodologies of previous studies.

The objective of this paper is to investigate the causal relationship between export growth and economic growth (measured as output growth) in Asian developing countries using cointegration and error-correction models. So far, only a few studies have used this methodology to study the causality relation between export growth and economic growth in developing countries. Given the small number of studies conducted using this methodology, it is expected that this paper will make a modest contribution to empirical literature. Eight Asian developing countries are included in this study: India, Indonesia, Korea, Malaysia, Pakistan, Philippines, Sri Lanka and Thailand.

The rest of the paper is organized as follows. Section II explains the methodology of cointegration and error-correction models. It also describes the data sources. The empirical results are reported and discussed in Section III. It also contains a comparison of our results with previous studies. The final section, Section IV, provides a discussion of implications of results and some summary conclusions.

3. Some of the studies done on this line include Voivades (1973), Feder (1983), Balassa (1985), Ram (1987), Sprout and Weaver (1993) and Ukpolo (1994).
4. See, for example Jung and Marshall (1985), Darrat (1987), Chow(1987), Kunst and Marin (1989), Sung-Shen, Biswas and Tribedy (1990), Bahmani-Oskooee *et al.* (1991), Ahmad and Kwan (1991), Serletis (1992), Khan and Saqib (1993), Dodaro (1993), Jin and Yu (1995) and Holman and Graves (1995).

II. Methodology and Data

1. Methodology

This paper uses relatively new statistical procedures, namely, the cointegration and error-correction models, to test the causal relationship between exports and economic growth. While these techniques are generally applied in multivariate models, this study uses these techniques in a bivariate model.[5] These econometric techniques have gained popularity in recent empirical research for a number of reasons including (a) the simplicity and relevance in analyzing time-series data, and (b) the ability to ensure stationarity and to provide additional channels through which Granger-causality could be detected when two variables are cointegrated.

Following Granger (1969), the Granger-causality tests have been developed to check whether or not the inclusion of past values of a variable X do or do not help in the prediction of present values of variable Y.[6] In order to avoid spurious causality both of the variables under consideration need to be stationary. The existence of a long-run equilibrium (stationary) relationship among economic variables is referred to in the literature as cointegration. According to Granger (1988), standard tests for causality are valid only if there exits cointegration. Therefore, a necessary precondition to causality testing is to check the cointegrating properties of the variables under consideration. The cointegration and error-correction methodology is briefly outlined in the following section.

Recent works by Granger (1986), Engle and Granger (1987), and Engle and Yoo (1987) have investigated the causal relationship between two variables when a common trend exits between them. Granger (1986) and Engle and Granger (1987) define a nonstationary time series X_t to be integrated of order d, $I(d)$, if it achieves stationarity after being differenced d times. For $d=0$, X_t is stationary in levels and no differencing is necessary while, for $d=1$, first differencing is needed to restore stationarity in time series X_t. If two series X_t and Y_t are both $I(d)$, Engle and Granger (1987) have shown that a linear combination, $Z_t = X_t - aY_t$, will also, in general, be $I(d)$. However, if the constant a provides an outcome where Z_t is integrated of order $(d-b)$, $I(d-b)$, and $b > 0$, then X_t and Y_t are said to be cointegrated. To be cointegrated, both X_t and Y_t must have the same order of integration (Engle and Granger (1987) and Granger (1986)).

Testing for causality or cointegration between the two variables, real exports and real GDP (both variables are expressed in logarithmic form), is done in two steps.

5. Although this study is based on the bivariate model, the results of the study do not rule out the importance of other causal factors.
6. If variable Y is better predicted by including past values of X than by not including them, then X is said to Granger-cause Y. Similarly, if the past values of Y can be used to predict X more accurately than simply using the past values of X, then Y is said to Granger-cause X. If both X is found to Granger-cause Y and Y is found to Granger-cause X, then it is said that a feedback occurs.

First, following Engle and Granger (1987), the time series properties of each variable are examined by unit root tests. In this step, it is tested whether exports and GDP are integrated of order zero, $I(0)$, that is, whether real exports ($\ln REXP$) and real domestic income ($\ln RGDP$) are stationary. This is accomplished by performing the augmented Dickey-Fuller (ADF) test. The ADF test is based on the regression equation with the inclusion of a constant and a trend of the form

$$\Delta X_t = \beta_0 + \mu t + \vartheta_1 X_{t-1} + \sum_{j=1}^{k} \beta_j \Delta X_{t-j} + \varepsilon_t, \tag{1}$$

where $\Delta X_t = X_t - X_{t-1}$ and X is the variable under consideration, p is the number of lags in the dependent variable, is chosen so as to induce a white noise term and ε_t is the stochastic error term. The stationarity of the variable is tested using the null hypothesis of $|\vartheta_1| = 1$ against the alternative hypothesis of $|\vartheta_1| < 1$. The critical values of ADF statistic as reported in Engle and Yoo (1987) can be used to test this hypothesis. If the null hypothesis cannot be rejected, it implies that the time series is non-stationary at the level and therefore it requires taking first or higher order differencing of the level data to establish stationarity. Engle and Granger (1987) prefer the ADF test due to the stability of its critical values as well as its power over different sampling experiments. The optimum lag length (p) in the PDF regression is selected using the minimum final prediction error (FPE) criterion developed by Akaike and then the results were confirmed by the Schwarz criterion.[7]

Testing the stationarity of economic time series is of great importance since standard econometric methodologies assume stationarity in the time series while they are, in fact, non-stationary. Consequently, the usual statistical tests are likely to be inappropriate and the inferences drawn are likely to be erroneous and misleading. For instance, the ordinary least squares (OLS) estimation of regressions in presence of non-stationary variables give rise to spurious regressions if the variables are not cointegrated (Granger and Newbold (1974)).

Having tested the stationarity of each time series, the next step is to search for cointegration between $\ln REXP_t$ and $\ln RGDP_t$. In other words, this step investigates whether the stochastic trends in $\ln REXP_t$ and $\ln RGDP_t$ that contained unit roots have a long-run relationship. In order to show that exports and economic growth have any type of causality, it should be shown that they are cointegrated in Granger sense. This is accomplished by using the Engle-Granger two-step cointegration procedure and Johansen-Juselius cointegration technique. The Engle-Granger two stage procedure involves two steps. First, if we have an economic model involving two time series Y_t and X_t, the time series properties of each variable are examined by unit root

7. The formulas for Akaike criterion (AIC) and Schwartz criterion (SC) are as follows:

$$AIC(k) = \ln\sigma^2 + 2k/N \quad \text{and} \quad SC(k) = \ln\sigma^2 + k\ln(N)/N,$$

where $\sigma^2 = e'e/N$, e is the residual vector, N is the number of observations, and k is the number of parameters to be estimated.

tests. Having tested the stationarity of each time series, two cointegration regressions (direct and reverse) between variables Y_t and X_t are estimated using the OLS.[8] The second step involves directly testing the stationarity of error processes of two cointegration regressions estimated in previous step.

Johansen (1988) and Johansen and Juselius (1990) have developed a maximum-likelihood testing procedure on the number of cointegrating vectors which also include testing procedures for linear restrictions on the cointegrating parameters, for any set of $I(1)$ variables. Since the Johansen cointegration test is now well known it is not discussed here in detail. However, two test statistics that are used to identify the number of cointegrating vectors, namely the trace test statistic and the maximum eigenvalue test statistic, are only given here. The Trace test statistic for the null hypothesis that there are at most r distinct cointegrating vectors is

$$\lambda_{trace} = T \sum_{i=r+1}^{N} \ln(1-\lambda_i), \tag{2}$$

where λ_i's are the $N-r$ smallest squared canonical correlations between X_{t-k} and ΔX_t (where $X_t = (REXP_t, RGDP_t)$ and where all variables entering X_t are assumed $I(1)$), corrected for the effects of the lagged differences of the X_t process.

The maximum likelihood ratio statistic for testing the null hypothesis of at most r cointegrating vectors against the alternative hypothesis of $r+1$ cointegrating vectors, i.e., the maximum eigenvalue statistic, is given by

$$\lambda_{max} = -T \ln(1-\lambda_{r+1}). \tag{3}$$

Johansen (1988) shows that equations (2) and (3) have non-standard distributions under the null hypothesis and provides approximate critical values for the statistic, generated by Monte Carlo methods.[9]

Engle and Granger (1987) have shown that if variables such as $\ln REXP_t$ and $\ln RGDP_t$ are integrated of order one, $I(1)$, and the stochastic error terms are both integrated of order zero, $I(0)$, then $\ln REXP_t$ and $\ln RGDP_t$ are said to be cointegrated. According to them, if the variables are integrated of degree $I(1)$ and are cointegrated then either unidirectional or bi-directional Granger causality must exist in at least the $I(0)$ variables. If the variables are cointegrated there must exist an error-correction representation that may take the following form:

$$\Delta \ln REXP_t = \Phi_0 + g\hat{\delta}_{t-1} + \sum_{i=1}^{k} \Phi_{1i} \Delta \ln REXP_{t-i} + \sum_{i=1}^{k} \Phi_{2i} \Delta \ln RGDP_{t-i} + \varepsilon_{1t}, \quad \theta$$

8. The direct and reverse cointegration regressions for two time series X_t and Y_t can be written as follows: $Y_t = \phi_0 + \phi_1 X_t + v_{1t}$ and $X_t = \varphi_0 + \varphi_1 Y_t + v_{2t}$

9. The critical values of Trace test and Maximum Eigenvalues test are given in Osterwald-Lenum (1992). A note with quantiles of the asymptotic distribution of the maximum likelihood cointegration rank test statistics, *Oxford Bulletin of Economics and Statistics*, 54(3), 461-71.

$$\Delta \ln RGDP_t = \pi_0 + h\rho_{t-1} + \sum_{i=1}^{k} \pi_{1i} \Delta \ln RGDP_{t-i} + \sum_{i=1}^{k} \pi_{2i} \Delta \ln REXP_{t-i} + \varepsilon_{2t}, \qquad (5)$$

where δ_{t-1} and ρ_{t-1} are the error-correction terms. The inclusion of error-correction terms in equations (4) and (5) introduces an additional channel through which Granger causality could be detected. According to Granger (1986), the error-correction models produce better short-run forecasts and provide the short-run dynamics necessary to obtain long-run equilibrium. However, in the absence of cointegration, a vector autoregression (VAR) in first-differences form can be constructed. In this case, the error-correction terms will be eliminated from equations (4) and (5). If the series are cointegrated, then the error-correction models given in equations (4) and (5) are valid and the coefficients g and h are expected to capture the adjustments of $\Delta \ln REXP_t$ and $\Delta \ln RGDP_t$ towards long-run equilibrium, while $\Delta \ln REXP_{t-i}$ and $\Delta \ln RGDP_{t-i}$ are expected to capture the short-run dynamics of the model.

2. Data

Annual data for the period 1960-1997 were used for estimation. The data on exports and gross domestic product (GDP) for the selected eight Asian developing countries are from several issues of International Monetary Fund, *International Financial Statistics Yearbook*. The sample of countries consists of India, Indonesia, Korea, Malaysia, Pakistan, Philippines, Sri Lanka, and Thailand. Due to the non-availability of data for all countries for the specified period, the analysis that follows is based on the annual data on each country for the periods specified in the parentheses: India (1960-1996); Indonesia (1965-1997); Korea (1960-1997); Malaysia (1960-1997); Pakistan (1960-1997); Philippines (1960-1997); Sri Lanka (1960-1997) and Thailand (1962-1997). The nominal figures of GDP were deflated by the GDP deflator (1990=100) for each country to express them in real terms. Following Bahmani-Oskooee and Alse (1993), the nominal values of exports were deflated by the export price index (1990=100) of each country to express them in real terms. Both of the indexes,[10] the GDP deflator and the export price index, were collected from the IMF, *International Financial Statistics Yearbook*.

III. Empirical Results

In the light of econometric methodology presented in the previous section, the cointegrating properties of the variables involved are examined and the empirical results are discussed in this section.

Table 1 presents the results of unit root tests obtained using the augmented Dickey-Fuller test. The results are based on annual data for eight Asian developing countries. The choice of countries and span of data reflects data availability. The results

10. These indexes were reported in various issues of IFS with a different base year and they were converted into a common base year of 1990 using splicing of indexes.

support the presence of unit roots in all the series for all countries. This is confirmed by the fact that the null hypothesis that the series are non-stationary is not rejected at the levels of both variables. However, the null hypothesis is rejected in favor of alternative hypothesis of series are stationary when the first difference of the variables are taken. Thus, their first difference is found to be stationary and hence $\ln REXP$ and $\ln RGDP$ are both integrated of order one, $I(1)$. In all cases, the null hypothesis of series has unit roots cannot be rejected. Thus, the tests of unit roots support the unit root hypothesis at the 5% level of significance for all data series.

Table 1 Augmented Dickey-Fuller Unit Root Test

	Level							
	$\ln REXP$				$\ln RGDP$			
Country	ADF_1	Lag	ADF_2	Lag	ADF_1	Lag	ADF_2	Lag
India	-0.3979	1	-2.5676	2	-1.5053	1	-0.8473	3
Indonesia	-2.4161	1	-1.7635	1	-2.4446	1	-1.9475	1
Korea	-2.5698	2	-1.7408	2	-2.5395	1	-2.6452	2
Malaysia	-0.2106	2	-1.3384	3	-0.6509	2	-2.1439	3
Pakistan	-0.4098	1	-2.5653	1	-0.2209	1	-1.4407	1
Philippines	-0.9162	1	-2.3586	1	-1.2261	1	-1.9551	1
Sri Lanka	-0.3971	2	-1.3303	2	-0.7023	1	-2.5208	1
Thailand	-1.6859	1	-1.4909	1	-0.7998	1	-1.7149	1
	Fist Difference							
	$\Delta \ln REXP$				$\Delta \ln RGDP$			
Country	ADF_1	Lag	ADF_2	Lag	ADF_1	Lag	ADF_2	Lag
India	-3.8690*	1	-4.4927**	1	-3.7971**	2	-4.8241*	2
Indonesia	-3.5467**	1	-3.8302**	2	-4.8200*	1	-4.5789*	1
Korea	-3.7352**	1	-5.1172*	2	-4.7512*	1	-4.3241*	2
Malaysia	-5.6819*	1	-6.5759*	1	-6.6482*	1	-6.3635*	1
Pakistan	-5.6029*	1	-5.6557*	1	-3.4790**	1	-3.8906**	1
Philippines	-6.1687*	1	-6.0243*	1	-4.8482*	1	-5.5448*	1
Sri Lanka	-5.6476*	1	-6.8741*	1	-4.2197*	1	-4.3307*	1
Thailand	-4.2207*	1	-4.5949*	1	-4.8147*	1	-4.6745*	1

Notes:

ADF_1 tests $H_0: \theta_1 = 0$ in $\Delta \ln REXP_t = \beta_0 + \theta_1 \ln REXP_{t-1} + \sum_{j=1}^{m} \beta_j \Delta REXP_{t-j} + \varepsilon_t$. (6)

ADF_2 tests $H_0: \theta_2 = 0$ in $\Delta \ln REXP_t = \varphi_0 + \varphi_1 t + \theta_2 \ln REXP_{t-1} + \sum_{j=1}^{m} \varphi_j \Delta REXP_{t-j} + \varsigma_t$. (7)

* and ** denote statistical significance at the 1% and 5% levels, respectively. The critical values of ADF_1 statistics as reported in Engle and Yoo (1987), for 50 observations are -3.58, -2.93 and -2.60 at 1%, 5% and 10% levels of significance respectively. The critical values of ADF_2 statistics as reported in Engle and Yoo (1987), for 50 observations are -4.15, -3.50 and -3.18 at 1%, 5% and 10% levels of significance respectively.

The time period covered for each country is as follows: India (1960-1996), Indonesia (1965-1997), Korea (1960-1997), Malaysia (1960-1997), Pakistan (1960-1997), Philippines (1960-1997), Sri Lanka (1960-1997), and Thailand (1962-1997).

Having confirmed the existence of unit roots for all the data series, the next step involves applying Engle-Granger two-step cointegration procedure and Johansen-Juselius cointegration test to check whether the two variables are cointegrated for each of the eight Asian countries. The optimum lag lengths are determined using the Akaike final prediction error (FPE) criterion. The results of the ADF test applied to residuals of the cointegration equations and the results of Johansen-Juselius cointegration tests are presented in Table 2. Together with the results, the values of the slope coefficients and Cointegration Regression Durbin Watson (CRDW) statistics are also presented.

Table 2 Results of Engle-Granger and Johansen Cointegration Tests

Country	Cointegration Equation	Slope	CRDW[a]	Calculated ADF for Residuals	Johansen Cointegration Test			
					λ_{Trace}		λ_{Max}	
					$r=0$	$r\leq 1$	$r=0$	$r=1$
India	ln REXP = f(ln RGDP)	1.5184	0.76	-3.2612[1]**				
	ln RGDP = f(ln REXP)	0.6270	0.75	-3.6632[1]**	16.45**	1.02	15.43**	1.02
Indonesia	ln REXP = f(ln RGDP)	1.5061	0.71	-3.5708[2]**				
	ln RGDP = f(ln REXP)	0.6301	0.72	-3.5578[2]**	15.80**	0.01	15.79**	0.01
Korea	ln REXP = f(ln RGDP)	1.5868	0.74	-3.8951[3]**				
	ln RGDP = f(ln REXP)	0.6100	0.75	-3.3984[3]**	21.06*	0.21	20.85*	0.21
Malaysia	ln REXP = f(ln RGDP)	0.4281	0.70	-2.7352[1]***				
	ln RGDP = f(ln REXP)	1.9938	0.68	-2.6338[1]***	18.96**	2.51	16.45**	2.51
Pakistan	ln REXP = f(ln RGDP)	1.4493	1.30	-3.5459[1]**				
	ln RGDP = f(ln REXP)	0.6674	1.26	-3.5711[1]**	18.15**	1.38	16.77**	1.38
Philippines	ln REXP = f(ln RGDP)	1.7096	0.99	-2.7894[2]***				
	ln RGDP = f(ln REXP)	0.5529	0.95	-2.6271[2]***	17.51**	0.07	17.44**	0.07
Sri Lanka	ln REXP = f(ln RGDP)	1.2271	1.05	-3.1474[1]**				
	ln RGDP = f(ln REXP)	0.7533	0.98	-3.2946[1]**	26.12*	1.82	24.30*	1.82
Thailand	ln REXP = f(ln RGDP)	1.3389	0.69	-2.7991[1]***				
	ln RGDP = f(ln REXP)	0.7106	0.70	-2.6271[1]***	18.51**	0.05	18.46**	0.05

Notes: *, **, and *** indicate the statistical significance at the 1%, 5% and 10% levels of significance respectively. The figures in brackets are optimum lag length for ADF statistic. The optimum lag length has been determined by the Akaike final prediction error (FPE) criterion. The critical values of ADF statistic as reported in Engle and Yoo (1987), for 50 observations, is -2.60.

[a] The critical value of the CRDW statistic in the vicinity of 50 observations is 0.78 and 0.69 at the 5% and 10% levels of significance, respectively. They are from Engle and Yoo (1987), Table 4.

Let us first use the Engle-Granger two-step procedure to check whether the two variables are cointegrated. The results presented in Table 2 indicate that the estimated ADF statistics for the residuals are greater than their corresponding critical values for all eight countries. Therefore, $\ln REXP$ and $\ln RGDP$ are cointegrated in all cases. This finding is confirmed by the CRDW statistic. Though ADF test is a more powerful test when compared with the use of the CRDW statistic, Engle and Granger (1987) point out that for quick approximate results one could use the CRDW statistic. The CRDW statistic must be significantly different from zero for the residuals of cointegration equations to be stationary. The results indicate that the CRDW statistic is statistically significant in all the cases. This is based on the fact that the CRDW statistic is greater than critical value given in the bottom of Table 2. Thus, the CRDW statistic confirms the stationarity of the residuals of cointegration equations for all countries. Second, the Johansen-Juselius cointegration test also provide evidence for the existence of one cointegration vector implying that the two variables are cointegrated in all eight cases. Thus, the results of both Engle-Granger two-step procedure and Johansen-Juselius cointegration test imply a long-run association between real exports and real GDP for all eight Asian countries. Therefore, equations (4) and (5) have been estimated including the error-correction terms.

The empirical results of the estimated error-correction models are presented in Table 3. The results show that bi-directional causality exists between export growth and GDP growth in all countries except Malaysia. This is based on the statistical significance of the error-correction coefficients (g and h) of the error-correction (EC) terms. According to Jones and Joulfaian (1991), the error-correction terms $\hat{\delta}_{t-1}$ and ρ_{t-1} represent the long-run impact of one variable on the other while the changes of the lagged independent variable describe the short-run causal impact. The results presented in Table 3 provide evidence on long-run impact from export growth to economic growth as well as from economic growth to export growth in seven of the eight Asian countries selected. The F-statistics for the joint significance of autoregressive terms for each variable are reported in last two columns of Table 3. The short-run dynamics of the error-correction processes can be identified by examining the statistical significance of the values given in these two columns. The optimum lag lengths for autoregressive terms in equations (4) and (5) were identified using the Akaike final prediction error criterion. Results given in the top section of Table 3 indicate that F-statistic for lagged $\Delta \ln REXP_t$ variables are statistically significant only in four cases while that for $\Delta \ln RGDP_t$ variables are statistically significant in seven cases. The statistically significant non-zero coefficients of $\Delta \ln RGDP_{t-j}$ show that the short-run Granger causality runs from GDP growth to export growth in all cases except Sri Lanka. Similarly, the statistically significant non-zero coefficients of $\Delta \ln REXP_{t-j}$ reflect feedback between current changes in real exports and its own lagged values in India, Korea, Philippines and Thailand. Further, the results presented in the bottom part of Table 3 indicate that the non-zero coefficients of $\Delta \ln RGDP_{t-j}$ reflect feedback between current changes in real GDP and its own lagged values in Philippines, Sri Lanka and Thailand. The statistically significant non-zero coefficient of $\Delta \ln REXP_{t-j}$ show that the short-run Granger causality runs from export growth to GDP growth in cases of Indonesia and Sri Lanka.

Table 3 Results of Error Correction Models

$$\Delta \ln REXP_t = \Phi_0 + g\hat{\delta}_{t-1} + \sum_{i=1}^{k} \Phi_{1i} \Delta \ln REXP_{t-i} + \sum_{i=1}^{k} \Phi_{2i} \Delta \ln RGDP_{t-i} + \varepsilon_{1t}$$

Country	t-Statistics for EC_{t-1}	F-Statistic $\sum \Phi_{1i} \Delta \ln REXP_{t-i}$	F-Statistic $\sum \Phi_{2i} \Delta \ln RGDP_{t-i}$
India	-2.2777**	2.8834***	2.8304***
Indonesia	-1.7181**	1.9698	4.1169**
Korea	-1.7624**	6.0751*	2.9418***
Malaysia	-1.3712	1.3607	2.2596***
Pakistan	-3.6194*	1.1301	5.1058**
Philippines	-1.7637**	2.8918**	2.8615***
Sri Lanka	-2.5015**	0.2489	1.8994
Thailand	-2.1518**	2.8839***	3.1956**

$$\Delta \ln RGDP_t = \pi_0 + h\rho_{t-1} + \sum_{i=1}^{k} \pi_{1i} \Delta \ln RGDP_{t-i} + \sum_{i=1}^{k} \pi_{2i} \Delta \ln REXP_{t-i} + \varepsilon_{2t}$$

Country	t-Statistics for EC_{t-1}	F-Statistic $\sum \pi_{1i} \Delta \ln RGDP_{t-i}$	F-Statistic $\sum \pi_{2i} \Delta \ln REXP_{t-i}$
India	-1.9032**	1.0069	0.7822
Indonesia	-1.7009**	1.8773	6.9859**
Korea	-1.8617**	0.8326	2.2780
Malaysia	-1.8719**	1.7688	1.9550
Pakistan	-2.5938**	2.6901	1.0121
Philippines	-2.1483**	9.7877*	2.6512
Sri Lanka	-1.7431**	5.9893**	6.9188**
Thailand	-1.8336**	5.7685**	1.4636

Notes: EC denotes the error-correction term. Critical values for δ_{t-1} is -2.02 at the 5% level of significance. Critical values of the *F*-statistic for sample size of 40 are 2.84 and 2.23 at the 5% and 10% level of significance respectively.

** and *** indicate the statistical significance at the 5% and 10% levels of significance respectively.

Let us now compare the findings of this study with those of previous studies. Table 4 summarizes the results of this study vis-à-vis twelve other studies. However, only a few of these studies share some procedural aspects of this study. Findings of this study are somewhat similar to the findings of the studies by Islam (1998), Rahman and Mustafa (1998) and Bahmani-Oskooee and Alse (1993) that use a similar methodology. Since the coverage of countries varies from study to study no direct comparison can be made. Of eleven studies done on Korea, for example, six studies (including this study) find evidence for bi-directional causality between export growth and economic growth. In general, the differences in outcomes of these studies could be due to a number of reasons including different time periods, different sample intervals, different methodologies, use of an incomplete error-correction specification and unverified stationarity conditions.

Table 4 Comparative Evaluation of Major Findings

	India	Indonesia	Korea	Malaysia	Pakistan	Philippines	Sri Lanka	Thailand
Ekanayake (our results)	BDC	BDC	BDC	ELG	BDC	BDC	BDC	BDC
Islam (1998)	ELG	ELG	ELG	GLE	BDC	NC	BDC	ELG
Rahman and Mustafa (1997)	GLE	GLE	BDC	BDC	GLE	ELG	GLE	ELG
Ghatak, Milner and Utkulu (1997)				ELG				
Dutt and Ghosh (1996)			NC		GLE	ELG		
Jin and Yu (1996)			NC					
Holman and Graves (1995)			BDC					
Bahmani-Oskooee and Alse (1993)			BDC	NC	BDC	BDC		BDC
Dodaro (1993)			NC		NC	NC		
Sung-Shen, Biswas & Tribedy (1990)			BDC					
Darrat (1987)			ELG					
Chow (1987)			BDC					
Jung and Marshall (1985)		ELG						

Notes: BDC denotes bi-directional causality, ELG denotes export-led growth, GLE denotes growth-led exports, and NC denotes no causality. Blank spaces indicate countries not included in the respective studies.

IV. Summary and Conclusions

This paper applies cointegration and error-correction models to test causal relation between export growth and economic growth in Asian developing countries. The previous time-series studies, that used either Granger or Sims procedures and have been concerned with causal relationship between export growth and economic growth in developing countries, have provided mixed conclusions. The cointegration and error-correction modeling techniques used in this paper have revealed that there is a bi-directional causality between export growth and economic growth in seven of the eight countries considered. There is evidence for short-run Granger causality running from economic growth to export growth in all cases except Sri Lanka. While there is strong evidence for long-run Granger causality running from export growth to economic growth in all cases, there is evidence of short-run causality running from export growth to economic growth only in Indonesia and Sri Lanka.

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