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Export-led Growth: A Survey of the Empirical Literature and Some Noncausality Results Part 1[1]

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Abstract

The economic development and growth literature contains extensive discussions on relationships between exports and economic growth. One debate centers on whether countries should promote the export sector to obtain economic growth. An abundant empirical literature on this export-led growth (ELG) hypothesis has followed. We contribute to this literature in two ways. In this paper, part 1, we provide a comprehensive survey of more than one hundred and fifty export-growth applied papers. We describe the changes that have occurred, over the last two decades, in the methodologies used to empirically examine for relationships between exports and economic growth, and we provide information on the current findings. The last decade has seen an abundance of time series studies that focus on examining for causality via exclusions restrictions tests, impulse response function analysis and forecast error variance decompositions. Our second contribution is to examine some of these time series methods. We show, in part 2, that ELG results based on standard causality techniques are not typically robust to specification or method. We do this by reconsidering two export-led growth applications - Oxley=s (1993) study for Portugal, and Henriques and Sadorsky=s (1996) analysis for Canada. Our results suggest that extreme care should be exercised when interpreting much of the applied research on the ELG hypothesis.

JEL CLASSIFICATIONS: F43, O11, 051, 052

KEYWORDS: economic growth, export promotion, causality, time series models, cointegration, innovation accounting.

1. Introduction

The notion that export activity leads economic growth has been subject to considerable debate in the development and growth literature for many decades (e.g., Keesing, 1967; Krueger, 1985). Is export growth the engine of economic growth, is it only a handmaiden or is there only a contemporaneous relationship between them? (Nurkse, 1961). This literature is part of a larger one, which relates the trade regime/outward orientation and growth, and a literature that dates back to the nineteenth century. Outward orientation is measured by some function of the trade flow of exports for the export-led growth (ELG) studies. We limit our attention to this body of work and we ignore, for practicality reasons alone, those studies which use alternative definitions of trade or openness .

Broadly, the focus of the ELG debate is on whether a country is better served by orienting trade policies to export promotion or to import substitution[2]. The neoclassical view has been that growth can be achieved by ELG; the growth records of Asian newly industrializing countries (NICs) - in particular, Hong Kong, Singapore, Korea and Taiwan, second-generation NICs (Malaysia and Thailand) - are cited as such examples (compared to, say, Latin America and Africa). Over the last thirty years these NICs have approximately doubled their standards of living every ten years. China is the latest country to join this group: China=s experience during the 1980s and 1990s tend[s] to support the argument that openness to trade is a mechanism for achieving more rapid and efficient growth and better distribution of domestic resources (Findlay and Watson, 1996, p.4). Many studies contain similar assertions for other countries and some authors (e.g., Krueger, 1995) identify trade policy as <u>the</u> crucial element of economic policy. The World Bank (1993) perceives the experiences of these countries as a >model=for development, a view also supported by the US Agency for International Development and the International Monetary Fund.

The effectiveness of export promotion is in the end an empirical issue; over the last twenty years or so there has been a plethora of such investigations, using a number of statistical techniques. Overall, it is difficult to decide for or against ELG, as there are conflicting results. The aim of this paper is to provide a summary of the empirical literature; to this end we provide information on more than one hundred and fifty papers. We concentrate on papers that are explicitly interested in the export-economic growth relationship rather than those that may be interested in explaining growth per se. We also exclude applied research involved in the endogenous/exogenous growth literature. Jung and Marshall (1985), Greenaway and Sapsford (1994a,b), Riezman et al. (1996), Dhananjayan and Devi (1997) and Shan and Sun (1998b) also provide surveys on the applied ELG work. The 1985 study is dated while the later papers are narrow: Greenaway and Sapsford provide information on thirteen papers, Riezman et al. discuss sixteen investigations, Dhananjayan and Devi review fourteen studies while the survey of Shan and Sun is longer, but still only considers thirty papers. Edwards (1993) also contains a discussion on a few of the early applications.

The empirical literature separates into three: the first group of studies use cross-country correlation coefficients to test the ELG hypothesis; these were followed by regression applications (typically least squares based) that were again usually cross-country predicated; the third, recent group of works, apply various time series techniques to examine the exports-growth nexus. Potential problems with the cross-country methods are well documented in the literature and some problems with the later time series studies are also noted. In our sequel paper (Part 2) we discuss a number of other concerns regarding the time series studies, which we illustrate employing data for Portugal as studied by Oxley (1993) and for Canada as analyzed by Henriques and Sadorsky (1996).

This paper is organized as follows. In the following section we briefly outline the possible relationships that may exist between exports and economic growth, and we describe and summarize our survey of the empirical literature in section 3. Further, section 3 presents discussions of the current time series techniques. Some concluding remarks are made in section 4.

2. Export-led growth; growth-led exports or feedback?

There are a number of reasons within trade theory to support the ELG proposition. First, export growth may represent an increase in demand for the country=s output and thus serves to increase real output. Second, an expansion in exports may promote specialization in the production of export products, which in turn may boost the productivity level and may cause the general level of skills to rise in the export sector. This may then lead to a reallocation of resources from the (relatively) inefficient non-trade sector to the higher productive export sector. The productivity change may lead to output growth. This effect is sometimes called >Verdoorn=s Law=after P.J. Verdoorn who suggested it in 1949. The outward oriented trade policy may also give access to advanced technologies, learning by doing gains, and better management practices (e.g., Hart, 1983; Ben-David and Loewy, 1998) that may result in further efficiency gains. Third, an increase in exports may loosen a foreign exchange constraint (e.g., Chenery and Strout, 1966), which makes it easier to import inputs to meet domestic demand, and so enable output expansion. Outward orientation makes it possible to use external capital for development and may assist with debt servicing. Export promotion may also eliminate controls that result in an overvaluation of the domestic currency.

Export development of certain goods based upon a country=s comparative advantage may allow the exploitation of economies of scale that may lead to increased growth. This argument proposes that domestic markets are too small for optimal scale to be achieved while increasing returns may occur with access to foreign markets. Additionally, ELG may be seen as part of the product and industry life-cycle hypothesis. This hypothesis describes economic growth as a cycle that begins with exports of primary goods. Over time, economic growth and knowledge change the structure of the domestic economy, including consumer demand, which propels the more technology intensive domestic industry to begin exporting. As domestic demand ebbs, economic growth arises from technologically advanced exports. Finally, some propose (e.g., Lal and Rajapatirana, 1987) that an outward-oriented strategy of development may provide greater opportunities and rewards for entrepreneurial activity, which, it is argued, is the key to extended growth, as it is the entrepreneur who will seek out risk and opportunity.

The support for ELG is not universal. Critics point out that the experiences in the East and Southeast Asian countries are unique in many ways and not necessarily replicable in other countries; e.g. Buffie (1992). Other researchers question whether a reliance on exports to lead the economy will result in sustained long-term economic growth in LDCs due to the volatility and unpredictability in the world market; e.g., Jaffee (1985). Another issue is whether the markets in developed countries are large enough for more exports from LDCs, or whether trade barriers will impede this route of development; e.g., Adelman (1984). Some scholars support the counter development strategy of protectionism or import substitution (e.g., Prebisch, 1950; Singer, 1950). This involves utilizing a variety of policy instruments (tariffs, quotas and subsidies) to substitute domestic output for imports; import substitution can be implemented without impacts from other economies and the benefits to increased employment and output are immediate. Such government policies can be used to foster domestic firms rather than foreign ones. Based on the experience of Latin American countries, in particular, it is argued that trade between the North and the South has been detrimental to some Latin American countries, resulting in high government expenditure on incentive schemes, ecological damage, trade imbalances and setbacks to domestic industry and agriculture; e.g., Hamilton and Thompson (1994). Part of this may be due to the type of good that is being traded (see also Eswaran and Kotwal, 1993).[3]

Promotion of import substitution industries may also help to develop a variety of industries while export promotion may only result in a select number of industries, which may lead a country to be stuck producing goods from which the economic gains have been exhausted. Some argue (e.g., Corden, 1987) that financing development via import substitution may be politically attractive as tariffs, quotas, etc., may raise taxes in a hidden fashion. Grossman and Helpman (1991) show that the use of tariffs may benefit countries with a comparative disadvantage in key sectors (R&D for instance) and lead to greater growth. Advocates of selective import protection also prevail (e.g., Taylor, 1988) and, empirically, many countries promote exports in one or more sectors, while protecting others. Export promotion and import substitution strategies may well be complementary; indeed, the latter may be a necessary step for export-based growth (e.g., Hamilton and Thompson, 1994).

There is also potential for growth-led exports (GLE). Bhagwati (1988) postulates that GLE is likely, unless antitrade bias results from the growth-induced supply and demand. Neoclassical trade theory supports this notion, as it suggests that other factors aside from exports are responsible for output growth (e.g., primary input growth and/or factor productivity growth). A GLE orthodoxy is justified by, for instance, Lancaster (1980) and Krugman (1984); economic growth leads to enhancement of skills and technology, with this increased efficiency creating a comparative advantage for the country that facilitates exports. Market failure, with subsequent government intervention, may also result in GLE.

A feedback relationship between exports and output is an interesting prospect. For example, Helpman and Krugman (1985) postulate that exports may rise from the realization of economies of scale due to productivity gains; the rise in exports may further enable cost reductions, which may result in further productivity gains. Bhagwati (1988) conjectures that increased trade (irrespective of cause) produces more income, which leads to more trade and so on. There is, finally, potential for no causal relationship between exports and economic growth when the growth paths of the two time series are determined by other, unrelated variables (e.g., investment) in the economic system; e.g., Pack (1988).

3. The empirical literature

The empirical approaches to the ELG debate have taken three forms. Details are given in Tables A1 and A2: Table A1 lists the cross-sectional investigations between 1963 and 1999 while Table A2 provides information on the literature between 1972 and 1999 that considers individual country analyses over time. The early cross-country studies on ELG, which we examine in section 3.1, are generally favorable to the hypothesis, though there are exceptions. However, the single-country time series studies provide less support for the hypothesis, though there is often disagreement for the same country from one study to another. We detail some examples in section 3.3. Some of the time-series analyses are flawed as they ignore nonstationarity issues in the data; we identify some potential difficulties in section 3.2.

3.1. Cross-sectional studies

One group of cross-section research looks at rank correlation coefficients or simple OLS regressions between exports and output. The number of countries dealt with varies from seven to more than one hundred; various time periods are investigated and several definitions of the export and economic growth variable are adopted. The ELG hypothesis is supported when a positive and statistically significant correlation is observed. The general conclusion is that high levels of economic growth are significantly associated with high levels of export growth.

One issue arising from this body of work is that some of the results may involve a spurious correlation due to exports themselves being part of national product. This accounting identity effect leads some authors to use output net of exports or alternative export variables; e.g., real manufactured export earnings or share of changes in exports in GDP. Further this research leads to a conclusion that there may be a need for a minimum threshold of development before any association may exist. As only exports and growth are investigated in the above-mentioned studies, any observed correlation may be reflective of underlying relationships via other economic variables. This concern led to a group of cross-sectional studies that estimate aggregate production functions that include exports as an explanatory variable along with other proposed economic growth determining fundamentals, such as labor, capital, and investment. Linear regression models are estimated in which a growth variable is regressed on an export variable. The ELG hypothesis is supported if the coefficient on the export variable is positive and statistically significant. The growth variable is typically real GDP, though some studies have used per capita GDP or manufacturing output or non-export GDP to overcome the accounting identity problem. Likewise, various definitions of exports are applied including growth in real exports, manufacturing or merchandise exports, export share of GDP, % share of changes in exports in GDP.

Some consider the differential impacts of exports on economic growth depending on the level of economic/industrial development of the country; the so-called critical minimum effort hypothesis. A popular approach is based on Feder=s (1983) model of export-growth linkages in which the growth rate of labor and capital inputs enter as explanatory variables for the growth of GNP as well as the growth rate of exports. This approach has been subject to criticism, as it assumes no diminishing returns to an increasing export share, and it also imposes that the relative efficiency is the same for export and non-export production, irrespective of the size of the domestic markets. These empirical studies have supported the notions that developing countries with favorable export growth have experienced higher rates of growth of national output over a wide range of countries and time periods.

Studies that do not support ELG include Papanek (1973), Kormendi and Meguire (1985), Helleiner (1986), Gonçlaves and Richtering (1987), Mbaku (1989), De Gregorio (1992), Sprout and Weaver (1993), Greenaway and Sapsford (1994b), Amirkhalkhali and Dar (1995), Yaghmaian and Ghorashi (1995), Burney (1996). Even though it is difficult to isolate why these investigations do not support export promotion while other studies do, different country sets, time periods and variable definitions are three obvious reasons. For example, Gonçlaves and Richtering (1987) find a positive and statistically significant export/economic growth effect when growth is measured via total GDP but not for non-export GDP, which may be a reflection of the accounting identity issue raised earlier; Sprout and Weaver (1993) and Amirkhalkhali and Dar (1995) determine that the groupings of countries matter; Greenaway and Sapsford (1994b), Yaghmaian and Ghorashi (1995) and Burney (1996) illustrate that ELG changes with time periods. Papanek (1973), Kormendi and Meguire (1985) and De Gregorio (1992) include explanatory variables not analyzed elsewhere, raising the question as to whether the export/economic growth effect observed in other studies is spurious by reflecting third variable effects. Sheehey (1990) observes positive correlations for other production categories; e.g., agriculture, manufacturing, construction, services. Since positive correlation is common to all or most other sectors it would seem that the framework might be flawed at detecting whether promotion of one sector can lead to overall economic growth.

Several authors suggest that endogeneity issues have not been adequately dealt with, though re-estimation of models using a simultaneous equations estimation principle does not typically change the outcome. More seriously, it is typically recognized that these studies fail to distinguish between statistical association and statistical causation, though the cross-country researchers often recognize this. For example, Ram (1985:416) notes that it is evidently important to be able to make a reasonably satisfactory transition from statements about the correlation patterns to some judgements about the causal structure . Effectively, these studies take positive associations as evidence of causation. Cross-country regressions provide little insight into the way the various right-hand side variables affect growth and the dynamic behaviors within countries; given the possible simultaneity involved in such models the positive association is as compatible with GLE as with ELG or feedback effects. Further, both output and exports could be causal with another set of unspecified variables. That reverse causation or feedback is not allowed for can lead to inconsistent decision rules.

In addition, these models have typically implicitly assumed that the regression parameters are constant across countries; that is, production functions and the degree of factor differentiation between factor productivities in different sectors are assumed everywhere the same. Such studies do not allow for differences between countries in their institutional, political, financial structures and in their reactions to external shocks that may be important even when the samples chosen consider countries that according to some criteria (e.g., income) may appear homogeneous. This shortcoming is often noted; e.g., Helleiner (1986), Feder (1983). Some authors estimate random coefficient models (e.g., Amirkhalkhali and Dar, 1995) while others (e.g., De Gregorio, 1992) estimate random effects panel models as ways to overcome this criticism. Many of the cross-country studies also use averaged growth rates, which may introduce mis-specifications and parameter instabilities (see McDonald and Roberts, 1996), as the averages ignore changes that have occurred over time for the same country.

The recognition of these described potential difficulties with this cross-sectional research in attempting to examine for ELG has led to the third group of studies that formally test for causality. We consider this research in the next section.

3.2. Time series causality studies

The most prevalent causality approach is grounded in Granger=s (1969) work, which builds on earlier research by Weiner (1956). The notion is one of predictability being synonymous with causality, and is based on the idea that a cause cannot come after an effect. Of the time series studies detailed in Table A2, 74% use some form of Granger=s causality to test for ELG; the other 26% use time series data to estimate regression models that do not incorporate dynamic effects. Granger's approach is atheoretical in the sense that no attempt is made to incorporate economic theory to impose any a priori restrictions upon the relationships between the variables of interest to the researcher. We say that y causes x if relevant available past information allows us to predict x better than when past information except y is used. We spend time here defining causality more rigorously than usual in applied studies as it enables weaknesses of the idea to be quite obvious, and it makes a comparison between systems of different dimensions more straightforward.

More formally, let Ω_t be the information set containing the relevant information available up to and including the time period t; let $x_t(1|\Omega_t)$ be the optimal (minimum mean squared error (MSE)) 1-step predictor of x_t at time t, based on the information in Ω_t; let $M_x(1|\Omega_t)$ denote the resulting 1-step forecast MSE. Then, y_t is said to Granger-cause x_t one-period ahead if, in the matrix sense, $M_x(1|\Omega_t) < M_x(1|\Omega_t$ excluding$\{y_s|s\#t\})$, where Ω_t excluding $\{y_s|s\#t\}$ is the set containing the relevant information except that pertaining to the past and present of y_t. There are many critics of this concept; this is not surprising as predict is not akin to force , which is philosophically more parallel to cause . Zellner (1979) for instance, argues against it on admissibility grounds. The definition of the *relevant* information set is problematic, and typically, attention focuses on the (potentially) restrictive class of optimal linear predictors. Nevertheless, Granger=s concept of causality is popular in an empirical world that searches for means to statistically ascertain directions of causality and the strength of any such relationships.

Three time series approaches dominate the applied literature investigating ELG: formal tests of restrictions, generation of impulse response functions (IRFs) and consideration of forecast error variance decompositions (FEVDs). In order to define the links between the three, we initially suppose that a K-dimensional stable[4] process z_t possesses a moving average representation of the form:

$$z_t = \mu + \sum_{i=0}^{\infty} \phi_i u_{t-i} = \mu + \phi(L)u_t , \quad \phi_0 = I_K \qquad (1)$$

where ϕ_i, i\$0, are KHK absolutely summable matrices, $\phi(L) = \sum_{i=0}^{\infty} \phi_i L^i$ is a matrix in the lag operator L, u_t is a white noise process with nonsingular covariance matrix Σ_u. Suppose z_t is partitioned as $z_t = (x_t^T, y_t^T)^T$, where x_t has dimension K_1, y_t has dimension K_2 and $K_1+K_2=K$. Note that all variables in the system will be involved in the GNC under study. Partitioning the MA representation accordingly, we write (1) as:

$$z_t = \begin{bmatrix} x_t \\ y_t \end{bmatrix} = \begin{bmatrix} \mu_1 \\ \mu_2 \end{bmatrix} + \begin{bmatrix} \phi_{11}(L) & \phi_{12}(L) \\ \phi_{21}(L) & \phi_{22}(L) \end{bmatrix} \begin{bmatrix} u_{1t} \\ u_{2t} \end{bmatrix} \qquad (2)$$

from which it follows that for forecasting x_t 1-step ahead, y_t Granger noncauses x_t if $\phi_{12,i} = 0$ for i = 1,2, ... We write this as 1-step $y_t \nrightarrow x_t$. Note that 1-step $y_t \nrightarrow x_t$, given the information set, is equivalent to 1-step $y_{jt} \nrightarrow x_t$, j=1,...,K_2; 1-step $y_t \nrightarrow x_{it}$, i=1,...,K_1; and 1-step $y_{jt} \nrightarrow x_{it}$, j=1,...,$K_2$ and i=1,...,K_1: Dufour and Renault (1998), Proposition 2.1.

The MA representation leads directly to the IRFs and FEVDs, concepts pioneered by Sims (1980, 1982). Suppose we desire the response of x_t (or one of its elements) to an impulse from y_t (or one of its components); that is, we wish to describe the time path on x_t from a shock or innovation in y_t. This is the IRF and, in the setup we have described, is given by the MA components; see, Lütkepohl (1993: 43-56). The impulse responses are then zero if one of the variables does not Granger-cause the other variables taken as a group. For example, in a bivariate system consisting of export growth and GDP growth the IRF function from an innovation in export growth will consist of zero effects when there is no ELG in the Granger sense. Conversely, to continue this example, statistically significant non-zero impulse responses suggest Granger-causality, *in the system we are currently describing.*

One problem with this treatment is that it follows from an innovation in only one variable, which may be unrealistic as variables in the system are unlikely to be independent so that shocks in one variable are likely to cause shocks in other variables, due to error term correlations. Consequently, most IRFs are generated by appropriately orthogonalizing to give uncorrelated errors. Unfortunately, no unique decomposition is possible and ordering of the variables matters. This may limit a linking between IRFs and Granger-causality in practice.

The FEVDs also arise from the MA representation of the system. We suppose that the error terms in (1) or (2) are uncorrelated, or that the system has been appropriately orthogonalized. The h-step forecast MSE for the j-th variable in z_t is given by: $\mathrm{MSE}(z_{j,t}(h)) = \sum_{i=0}^{h-1} \sum_{k=1}^{K} \phi_{jk,i}^2 = \sum_{k=1}^{K} \omega_{jk,h}$ where $\phi_{jk,i}$ is the jkth element of ϕ_i and $\omega_{jk,h}/\mathrm{MSE}(z_{j,t}(h))$ is the proportion of the h-step forecast error variance of variable j accounted for by innovations in variable k - the so called FEVDs. In a system consisting of two variables (or vectors) y_t and x_t, Granger-noncausality, denoted as GNC, implies that the FEVD of y_t, for instance, accounted for by the innovations of x_t must be zero. Conversely, in such a system, a significant non-zero FEVD implies causality in the Granger sense. However, orthogonalizing the error terms may result in non-zero FEVDs even when there is GNC.

Assuming that z_t is invertible, we can rewrite (1) and (2) as a vector autoregressive (VAR) model, which could be of order infinity, but for our purposes we assume is of finite order p:

$$z_t = \begin{bmatrix} x_t \\ y_t \end{bmatrix} = \begin{bmatrix} \nu_1 \\ \nu_2 \end{bmatrix} + \sum_{i=1}^{p} \begin{bmatrix} \theta_{11,i} & \theta_{12,i} \\ \theta_{21,i} & \theta_{22,i} \end{bmatrix} \begin{bmatrix} x_{t-i} \\ y_{t-i} \end{bmatrix} + \begin{bmatrix} u_{1t} \\ u_{2t} \end{bmatrix} \qquad (3)$$

from which 1-step $y_t \nrightarrow x_t$ follows if $\theta_{12,i} = 0$ for i = 1,2, ... p. Examining the validity of these exclusion restrictions, using likelihood ratio (LR), Wald and F-tests, is the typical method adopted to test for GNC.

Many of the studies in Table A2 examine for GNC within bivariate and higher order systems; allowing for this, 57% undertake bivariate analyses and of these, all but one, examine for GNC via restrictions tests on the AR representation. The implication of this discussion is that for these studies similar GNC results would have been obtained via the MA representation (subject to the remarks on orthogonalization).

Most of this discussion is couched in terms of 1-step GNC. For a bivariate or bivector system we can proceed directly to h-step GNC, h=1,2...4; i.e., when z_t is partitioned as $z_t = (x_t^T, y_t^T)^T$, the following three statements are equivalent (Dufour and Renault, 1998, Proposition 2.3): (i) 1-step $y_t \nrightarrow x_t$; (ii) h-step $y_t \nrightarrow x_t$, œ h; (iii) 4-step $y_t \nrightarrow x_t$. The presence of GNC one-period ahead is a necessary and sufficient condition for GNC at all horizons. Thus, for the bivariate studies in Table A2 the causality results are implicitly for all horizons and not simply 1-step ahead, as some authors suggest.

We now extend our discussion to allow z_t to be partitioned into three subvectors as $z_t = (x_{1t}^T, x_{2t}^T, x_{3t}^T)^T$, where x_{st} has dimension $K_s\$1$, s=1,2,3 and $\sum_{s=1}^{3} K_s = K$. We consider GNC from x_{1t} to x_{2t}; in this system there are auxiliary variables in x_3 employed for prediction, but not involved in the GNC study. We write the MA representation and corresponding VAR(p) process, assuming invertibility, respectively as:

$$z_t = \begin{bmatrix} x_{1t} \\ x_{2t} \\ x_{3t} \end{bmatrix} = \begin{bmatrix} \mu_1 \\ \mu_2 \\ \mu_3 \end{bmatrix} + \begin{bmatrix} \phi_{11}(L) & \phi_{12}(L) & \phi_{13}(L) \\ \phi_{21}(L) & \phi_{22}(L) & \phi_{23}(L) \\ \phi_{31}(L) & \phi_{32}(L) & \phi_{33}(L) \end{bmatrix} \begin{bmatrix} u_{1t} \\ u_{2t} \\ u_{3t} \end{bmatrix} \qquad (4)$$

$$z_t = \begin{bmatrix} x_{1t} \\ x_{2t} \\ x_{3t} \end{bmatrix} = \begin{bmatrix} \nu_1 \\ \nu_2 \\ \nu_3 \end{bmatrix} + \sum_{i=1}^{p} \begin{bmatrix} \theta_{11,i} & \theta_{12,i} & \theta_{13,i} \\ \theta_{21,i} & \theta_{22,i} & \theta_{23,i} \\ \theta_{31,i} & \theta_{32,i} & \theta_{33,i} \end{bmatrix} \begin{bmatrix} x_{1,t-i} \\ x_{2,t-i} \\ x_{3,t-i} \end{bmatrix} + \begin{bmatrix} u_{1t} \\ u_{2t} \\ u_{3t} \end{bmatrix} . \qquad (5)$$

Then, 1-step GNC from x_{1t} to x_{2t}, 1-step $x_{1t} \nrightarrow x_{2t}$, results when $\theta_{21,i} = 0$, i=1,...,p. However, when $K_3\$1$, this does not correspond to $\phi_{21,i} = 0$, i=1,2,...in the MA representation (4); Dufour and Tessier (1993). That is, 1-step $x_{1t} \nrightarrow x_{2t}$ in the AR characterization is compatible with an innovation of x_1 resulting in significant impulse responses and FEVDs for x_2. Dufour and Tessier (1993) show that the exclusion restrictions $\theta_{21,i} = 0$, i=1,...,p in the AR form correspond to nonlinear restrictions in the MA representation that depend on not only the impulse responses on the innovations of x_1 on x_2, but also those of x_1 on x_3, those of x_3 on x_2 and the own impulse responses of x_3. Conversely, from the MA representation zero impulses from an innovation on x_1 to x_2 ($\phi_{21,i} = 0$, i=1,2,...)implies nonlinear restrictions on the coefficients of the VAR(p) process involving the parameter matrices θ_{21}, θ_{23}, θ_{33} and θ_{31}. So, even if the IRFs and FEVDs suggest noncausality there may still be Granger-causality in the AR representation. Consequently, in a system that uses auxiliary variables for prediction purposes, which are not involved in the GNC question, the MA and AR representations do not yield equivalent notions of GNC. This is important when comparing the results in Table A2 as 43% of the causality analyses employ a trivariate or higher-order system and of these 37 studies, 6 consider IRFs or FEVDs while the rest apply restrictions tests from the AR representation. For instance, Riezman et al. (1996) use annual data within a trivariate system and find many differences between the causality results from the AR and MA representations.

In the auxiliary variable system, can we extend these results directly from 1-step to h-step, h=1,2…? Unfortunately, the answer is typically "no". In multivariate models where auxiliary variables (x_3) are used, it is possible that x_1 does not 1-step Granger-cause x_2, but can still help to predict x_2 several periods ahead; e.g., Sims (1980) and Dufour and Renault (1998). For example, x_1 may help to predict x_2 two periods ahead, even though it is 1-step noncausal, because x_1 may 1-step cause x_3, which in turn 1-step causes x_2. Clearly, our notions of causality should incorporate such indirect effects at longer horizons but the currently applied methods do not[5]. Consequently, care is needed when interpreting GNC in a multivariate system, incorporating additional variables, as opposed to a bivariate system. Indirect effects are real possibilities in an exports-economic growth system and are not allowed for in the currently used methods of detecting causality. When studying Table A2 it is important to note this point, as it implies that differences between the bivariate and higher-order systems may be a facet of the implicit time horizons of the GNC tests involved, as well as differences due to information set. In the higher-order systems, do we expect causality to be limited to one-period ahead effects?

This section highlights the clear differences in interpreting GNC in a bivariate or bivector system and in a system that does not involve all variables in the GNC test. These distinctions have not been recognized by the ELG empirical researchers and may well go some distance to explain many of the apparent conflicts in the literature. We now provide some other sources of difficulties.

1. Definition of the information set: The determination of the *relevant* information set leads to one common source of difficulty in a GNC study. Aggregation of the data may also make a difference. When an annual system is found to have GNC from exports to GDP it need not follow that quarterly exports has no impact on quarterly GDP. Likewise, employing seasonally adjusted variables in the information set may not produce the same causal outcome as using seasonally unadjusted variables. An illustration from Table A2 is testing for GNC in Australia. Arnade & Vasavada=s (1995) study, which examines for causality in a trivariate system involving annual data on real agricultural output and agricultural exports, suggests noncausality; ELG is put forward by Paul & Chowdhury (1995) with annual data on real GDP and exports in a bivariate study; Bodman (1996) uses quarterly, seasonally adjusted data on manufacturing output and exports in a bivariate examination and detects evidence for ELG; Karunaratne (1996) detects ELG when using quarterly seasonally adjusted data in a 4-variable system with real GDP per capita and exports per capita; noncausality arises from the Pomponio (1996) bivariate investigation involving annual data on manufactured output and exports; Riezman et al.=s (1996) analysis with annual data on GDP and export growth suggests GLE in their bivariate model, but noncausality in their trivariate system; Karunaratne (1997) in an expanded 6-variable study with quarterly, seasonally adjusted data reports evidence supporting bidirectionality while Shan & Sun (1998a) in a 5-variable system with quarterly, seasonally adjusted data assert evidence for GLE. The varying outcomes may well be due to different information sets as well, as dissimilar time periods and methods.

2. Estimation and lag-order selection: Let z_t be a stable, K-dimensional VAR(p) process with white noise disturbances u_t and with fourth moments of u_t that exist and are bounded. Estimation of the parameters of the VAR(p) model by least squares, denoted as LS, with common lag structure p, is equivalent to seemingly unrelated regression estimation and the LS estimator of the VAR parameters is consistent and asymptotically normal. Consequently, a Wald (or LR) test statistic for the validity of exact linear restrictions has a limiting null χ^2 distribution with degrees of freedom equal to the number of restrictions under test. If the MA parameters are estimated recursively from the VAR coefficients and error covariance matrix, then it follows that the resulting MA estimators are also consistent and asymptotically normal; Lütkepohl (1993: Sec. 3.7).

Consequently, the estimated impulse responses are asymptotically normal.

Typically the VAR lag order is unknown. The usual approach is to either adopt an arbitrarily assigned value or to employ a databased method; e.g., an information criterion. The choice of the lag length is important to avoid incorrect GNC conclusions. The finite-sample behavior of lag length determination methods (using information theoretic criteria as well as sequential testing approaches) has been studied theoretically and via simulation experiments; in this context, >behavior=is to be understood in the sense of maximizing the frequency of fitting a model with the true lag order. Our survey of the ELG studies in Table A2 suggests that presetting the lag order and a group of model selection criteria are typical. The impact of always under-specifying or over-specifying the lag order on the size and power of GNC tests on the VAR parameters is evaluated by Toda and Phillips (1994), Dolado and Lütkepohl (1996), and Zapata and Rambaldi (1997). These results suggest that there can be serious distortions in presetting the lag order with parsimony not recommended. Giles and Mirza (1999), in their Monte Carlo investigation of the properties of GNC tests, allow for the lag order to be selected by sequential testing methods and two information criteria: Schwarz=s (1978) criterion (SC) and Akaike=s (1969) Final Prediction Error (FPE) criterion. The findings of Giles and Mirza indicate some preference for the SC in lower dimensional systems, but perhaps the FPE in larger systems. Typically, the distortions involved in applying databased lag order selection methods are not as serious as those involved in always under- or over- specifying the lag order.

Our discussion of lag selection methods is brief as the currently available Monte Carlo evidence suggests that the impact of a different databased selection criteria on the empirical size and power of GNC tests is relatively minor. Overestimation of the lag-order seems preferable. This may suggest use of criteria such as Akaike's (1973) Information Criterion (AIC) or the FPE criterion, rather than the SC or the Hannan and Quinn (1979) criterion (HQ), as the former move away from the lowest possible lag order at a slow rate as the sample size increases.

<u>2. Nonstationarity:</u> We have so far limited our attention to stationary, stable systems. This excludes trends, and shifts in the means or covariances or seasonal patterns. However, we may expect the VAR to have nonstationary elements (unit roots and possibly cointegration). These characteristics do not alter the definitions of GNC either within the AR or MA representation, nor will the presence of unit roots change the relationship between VAR coefficients, IRFs and FEVDs. However, nonstationarity will alter the asymptotic distributional results of the LS estimators of the coefficients, which results in GNC test statistics that may not have standard asymptotic null distributions. These features led researchers to adopt differenced VAR models, denoted as VARD models, or vector error correction models, denoted by VECM; it matters, though, which method is adopted to deal with the nonstationarity.

For this discussion we suppose that a Wald test is employed to test the validity of the exclusion restrictions in an unrestricted levels VAR model, denoted as a VARL model; a GNC conclusion results from support for the null hypothesis. The asymptotic null distribution of the Wald test statistic depends on the time series features in the VARL system, as LS estimation of the VARL coefficients in the presence of unit roots is asymptotically efficient, but second-order biased. The usual Wald statistic for GNC may involve a singular covariance matrix that may result in a nonstandard asymptotic null distribution (Toda and Phillips, 1993, 1994), and a LS regression involving variables with unit roots may give rise to a spurious regression (Granger and Newbold, 1974). Correspondingly, the estimates of IRFs and FEVDs obtained from VARL models with unit roots are also inconsistent, as the estimates tend to random matrices; Phillips (1998). These features suggest that GNC testing should not be undertaken within a VARL model that may have unit roots (and cointegration), and nor should IRFs and FEVDs be generated from such models. Scholars responded by assuming explicitly that the time series under study were nonstationary and could be made stationary by differencing, or else they frequently incorporated preliminary tests for unit roots.

Engle and Granger=s (1987) paper changed the direction of empirical macroeconomics with their concept of cointegration and the associated VECM representation. To formalize this, we write the MA representation (1) in its VARL(p) form, noting that for simplicity we have removed deterministic components:

$$z_t = \theta(L)\, z_{t-1} + u_t \qquad (6)$$

where $\theta(L) = \sum_{i=1}^{p} \theta_i L^{i-1}$, with L the usual lag operator and θ_i, i=1,...,p are KHK parameter matrices. We assume that the system is initialized at t=p+1...0 and the initial values can be any random vectors including constants. Applying the first-difference operator Δ, (6) can be written as a VECM(p-1)

$$\Delta z_t = \Pi z_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta z_{t-i} + u_t \qquad (7)$$

where, $\Pi = -(I - \sum_{i=1}^{p} \theta_i)$, $\Gamma_i = -\sum_{j=i+1}^{p} \theta_j$ for i=1,2,...,p-1. We assume Δz_t is stationary and that all the roots of $\left| I - \sum_{i=1}^{p} \theta_i w \right| = 0$ lie outside the complex unit circle, except for possibly some unit roots. The nonstationary characteristics of z_t are determined from the rank of Π, which we denote as r. There are three possibilities: (i) r=K. Then, Π has full rank and z_t is integrated of order zero (I(0)) so that the VARL system is stationary. (ii) r=0. Then, Π is the null matrix so that $z_t \sim I(1)$ with noncointegration, and the VARL system is nonstationary. (iii) 0<r<K. Then, Π is of reduced rank and it can be decomposed as $\Pi = \alpha\beta^T$, where α and β are full-rank KHr matrices. The cointegrating matrix is β as $\beta^T z_t$ is stationary, and α measures the rate of adjustment of the process z_t to the disequilibrium error. This system has (K-r) unit roots and r cointegrating vectors. In this case the VARL model may sometimes still be used for valid Wald testing of the GNC null hypothesis. Likewise, the VECM (7) may provide a means to consistently estimate the VAR coefficients, the IRFs and FEVDs and for valid testing of the GNC null.

When there is cointegration, Toda and Phillips (1993, 1994) show that the Wald test for GNC in the VARL(p) model will have its standard limiting χ^2 null distribution when there is sufficient cointegration with respect to the causal effects being tested. Explicitly, given z_t partitioned as $z_t = (x_{1t}^T, x_{2t}^T, x_{3t}^T)^T$, we suppose we wish to test 1-step $x_{3t} \nrightarrow x_{1t}$ from the AR model. Cointegration is then sufficient (Toda and Phillips, 1993, Corollary 1) if rank(β_3) = K_3, where β_3 is the last K_3 rows of the cointegrating matrix β; e.g., the presence of cointegration is always sufficient in a bivariate system, so that estimation, and testing for GNC, may be undertaken using a VARL model. The mere presence of cointegration in a trivariate or higher-dimensional system is not sufficient for valid use of a VARL model; there must be adequate cointegration of the right sort! Insufficient cointegration results in the VARL model's Wald statistic for GNC having a nonstandard limiting distribution that may depend on nuisance parameters. Unfortunately, Toda and Phillips are unable to provide a satisfactory means of testing the rank condition on β_3 for sufficient cointegration. Consequently, attention has focused on testing for GNC using the VECM. Note, first, that when there is noncointegration, (7) reduces to a classical first-differenced VAR, a VARD(p-1) model. Second, note that estimation of a VARD(p-1) model when there is cointegration involves a misspecification; the omission of the relevant cointegration information.

Under our assumptions, (7) is a stable, stationary system and the GNC exclusion restrictions on

(6) map directly to restrictions on the appropriate elements of Π, $\Gamma_1 \ldots \Gamma_{p-1}$. Suppose we estimate the VECM by the maximum likelihood method suggested by Johansen (1988). Then, (Toda and Phillips, 1993, 1994) the Wald statistic of the null hypothesis for 1-step $x_{3t} \not\rightarrow x_{1t}$ on the VECM parameters will have its limiting χ^2 distribution provided rank(α_1)=K_1 or rank(β_3)=K_3, where α_1 is the first K_1 rows of α; i.e., again any cointegration must be of an appropriate kind. The presence of cointegration is sufficient in the bivariate system, but for higher-dimensional systems the causal variables must be adequately involved in the cointegration. Nuisance parameters and nonstandard distributions enter the limit theory when either of the rank conditions is not satisfied. Toda and Phillips provide sequential testing strategies for examining for sufficient cointegration in the VECM.

Given the uncertainties of testing for GNC within a VARL model, the usual route taken is to apply the following pretesting strategy: 1. Test for unit roots. 2a. We estimate a VARL model when z_t is deemed stationary, and we use this model to undertake the GNC test. 2b. We test for cointegration when z_t is determined nonstationary. 3b(i). When no cointegration is found, we estimate a VARD model and proceed to the GNC examination. 3b(ii). When cointegration is detected, we study GNC within a VECM or VARL model. None of the papers in Table A2 examine whether any cointegration is sufficient, but theoretically from Toda and Phillips 3b(ii) should indeed be: 3b(ii) When cointegration is detected, we test for sufficient cointegration, and we subsequently appropriately test for GNC (see Toda and Phillips, 1993, 1994). Of the papers in Table A2, 54% applied variants of this sequential testing strategy, but it is fraught with potential problems. For instance, it is well known that typically applied unit root and cointegration tests suffer from size distortion and often have low power, which implies that we may often not be using the right model for the GNC test. Giles and Mirza's (1999) Monte Carlo study on the properties of GNC procedures indicates that often this pretesting route is not satisfactory, as it can lead to severe over-rejection of a noncausal null; often more so than when using a VARL model, even when the processes are nonstationary! That is, pretesting for nonstationarity before the GNC test can often lead to wrong conclusions of causality. Their results also demonstrate that the method used to pretest for nonstationarity is crucial; the underlying problem is one of accuracy of determining the cointegrating rank.

What does this imply for IRFs and FEVDs from VECMs? Phillips (1998) shows that the VECM will produce consistent and asymptotically normal estimates of the IRFs and FEVDs, provided that the cointegrating rank is correctly specified or consistently estimated[6]. However, there is only limited Monte Carlo evidence on the finite sample performance of the pretesting strategies on the properties of the estimates of the IRFs and FEVDs.

Are there alternative approaches? Toda and Yamamoto (1995) and Dolado and Lütkepohl (1996), hereafter denoted by TYDL, propose a technique that avoids the preliminary tests for unit roots and cointegration, and it is applicable irrespective of the integration or cointegration present in the system. The aim is to remove the singularity involved in the asymptotic distributions of the LS estimators by fitting an augmented VARL process whose order exceeds the true order by the highest degree of integration in the system. We estimate an VARL(p+1) when the highest degree of integration in the system is one and the true lag order is p, irrespective of the presence of cointegration. The test for GNC then involves only the first p lags as the (p+1)'th coefficients are zero when they are indeed redundant; in this case the Wald test statistic for GNC maintains its limiting χ^2 null distribution. The cost of redundant information is efficiency and power losses, though available Monte Carlo evidence suggests that the power losses for the Wald GNC test are relatively minor in trivariate or higher-order systems, for moderate to large sample sizes (say greater than 100), and for systems in which the true lag order is large. The study undertaken by Giles and Mirza (1999) also shows that this augmented lags method performs consistently well over a wide range of systems including near-integrated, stationary and mixed integrated and stationary systems; cases for which the pretesting approaches tended to over detect causality.

There are seventy-four investigations in Table A2 that employ some form of VAR model to explore for causality between exports and economic growth. Of these, 10% adopt a VARL model without pretests for nonstationarity; a VARD model without pretests for nonstationarity is considered by another 30%; 3% (i.e., 2 studies) apply some other operator to transform the data without nonstationarity pretests; 54% use the pretesting strategy outlined above (but no study tests for sufficient cointegration); while only 4 studies apply the augmented lags method proposed by TYDL. The analyses that employ VARL models in the raw data may well suffer from spurious regression problems, as the series under study are typically believed to be nonstationary, and consequently incorrect null distributions have been used for the GNC tests. Likewise, the application of VARD models may be misspecified when the series are cointegrated, as potential causality from the long-run relationship has been omitted. The majority of studies that adopt a pretesting approach typically estimate a VECM or a VARD model, depending on the outcome of prior tests for unit roots and cointegration. Of those that specified their pretesting methods, most applied the Augmented Dickey-Fuller (ADF) test (Dickey and Fuller, 1979, 1981; Said and Dickey, 1984) as the unit root pretest, and either Engle and Granger=s (1987) ADF test or a variant of Johansen=s likelihood ratio procedure for the cointegration test. Unfortunately, these methods can often lead to incorrect conclusions. We explore the sensitivity of ELG results to the procedure used in our sequel paper.

3. Deterministic terms: This is an important question that is ignored by virtually all of the studies in Table A2[7]; what deterministic trend degree should be used? Does it matter for GNC testing? Needless to say, it matters and the economic implications differ. This too is an issue we address in our sequel paper, and so we defer any further discussion on this matter in this paper.

3.3 ELG empirical time series studies

In the last section we provided some information about the time series techniques used to test for ELG and we briefly mentioned some empirical work. We present further details in this section. We would ideally like to provide a country-by-country description, but as this is infeasible, we concentrate on discussing two countries in detail to illustrate the spectrum of results that have been obtained: South Korea[8] and Japan, both of which are extensively represented in Table A2.

3.3.1 South Korea

There are thirty-seven empirical works detailed in Table A2 that examine for the relationship between exports and economic growth in South Korea. Of these, eleven estimate a form of aggregate production function model, while the others examine for GNC via a VAR framework. The former studies include bivariate and multivariate analyses with the multivariate work attempting to account for other factors that may contribute to economic growth, including investment, government spending, and population/employment growth. The aggregate production studies employ annual data and of these, eight authors report a significant export/economic growth effect, while the others detect no significant relationship. A sensitivity analysis may be helpful to detect the reasons behind some of the conflicting results. Two of the papers that did not discern a significant relationship, investigate per capita economic growth and the third (Salvatore and Hatcher, 1991) includes as a regressor real industrial production growth; these features may be those that distinguish these disssenting studies from the others. The Salvatore and Hatcher result may be supportive of the view expressed by Sheehey (1990) that the positive correlation occurs with other categories of economic activity and, consequently, this aggregate approach may not be a fruitful way to isolate the impact of one particular sector on economic activity. The data period does not seem to be a determining factor, as the three non-supportive applications employ time spans similar to some of the supportive papers.

Typically, the production function type regressions are estimated in terms of growth rates or first differences of the variables, which are likely to be stationary representations of the series. Consequently, these regressions are not estimating long-run relationships. Many of the criticisms of the aggregate production function approach outlined in section 3.1 also apply here: the accounting identity problem, endogeneity and specification issues, and the distinction between statistical association and causation. The observed significant correlations are compatible with ELG, GLE or bidirectional (BD) causality.

Turning to the VAR research, the four cases of ELG, GLE, BD and NC (noncausality) are all represented! Only six of these twenty-six studies use quarterly data. Interestingly, the six quarterly studies reach the same conclusion of BD causality. Restrictions tests on the VAR coefficients are undertaken by the four bivariate quarterly applications, while one multivariate quarterly analysis evaluates FEVD and IRFs from the moving average representation derived from the estimated autoregressive model, and the other study uses the TYDL augmented VARL approach. Accordingly, except for this latter work, these papers are effectively considering more than one-period ahead causality. The bivariate investigation of Gupta (1985) uses a Sims= test rather then the Granger test we outlined in section 3.2. The basis of Sims=test is that the vector y can be expressed as a distributed lag function of current and past values of the vector x with a residual that is not correlated with any values of x, past or future, if and only if, y does not cause x in Granger=s sense. We can test this via a regression of y on past and future values of x with the outcome of causality supported when we reject the null hypothesis that the parameters for the future values of x are simultaneously zero. Sims=test and Granger=s test may not give the same causality outcome but do so here. All of the studies, except Gupta (1985), model effectively with the growth rates of real GDP and exports; Gupta uses an alternative transformation to obtain stationarity[9]. Only two of the papers undertake preliminary tests for cointegration with both applying the EG-ADF test and arriving at contrasting conclusions. This could be due to different information sets, including time periods. Several methods are adopted to determine the lag structure, such as the FPE criterion, a specific to general approach and presetting the lag order, and various time periods are covered. Even given these differences, we observe a common outcome of bidirectional causality between exports and economic activity.

Robustness is not a feature of the annual investigations. There we find support for ELG from seven studies: four cases determine GLE; five applications report BD causality and the remaining ten studies advocate NC. (Note that several examinations employ more than one procedure.) In analyzing this literature the reader should note two points. First, several authors seem to believe that there can be no ELG when there is noncointegration, and, consequently, conclude that there is noncausality in these cases. However, causality can arise from the short-run dynamics as well as from the long-run relationship. Secondly, some papers detect cointegration within a bivariate framework and then report GNC, which is not a feasible outcome within the error correction framework, as (linear) cointegration implies (linear) Granger-causality in at least one direction in a bivariate system. This need not follow in a multivariate system, as the cointegrating relationship(s) need not involve the variables in the GNC test.

Bivariate studies dominate the annual South Korean analyses with only eleven trivariate or higher order systems. The information set and method seem to matter; e.g., Riezman et al. (1996) report GLE from their bivariate analysis, ELG from one trivariate (with real import growth) method, GLE from another trivariate method, but NC from their 5-variable study of South Korea over the same time period. We consider now the bivariate investigations for which there are some commonalities. Several studies adopting similar time spans covering the late 1950s to mid 1980s, report noncausality with each effectively applying a VARD model in the log-levels of real GDP and exports (without pretests for cointegration). These models are misspecified if there is a long-run relationship between exports and GDP, as the causality effect from that long-run relationship is missed. Dutt and Ghosh (1996) and Kugler and Dridi (1993) propose that there is cointegration between these two variables, though Dutt and Ghosh (1994), who adopt an alternative cointegration test, do not support this conclusion. These differences explain some of the variation in the outcomes for the bivariate cases. Method matters as well; e.g., Hsiao (1987) reports BD causality from Sims approach, but NC from the Granger test. Time period may also be relevant; e.g., Hodman and Graves (1995) determine BD causality from a bivariate VARD over the period 1953:1990 applying Granger=s test in contrast to the similar models above that detected NC.

Turning to the multivariate investigations, it is difficult to determine the reasons behind the various outcomes. Four papers use VARD models without pretests for cointegration, and each employs different sets of variables as well as time periods: two studies report NC, one ELG and the other BD causality from 1-step ahead Granger exclusion restriction tests. These models are misspecified when there are one or more cointegrating relationships. Riezman et al. (1996) likewise conclude ELG from their trivariate FEVDs, but GLE from an alternative approach to causality testing suggested by Geweke (1984). In a 5-variable system their results suggest NC, and so their analysis describes ELG, GLE and NC effects for South Korea depending on method and information set! Three of the South Korean multivariate studies pretest for cointegration with two applying Johansen=s maximum likelihood approach and reaching opposite conclusions, though each considers a different specification for the deterministic trend terms. The EG-ADF approach is also employed in the 7-variable system of Ghatak (1998) to conclude support for cointegration and evidence for ELG. Ghatak reports the same outcome from a Bayesian VAR procedure, but not from a VARL model. The latter result may be driven by misspecification of the null distribution of the GNC test statistic in the nonstationary system, as there is no discussion of whether the cointegration is sufficient or not.

3.3.2 Japan

Twenty studies are outlined in Table A2. Of these: four are OLS production function analyses while a VAR framework is adopted by the other applications; six of the VAR investigations estimate VARD models without prior testing for cointegration; five studies undertake a pretest for cointegration before deciding whether to employ a VARD or VECM (or VARL) model; FEVD=s from VARD models are reported in two papers; three VAR applications base their conclusions for ELG solely on whether cointegration is present or not; and one paper examines the TYDL augmented lags method of testing for GNC from the augmented VARL model. Three of the four production function papers determine that there is no significant relationship between export growth and economic activity. The data period covered is the key distinguishing feature between these cases and the sole production function study that detects a significant relationship; the latter are over the period 1885:1940 while the former investigations are from the late 1950s. The comments we raised in the previous section pertaining to the reliability of the results from these examinations apply equally well here. We refer the reader back to those remarks.

Seven VAR studies employ quarterly data with most covering the period from the late 1950s to the late 1980s and one examining for causality from the mid 1970s to the late 1990s. Bidirectional causality is the main outcome for the earlier time period and, unfortunately, the study that considered the more recent period only examined for unidirectional causality from exports to growth with no causality detected. Five of the applications explore for causality within a 4-variable framework with most concluding a BD result, which seems surprising as one might expect the 1-period ahead prediction requirement for quarterly data to be restrictive. An interesting comparison is available from the Sharma et al. (1991) and Marin (1992) papers. Both studies use the same time period and 4-variable Granger causality, though different information sets. Marin examines for GNC between labor productivity, defined as manufacturing output per employee, and real exports of manufactured goods, while Sharma et al. use the broader GDP and total exports. Marin detects cointegration and so tests for GNC within a VECM, while Sharma et al. use a VARD model without pretests. Marin determines BD whereas Sharma et al. only ELG. Are the outcomes due to variable differences and/or model specification? This comparison highlights the potential sensitivity of the GNC test outcome to the variable specifications and to the adopted method/model. We explore this further in our sequel paper.

The bivariate annual GNC investigations for Japan typically support GLE rather than BD causality, though Islam (1998) concludes ELG, Boltho (1996) reports that there is some evidence of BD causality when the subgroup of car exports is studied rather than total exports, and Pomponio (1996) detects NC between manufacturing output and exports growth. Islam=s result may be driven by variable differences, as he considers the proportion of export earnings in GDP and non-export GDP, while the other authors adopt real GDP and real exports. Variable definitions may explain Pomponio=s inconsistent outcome, as well as a shorter, more recent time period. Boltho=s result is important; very few cases disaggregate exports or GDP, and it makes sense that this might be a fruitful way to proceed.

Time periods overlap for the multivariate VAR investigations - 1952:80, 1950:90, 1961:87, 1965:85 and 1967:91. Further, the definitions of economic growth and export growth are dissimilar for the five multivariate Japan cases. For instance, Arnade and Vasavada (1995) determine GNC in their study with real agricultural output and agricultural exports, while Grabowski et al. (1990) propose ELG when using real GDP and exports along with three additional predictive variables. Consequently, it is not surprising that the causality results include ELG, GLE and NC. Some examinations detect cointegrating relationships while others do not. The ancillary variables range from import growth to a set comprising the share of non-defense expenditures in GDP, imports as a share of GDP and total investment share of GDP. Is there evidence to suggest 1-step ELG in Japan with annual data? Conditional on the details of the analysis, there does seem support for ELG in Japan.

4. Concluding Remarks

In this paper we have attempted to provide comprehensive information on the empirical research that investigates the export-led growth hypothesis, and to indicate the range of methods applied to examine this hypothesis. We are certain to have made omissions, but hopefully our survey is indicative of the dimension of the empirical literature. It is evident that there is no obvious agreement on the ELG debate. The early cross-country studies on ELG were favorable to the hypothesis, while there is little agreement among the time-series studies. The cross-country research is possibly flawed; in particular, the positive association that is taken as evidence of ELG is as compatible with GLE or feedback effects. The subsequent time series research attempts to rectify some of the issues with the cross-country work, but is itself fraught with problems. Conclusions regarding ELG are sensitive to many unknown features of the model including information set, lag order and nonstationarity characteristics. The GNC techniques commonly used to examine for causation between exports and overall economic activity are not robust; we illustrate this in our sequel paper. We recommend that applied researchers exercise extreme care when testing for GNC to avoid spurious results.

Our survey of the time series techniques used to test for ELG shows the exclusive use of linear VAR models, and yet the theory is available to eliminate many of the limitations of these models. For instance, it is well recognized that moving average (MA) processes are common in economic systems. Testing for GNC in such VARMA models involves nonlinear restrictions on the parameters, though in some instances sufficient conditions for GNC can be expressed as linear constraints; e.g., Lütkepohl (1993); Boudjelleba et al. (1994). Further, there are many nonlinear models that may be of interest; e.g., smooth transition threshold models (e.g., Ter@svirta, 1998), and regime switching VAR models (e.g., Warne, 1996, provides conditions for 1-step GNC in such models).

The majority of papers in our survey focus on broad macroeconomic data and yet there are grounds for attention to less aggregated variables. For instance, Fosu (1990), Giles et al. (1992), Boltho (1996), Ghatak et al. (1997) and Tuan & Ng (1998) detect different conclusions for sector decompositions than at the broad macro level. We believe that much could be learned about the export-led growth question by assessing micro-based data.

Further, we advise researchers to conduct a careful qualitative analysis prior to embarking on empirical statistical testing; for instance, Boltho (1996) and Tuan and Ng (1998). Noncausality methods do not allow for the heterogeneity and complexity of the historical changes in economic and institutional policies that are likely to impact on the export/economic growth nexus for a country over time. We reiterate comments from Kindleberger (1961: 305) We conclude, as we began, that expanding or contracting foreign trade... can have an impact on growth... but that the relationships between foreign trade and growth are varied and complex. This statement is still appropriate and we believe that statistical tests should be employed as supplementary information in an export-led growth examination. We need to remember that evidence for (Granger) causality is simply advocacy for an improvement in predictability and not for general economic development strategies.

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Appendix

Notes to Tables A1 & A2

PEG Statistically significant, positive, export-economic growth relationship.
ELG Export-led growth.
GLE Growth-led exports.
BD Bidirectional causality between the export variable & the economic growth variable.
NC Noncausality between the export variable & the economic growth variable.
LDC Less developed country.
NIC Newly industrialized country.
SPIN South Pacific island nation.
OLS Ordinary least squares estimation.
SEM Simultaneous equations model.
FIML Full information maximum likelihood estimation.
IV Instrumental variables estimation.
2SLS Two stage least squares estimation.
3SLS Three stage least squares estimation.
AUTO Feasible generalized least squares estimation allowing for first order serial correlation.
AR Autoregressive lag model with no lags of the dependent variable as regressors.
FB Fuller and Batesse (1974).
RC Random coefficient estimation to allow for country-specific coefficients.
GDP Gross domestic product.
GNP Gross national product.
Δ First differencing operator.
$VARD^2$ Second differenced VAR model.
BVAR Bayesian VAR model.
LR Likelihood ratio general to specific testing.
F F test of exclusion restrictions employed for the noncausality test; F distribution used as finite sample approximation for the null distribution.
Wald Wald test of exclusion restrictions employed for the noncausality test; χ^2 distribution used as finite sample approximation for the null distribution.

Akaike FPE Minimizing FPE used to examine the noncausality null hypothesis.

Rank-F See Holmes and Hutton (1990) for a discussion of the rank-F test for noncausality.

LM Lagrange multiplier test.

BIC Bayesian information criterion for lag selection.

FPE Akaike=s (1969) Final Prediction Error criterion for lag selection.

AIC Akaike=s (1973) Information criterion for lag selection.

SC Schwarz=s (1978) criterion for lag selection.

HQ Hannan and Quinn=s (1979) criterion for lag selection.

DF Dickey-Fuller unit root test. The terms in parenthesis report the deterministic terms incorporated in the integrating regression.

ADF Augmented Dickey-Fuller unit root test. The terms in parenthesis are the method used to choose the augmentation lag and the deterministic terms included in the integrating regression.

ZA Zivot and Andrews (1992) unit root test.

CRDW Cointegrating regression Durbin-Watson cointegration test.

EG-ADF Engle & Granger=s ADF cointegration test. The terms in parenthesis are the method employed to select the augmentation lag and the deterministic terms included in the integrating regression.

PO Phillips & Ouliaris (1990) cointegration test. The expressions in the parenthesis give the technique adopted to select the truncation lag and the deterministic components included in the integrating regression.

PP Phillips & Perron (1988) test. The expressions in the parenthesis give the technique adopted to select the truncation lag and the deterministic components included in the relevant regression.

JJ Johansen (1988, 1991) & Johansen & Juselius (1990) maximum likelihood cointegration test. The terms in the parenthesis report the procedure used for lag selection and the deterministic components included in the relevant regression with the cases as defined by Osterwald-Lenum (1992), among others.

CCR Canonical cointegrating regression of Park (1992).

KPSS Kwiatkowski et al.=s (1992) unit root test. The expressions in the parenthesis give the technique adopted to select the truncation lag and the deterministic components included in the integrating regression.

ACF Autocorrelation function.

CLF Conditional linear feedback.

EH Engle and Hendry (1993).

HER Engle et al. (1983).

TYDL Augmented lags method of Toda and Yamamoto (1995) and Dolado and Lütkepohl (1996).

Table A1 Cross-country studies of exports and growth

Authors:	Maizels (1963)	*Data*:	pooled - 7 developed countries, 1899:1959
Method:	rank correlation(averaged growth in manufacturing output and exports)		
Results:	PEG		
Authors:	Haring & Humphrey (1964)	*Data*:	pooled - 1950:60
Method:	OLS (level of GNP on exports in current prices)		
Results:	PEG		
Authors:	Emery (1967)	*Data*:	pooled - 50 countries, 1953:63
Method:	OLS (averaged growth in real GNP per capita on averaged growth in exports)		
Other variables:	growth in real current account earnings		
Results:	PEG		
Authors:	Maizels (1968)	*Data*:	pooled - 9 countries, 1950:62
Method:	OLS (level of GNP on level of exports)		
Results:	PEG		
Authors:	Syron & Walsh (1968)	*Data*:	pooled - 50 countries, 1953:63. 2 broad groups & then 3 groups by % of foodstuffs.
Method:	OLS (averaged growth in real GNP per capita on averaged growth in real exports)		
Results:	PEG for broad groups. Not significant for the group with large food exports.		
Authors:	Kravis (1970)	*Data*:	pooled - 37 non-oil exporting LDCs, 1950/52:63/65
Method:	rank correlation (averaged real GDP & export changes)		
Results:	PEG		
Authors:	Michalopoulos & Jay (1973)	*Data*:	pooled - 39 LDCs, 1960:69
Method:	OLS (averaged growth in real GDP on averaged growth in real exports)		
Other variables:	import to GNP ratio; labor force growth; domestic & external real investment		
Results:	PEG		
Authors:	Papanek (1973)	*Data*:	pooled - 34 countries for the 1950s; 51 countries for the 1960s. Also split into groups.
Method:	OLS (averaged growth in real GDP on export share of GDP or averaged export share per capita)		
Other variables:	averaged gross domestic savings as share of GDP; averaged net transfers received by government plus official long-term borrowings as share of GDP; averaged private investment as share of GDP; averaged other foreign inflows as share of GDP; averaged educational level; averaged size of the manufacturing sector.		
Results:	insignificant PEG		
Authors:	Voivodas (1973)	*Data*:	pooled - 22 LDCs, 1956:67
Method:	OLS (real GDP growth on real export share of GDP)		
Other variables:	country dummy variables		
Results:	PEG		
Authors:	Michaely (1977)	*Data*:	pooled - 41 countries, 1950:73 & sub-sample of 23 middle-income.
Method:	rank correlation (averaged per capita GNP growth and averaged growth of export share)		
Results:	PEG - minimum threshold of development needed before associated.		
Authors:	Balassa (1978a)	*Data*:	pooled - 11 semi-industrialized countries, 1960:66 & 1966:73
Method:	rank correlation (averaged growth in real GDP on averaged growth in real exports)		
Results:	PEG		
Data:	pooled - 10 semi-industrialized countries, 1960:66 & 1966:73		
Method:	OLS (averaged growth in real GNP on averaged growth in real exports)		
Other variables:	averaged labor force growth; averaged domestic investment as share of output; averaged foreign investment as share of output.		
Results:	PEG		
Authors:	Balassa (1978b)	*Data*:	pooled - 11 developing countries (Argentina, Brazil, Chile, Colombia, Mexico, Israel, Yugoslavia, India, Korea, Singapore, Taiwan), 1960:66 & 1966:73. 4 groups.
Method:	rank correlation (averaged growth of value added in manufacturing & incremental export-output ratios & also averaged growth of manufactured exports)		
Results:	PEG		
Method:	OLS (averaged growth in real GNP on averaged growth in real exports)		
Results:	PEG		

Table A1 Cross-country studies of exports and growth (continued)

Authors:	Heller & Porter (1978)	*Data*: pooled - 41 LDCs, 1950:73 & sub-sample of 24 middle-income.
Method:	rank correlation (averaged growth in per capita non-export real GDP on averaged growth in real exports)	
Results:	PEG - minimum threshold of development needed before associated.	
Authors:	Williamson (1978)	*Data*: pooled - 22 Latin American countries, 1960:74.
Method:	OLS (Δreal GDP on level of real exports (lagged))	
Other variables:	real foreign private direct investment inflows (lagged); other foreign capital (lagged)); country dummy variables.	
Results:	PEG	
Authors:	Balassa (1981)	*Data*: pooled - 12 NICs, 1960:66 & 1966:73.
Method:	rank correlation (averaged growth of exports+output for agriculture, manufacturing & total)	
Results:	PEG	
Method:	OLS (averaged real GNP growth on averaged real export growth)	
Other variables:	averaged labor force growth; averaged domestic investment as share of GNP; averaged foreign investment as share of GNP.	
Results:	PEG	
Authors:	Tyler (1981)	*Data*: pooled - 55 middle-income DCs, 1960:77. 2 groups.
Method:	rank correlation (averaged real GDP growth on averaged real export growth or averaged real manufactured export earnings)	
Results:	PEG	
Method:	OLS (averaged real GDP growth on averaged real export growth)	
Other variables:	averaged labor force growth; averaged growth in capital formation.	
Results:	PEG	
Authors:	Balassa (1982)	*Data*: pooled - 11 developing countries (Argentina, Brazil, Chile, Colombia, Mexico, Israel, Yugoslavia, India, Korea, Singapore, Taiwan), 1960:73.
Method:	rank correlation (averaged real GNP growth & averaged real export growth)	
Results:	PEG	
Authors:	Feder (1983)	*Data*: pooled - 19 countries & 32 countries, 1964:73.
Method:	OLS (averaged real GDP growth on averaged % share of changes in exports in GDP)	
Other variables:	averaged investment share of GDP; averaged population growth; foreign investment share.	
Results:	PEG	
Authors:	Salvatore (1983)	*Data*: panel - 52 developing countries, 1961:78. 3 groups.
Method:	4 equation SEM (FIML). Growth equation: growth of real per capita GDP on growth in the % of exports to GDP.	
Other variables:	in growth equation: gross fixed capital formation as % of GDP; industrial output as % of GDP.	
Results:	PEG	
Authors:	Balassa (1984)	*Data*: pooled - 10 countries.
Method:	OLS (averaged real GNP growth on averaged real export growth)	
Other variables:	averaged labor force growth; averaged domestic investment as share of output.	
Results:	PEG	
Authors:	Kavoussi (1984)	*Data*: pooled - 73 developing countries, 1960:78.
Method:	rank correlation (averaged real GDP growth on averaged merchandise exports growth)	
Results:	PEG	
Method:	OLS (averaged real GDP growth on averaged merchandise exports growth)	
Other variables:	averaged labor force growth; averaged investment growth.	
Results:	PEG	
Authors:	Balassa (1985)	*Data*: pooled - 43 developing countries, 1973:79.
Method:	OLS (averaged real GDP growth on averaged merchandise export growth & 1973 share of manufactured goods in real total exports or averaged % share of changes in exports in GDP)	
Other variables:	averaged domestic investment share of GDP; averaged labor force growth; foreign investment share; initial year per capita incomes.	
Results:	PEG	
Authors:	Kormendi & Meguire (1985)	*Data*: pooled - 47 countries, 1950:77.
Method:	OLS (averaged real aggregate output growth on averaged export to output ratio)	
Other variables:	per capita income; standard deviation of real output growth; averaged money supply growth; money supply shocks; averaged inflation growth; averaged population growth; averaged investment to income ratio; averaged government spending to output ratio. Also repeated with last variable excluded.	
Results:	no PEG for first regression; PEG when government spending regressor excluded.	

Table A1 Cross-country studies of exports and growth (continued)

Authors:	Jaffee (1985)	*Data*:	pooled - 80 & 63 LDCs, 1960:77.
Method:	OLS (averaged log real GNP per capita on averaged exports as share of GNP)		
Other variables:	initial year real GNP per capita; secondary school enrollment; population; domestic capital formation; natural resources index.		
Results:	PEG		
Authors:	Kavoussi (1985)	*Data*:	pooled - 52(51) developing countries, 1967:73 (1973:77).
Method:	rank correlation (averaged real GNP growth on averaged real exports growth as export orientation index)		
Results:	PEG		
Authors:	Ram (1985)	*Data*:	pooled - 73 LDCs, 1960:70 & 1970:77. 2 groups. Also as 43(42) primary-oriented countries.
Method:	OLS (averaged real GNP growth on averaged exports growth)		
Other variables:	averaged labor force growth; averaged investment as % of GDP; country dummy variables.		
Results:	PEG but ›strength=varies with external demand.		
Authors:	Helleiner (1986)	*Data*:	pooled - 23 low-income countries, 1960:79 & pooled - 24 African countries, 1960:79.
Method:	OLS (averaged real GDP growth on Δ in averaged export share of GDP)		
Other variables:	averaged labor force growth; averaged investment as share of output; import volume instability; change in mean import share of GDP.		
Results:	no PEG		
Authors:	Rana (1986)	*Data*:	pooled - 14 Asian LDCs, 1965:82, 1965:73 & 1974:82.
Method:	rank correlation (3-year averaged in nominal exports & output or output net of exports and repeated in real terms)		
Results:	PEG		
Method:	OLS (3-year averaged real output growth on 3-year averaged % share of changes in exports in output or 3-year averaged exports growth)		
Other variables:	3-year averaged investment share of output; 3-year averaged labor force growth; dummy variable for pre-1973.		
Results:	PEG		
Authors:	Gonçlaves&Richtering(1987)	*Data*:	pooled - 70 low-, middle- & high-income countries, 1960:81.
Method:	rank correlation (averaged real GDP growth on growth rate of exports (various definitions) and between growth rate of non-export GDP and growth rate of exports). Also OLS contemporaneous growth regressions.		
Results:	PEG from correlations but not between non-export GDP and exports. So, conclude PEG ›spurious=growth from elsewhere.		
Authors:	Rana (1988)	*Data*:	pooled - 43 countries, 1960:73 & 1973:81.
Method:	OLS & FB (ΔGNP between the initial (Yr_0)& terminal (Yr_T) years as % of Yr_0 GNP on Δmerchandise exports between the initial & terminal years as % of initial year GNP)		
Other variables:	sum of gross domestic investment from Yr_0 to Yr_T as % of Yr_0 GNP. Repeated with additional regressor of averaged export growthHexport share of GDP.		
Results:	PEG		
Authors:	Singer & Gray (1988)	*Data*:	pooled - 52/51 developing countries, 1967:73 ; 1973:77; & 1977:83.
Method:	rank correlation (averaged real GNP growth & averaged real exports growth)		
Results:	PEG for most groups; some insignificant.		
Authors:	Kohli & Singh (1989)	*Data*:	pooled - 31 countries, 1960:70 & 1970:81.
Method:	OLS (averaged real GDP growth on averaged % share of changes in exports in GDP; also quadratic export variable to allow for diminishing returns to exports)		
Other variables:	averaged investment share of GDP; averaged population growth; foreign investment share.		
Results:	PEG		
Authors:	Mbaku (1989)	*Data*:	pooled - 37 African countries, 1970:81 & 2 groups low- & middle income countries.
Method:	OLS (averaged real GNP growth on averaged real export growth)		
Other variables:	averaged labor force growth; averaged real investment growth or growth of investment as share of GNP		
Results:	PEG - stronger for middle-income countries. Second definition of investment results in no PEG for low-income group.		
Authors:	Moschos (1989)	*Data*:	pooled - 71 & split 13/58 developing countries, 1970:80.
Method:	OLS & IV switching regressions to allow for different relationships dependent on level of development (averaged real GDP growth on averaged real export growth)		
Other variables:	averaged real investment growth; averaged labor force growth.		
Results:	PEG		

Table A1 Cross-country studies of exports and growth (continued)

Authors:	Fosu (1990)	*Data*:	pooled - 28 African countries, 1960:70 & 1970:80.
Method:	OLS (averaged real GDP growth on averaged real merchandise exports growth)		
Other variables:	averaged investment share of GDP; averaged labor force growth.		
Results:	PEG		
Authors:	Otani & Villaneuva (1990)	*Data*:	pooled - 55 low-, middle-, & high-income developing countries, 1970:85.
Method:	OLS (averaged real GDP per capita growth on averaged real exports growth)		
Other variables:	averaged population growth; averaged ratio of domestic savings to GNP; averaged real interest rate on external debt; averaged budgetary share of expenditure on human capital.		
Results:	PEG		
Authors:	Sheehey (1990)	*Data*:	pooled - 36 countries, 1960:70.
Method:	OLS (averaged real GDP growth on averaged real exports growth or averaged % share of changes in exports in GDP)		
Other variables:	averaged investment share of GDP.		
Results:	PEG		
Authors:	Alam (1991)	*Data*:	pooled - 41 developing countries, 1965:73 & 1973:84.
Method:	OLS(averaged real GDP growth on averaged real export growth)		
Other variables:	averaged investment as share of real GDP; averaged labor force growth; dummy variables for trade regimes.		
Results:	PEG		
Authors:	Dodaro (1991)	*Data*:	pooled - 84 LDCs, 1965:70 & 1970:81.
Method:	OLS(averaged real GDP growth on averaged manufacturing exports as % of total merchandise exports or on export share defined by stage of processing)		
Other variables:	country dummy =1 if over 50% of exports are made up of fuels, minerals & metals.		
Results:	PEG for first; second regression also PEG but depends on degree of processing in a country=s export basket.		
Authors:	Esfahani (1991)	*Data*:	pooled - 31 semi-industrialized countries, 1960:73, 1973:81 & 1980:86.
Method:	2SLS(averaged GDP growth, export growth & import growth equations)		
Other variables:	relative import shortage; population; area; goods designated for domestic & foreign usage.		
Results:	PEG		
Authors:	Salvatore & Hatcher (1991)	*Data*:	pooled - 26 countries, 1963:73 & 1973:85. 4 groups depending on trade.
Method:	OLS & AUTO (averaged real per capita income growth on averaged real exports growth)		
Other variables:	averaged gross fixed capital formation as % of GDP; averaged real industrial production growth.		
Results:	PEG		
Authors:	Sawhney & DiPietro (1991)	*Data*:	pooled - 120 World Bank countries, 1965:80. 4 groups by income.
Method:	OLS (averaged % growth in real GDP on averaged % growth in exports)		
Other variables:	averaged growth in labor; averaged growth in investment.		
Results:	PEG with importance of exports changing with the level of development.		
Authors:	Dollar (1992)	*Data*:	pooled - 92 countries, 1976:85.
Method:	OLS for relationship between price level and endowments then an index is developed (per capita GDP, average price level, population density)		
Results:	PEG		
Authors:	De Gregorio (1992)	*Data*:	pooled/panel - 12 Latin American countries (Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Ecuador, Guatemala, Mexico, Peru, Uruguay, Venezuela), 1950:85.
Method:	random effects panel (averaged rate of growth of real GDP on averaged growth of exports as share of GDP)		
Other variables:	Various including: terms of trade; averaged inflation rate; variance of inflation; averaged domestic & foreign investment; literacy; political variables.		
Results:	no PEG		
Authors:	Moore (1992)	*Data*:	pooled - 87 middle- & high-income countries, 1960:66, 1966:73, 1973:79 & 1979:86.
Method:	2 equation switching regression - dependent on level of country GNP (averaged real GNP growth on averaged % share of changes in exports in GDP & repeated with additional regressor of averaged real exports growth)		
Other variables:	averaged population growth; averaged investment share of GNP.		
Results:	PEG - switching regression suggests different effects for middle- & high-income countries.		
Authors:	Sheehey (1992)	*Data*:	pooled - 53 non-oil developing countries, 1960:81.
Method:	OLS(averaged real GDP growth on averaged exports to GDP ratio & its average annual growth rate & average growth of exports)		
Other variables:	averaged labor force growth; averaged investment share of GDP.		
Results:	some PEG		

Table A1 Cross-country studies of exports and growth (continued)

Authors:	Sprout & Weaver (1993)	*Data*:	pooled - 72 LDCs, 1970:84. 3 groups depending on exports.
Method:	2SLS(averaged real GDP growth on averaged real exports growth or growth of export share of GDP)		
Other variables:	averaged labor force growth; averaged investment share of GDP.		
Results:	PEG for large & non-primary exporter groups but not for primary products exporters group.		
Authors:	Coppin (1994)	*Data*:	pooled - 59 LDCs, 1980:88.
Method:	OLS(averaged real GDP growth on averaged real exports growth or growth in real manufacturing exports as share of total real exports)		
Other variables:	averaged labor force growth; averaged growth in energy consumption (capital); change in broad money as share of GDP.		
Results:	PEG		
Authors:	Greenaway&Sapsford(1994b)	*Data*:	pooled - 104 countries & 85 non-industrialized countries, 1960:73, 1973:80 & 1980:88.
Method:	OLS(averaged real GDP growth on averaged growth of real exports or averaged real GDP per capita growth on same or averaged real GDP per worker on same)		
Results:	PEG for 1973:80, 1980:88 but not for 1960:73.		
Authors:	Hotchkiss et al. (1994)	*Data*:	pooled - 85 low-, middle- & high-income countries, 1960:66, 1966:73, 1973:79 & 1979:86.
Method:	2 equation switching regression -dependent on level of country GNP (averaged real GNP growth on averaged % share of changes in exports in GDP and repeated with additional regressor of averaged real exports growth)		
Other variables:	averaged population growth; averaged investment share of GDP.		
Results:	PEG - switching regression suggests different effects for low-, middle- & high-income countries.		
Authors:	Amirkhalkhali & Dar (1995)	*Data*:	pooled/panel - 23 developing countries, 1961:90. Also 4 groups by trade.
Method:	OLS & RC (real GDP growth on real exports growth)		
Other variables:	population growth; investment to output share.		
Results:	PEG but not for the strong inward oriented group.		
Authors:	Song & Chen (1995)	*Data*:	pooled - 22 countries & 33 countries, 1960:75, 1975:91 & 1960:91.
Method:	OLS(averaged real GDP growth on averaged % share of changes in exports in GDP)		
Other variables:	averaged population growth; averaged investment share of GDP.		
Results:	PEG generally but depends on sample period & country group.		
Authors:	Yaghmaian&Ghorashi(1995)	*Data*:	pooled - 30 developing countries, 1980:90.
Method:	OLS (averaged real GDP growth on averaged real exports growth)		
Other variables:	investment to output share; averaged growth in total employment.		
Results:	No PEG.		
Authors:	Burney (1996)	*Data*:	pooled - 89 countries, 1965:80 & 95 countries, 1980:90. Also 6 groups.
Method:	OLS & RC(averaged real GDP growth on averaged real exports growth)		
Other variables:	averaged population growth; averaged investment growth; averaged growth in energy consumption.		
Results:	PEG for 1980:90 but not for 1965:80.		
Authors:	Fosu (1996)	*Data*:	pooled - 76 LDCs, 1967:73, 1973:80, 1980:86, 1967:86.
Method:	OLS (averaged real GDP growth on averaged real exports), with het-consistent se=s. Repeated with averaged proportion of non-fuel primary exports to total exports added as an additional regressor and replacing exports. Also with non-export GDP replacing GDP.		
Other variables:	averaged gross domestic investment growth as a proportion of GDP.		
Results:	PEG		
Authors:	Park & Prime (1997)	*Data*:	pooled - China 26 provinces & 11-coastal provinces, 1985:93. Also undertaken as panel.
Method:	OLS(averaged real provincial GDP growth on averaged % share of exports in GDP or % share of changes in exports in GDP or averaged growth in real exports)		
Other variables:	averaged labor force growth; averaged % share of gross investment in GDP.		
Results:	PEG for growth in real exports & % share of changes in exports in GDP. All significant for panel model.		
Authors:	McNab & Moore (1998)	*Data*:	pooled - 41 developing countries, 1963:73 & 1973:85.
Method:	OLS & 3SLS (averaged GDP growth equation & averaged growth rate of exports weighted by the proportion of exports in GDP. The GDP equation is of a Feder (1983) form while the export equation relates the dependent variable to World Bank trade policy measures and GDP growth.)		
Other variables:	averaged population growth; averaged investment to output share. Repeated also with primary and secondary education ratios; initial level of real GDP per capita (proxy for technology gap).		
Results:	PEG but conclude that high degree of correlation is likely related to bidirectional causality between the two variables because of the endogeneity of the export expansion variable.		

Table A2 Time-series studies of exports and growth

Authors:	Blumenthal (1972)	*Data:*	Japan - annual & qtr., 1953:67
Method:	OLS (growth of real exports on growth of real GDP)		
Results:	No PEG		
Authors:	Voivodas (1974)	*Data:*	Korea - annual, 1955:70
Method:	OLS (growth of real GDP on proportion of exports to output)		
Results:	PEG		
Authors:	Krueger (1978)	*Data:*	Brazil, Chile, Colombia, Egypt, Ghana, India, Israel, South Korea, Philippines, Turkey - annual, 1954:71.
Method:	OLS (log real GNP on log real exports relative to average exports over the entire period)		
Other variables:	Time trend; dummy variables for trade regimes		
Results:	PEG		
Authors:	Fajana (1979)	*Data:*	Nigeria - annual, 1954:74
Method:	OLS (growth of real GDP on real exports share of GDP) ; OLS (Δreal GDP on Δreal exports); OLS (growth of real GDP on proportion of exports to GDP)		
Other variables:	Trade balance; current account.		
Results:	PEG		
Authors:	Schenzler (1982)	*Data:*	Chile, India, South Korea - annual, 1950:79
Method:	OLS (real GDP growth on real export growth or export share)		
Other variables:	Investment share; government spending share; foreign aid share.		
Results:	PEG		
Authors:	Gupta (1985)	*Data:*	South Korea – qtr., 1960(1):79(4) & Israel – qtr., 1969(1):81(1). Real GNP & exports.
Method:	Bivariate Sims (F); prewhitened via ARIMA transformations; transformed VAR with trend & constant.		
Lag selection:	Preset to 4.		
Results:	*BD*		
Authors:	Jung & Marshall (1985)	*Data:*	37 developing countries - annual, periods within 1950:81. Real GNP/GDP growth & export growth.
Method:	Bivariate Granger (F); VARD & some VARD^2 with constant.		
Lag selection:	Preset to 2; increased to 3 if residuals correlated.		
Results:	*ELG:* Indonesia, Greece, Egypt, Costa Rica, Ecuador. *GLE:* Iran, Nigeria, Kenya, South Africa, Korea, Pakistan, Taiwan, Thailand, Bolivia, Chile, Peru. *BD:* Israel. *NC:* Venezuela, Morocco, Tunisia, India, Philippines, Sri Lanka, Portugal, Turkey, Argentina, Brazil, Colombia, Dominican Republic, El Salvador, Guatemala, Guyana, Honduras, Jamaica, Mexico, Paraguay, Uruguay.		
Authors:	Darrat (1986)	*Data:*	Hong Kong, Korea, Singapore, Taiwan - annual, 1960:82. %change in real GDP & exports.
Method:	Bivariate Granger (F); VARL in specified variables.		
Lag selection:	Set to 2 after nonparametric test for serial noncorrelation.		
Results:	*GLE:* Taiwan. *NC:* Hong Kong, Korea, Singapore.		
Authors:	Chow (1987)	*Data:*	8 NICs - annual, 1960:84. Real manufactured exports, real manufactured output.
Method:	Bivariate Sims (F); data prefiltered by $(1\text{-}0.75L)^2$; transformed VAR with constant.		
Lag selection:	Preset to 3.		
Results:	*ELG:* Mexico. *BD:* Brazil, Hong Kong, Israel, Korea, Singapore, Taiwan. *NC:* Argentina.		
Authors:	Darrat (1987)	*Data:*	Hong Kong, South Korea, Singapore, Taiwan - annual, 1955:82. Real GDP & export growth.
Method:	AR (GDP growth on lagged & current export growth); AR (export growth on lagged & current GDP growth)		
Lag selection:	Preset - up to 4 lags.		
Results:	*ELG:* South Korea. *GLE:* Singapore, Taiwan. *NC:* Hong Kong.		
Authors:	Hsiao (1987)	*Data:*	Hong Kong, South Korea, Singapore, Taiwan - annual, periods within 1960:82. Logs; real GDP & exports.
Method:	Bivariate Sims & Granger (F); VARD with constant.		
Lag selection:	Preset to 3 except 2 for Singapore.		
Results:	*Sims - GLE:* Hong Kong. *BD:* South Korea, Taiwan, Singapore.		
	Granger - GLE: Hong Kong. *NC:* South Korea, Taiwan, Singapore.		

Table A2 Time-series studies of exports and growth (continued)

Authors: Ram (1987) *Data:* 88 countries - annual, various periods within 1960:82.
Method: OLS & AUTO (real GDP growth on real export growth or % share of changes in exports in GDP)
Other variables: Population growth; real investment as share of output; dummy variable for 1973 oil crisis.
Results: PEG for Algeria, Angola, Bangladesh, Barbados, Benin, Bolivia, Burma, Cameroon, Colombia, Costa Rica, Cyprus, Ecuador, Egypt, Fiji, Gambia, Guatemala, Guyana, Haiti, Honduras, Hong Kong, Indonesia, Iran, Iraq, Jamaica, South Korea, Malaysia, Malta, Mauritania, Mauritius, Nigeria, Panama, Senegal, Sierra Leone, Singapore, Sudan, Tanzania, Togo, Trinidad & Tobago, Tunisia. No PEG for Afghanistan, Argentina, Botswana, Brazil, Burundi, Central Africa, Chad, Chile, Congo, Dominican Rep., El Salvador, Ethiopia, Ghana, Greece, India, Israel, Ivory Coast, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mexico, Morocco, Mozambique, Nicaragua, Niger, Pakistan, Papua New Guinea, Paraguay, Peru, Philippines, Portugal, Rwanda, Somalia, South Africa, Sri Lanka, Swaziland, Syria, Thailand, Turkey, Uganda, Upper Volta, Uruguay, Venezuela, Yugoslavia, Zaire, Zambia.

Authors: Grabowski (1988) *Data:* Japan - annual, 1885:1940. Growth of real GNE & exports or exports as a share of GNE, or growth of per capita GNE & exports.
Method: OLS simple regressions between various variable definitions. 3 equation SEM (3SLS).
Other variables: Real gross capital formation as a share of GNE or growth of gross capital formation per capita; labor force growth; agricultural land growth; Δgrowth of GNE; volume of world trade; time trend.
Results: PEG

Authors: Afxentiou & Serletis (1989) *Data:* Canada - annual, 1870:1985, 1870:96, 1896:1929, 1930:50, 1950:85. Logs; nominal GNP & exports.
Method: OLS in levels and first differences.
Unit root test: ADF (SC; with & without constant & trend).
Cointegration test: CRDW; EG-ADF (SC; with constant). CRDW: cointegration; EG-ADF: noncointegration.
Other variables: Investment; government spending.
Results: PEG

Authors: Kunst & Marin (1989) *Data:* Austria – qtr., 1965(2): 85(4). Logs; real output per employee in manufacturing sector & real exports of manufactured goods.
Method: 4-variable Granger (F); VARD with no deterministic trends.
Lag selection: AIC
Other variables: Terms of trade (export unit value/import unit value for manufactured goods); real OECD GDP; seasonal dummy variables.
Results: *GLE*

Authors: Grabowski et al. (1990) *Data:* Japan - annual, 1885:1939 & 1952:80. Logs; real GDP & exports.
Method: 5-variable Granger (F); VARD with constant.
Lag selection: FPE
Other variables: Real gross capital stock; labor force; agricultural productivity.
Results: No *ELG* for 1885:1939; *ELG* for 1952:80.

Authors: Sung-Shen et al. (1990) *Data:* South Korea, Japan, Taiwan – qtr., seas. adj., periods within 1957(1):87(1). Logs; real GDP & exports.
Method: Bivariate Granger (F; Akaike FPE); VARD with constant.
Unit root test: DF (with constant)
Lag selection: FPE
Results: *BD:* Japan, South Korea, Taiwan.

Authors: Afxentiou & Serletis (1991) *Data:* 16 industrial countries - annual, 1950:85. Logs; real GNP & exports.
Method: Bivariate Granger (F); VARD for all countries except VARL for cointegrated countries with no deterministic terms.
Unit root test: PP (n.s.; with & without constant)
Cointegration test: PP (n.s.; with constant). Noncointegration except for Iceland, Netherlands & Norway.
Lag selection: SC
Results: *GLE:* Norway, Japan, Canada. *BD:* US. *NC:* Austria, Belgium, Denmark, Finland, Germany, Iceland, Ireland, Netherlands, Spain, Sweden, Switzerland, UK.

Authors: Ahmad & Kwan (1991) *Data:* pooled - 47 African developing countries - annual, 1981:87. Real GDP per capita & annual growth of real GDP. Total real exports; total real manufactured exports & share of real manufactured exports to real exports. Disaggregated into 30 low-income & 17 middle- & high-income countries.
Method: Bivariate Granger (F); VARL in described variables with constant.
Lag selection: AIC
Results: No *ELG;* some *GLE* in pooled cases.

Table A2 Time-series studies of exports and growth (continued)

Authors:	Bahmani-Oskooee et al. (1991) *Data:* 20 LDCs - annual, periods within 1951:87. Real GDP & export growth.
Method:	Bivariate Granger (Akaike FPE); VARL in growth variables, some VARD, with constant.
Other variables:	FPE
Results:	*ELG:* El Salvador, Greece, Morocco, Peru, Taiwan. *GLE:* Nigeria, South Africa. *BD:* Dominican Republic, Indonesia, Korea, Paraguay, Thailand.. *NC:* Brazil, Ecuador, Guyana, Honduras, Jamaica, Philippines, Sri Lanka, Tunisia.
Authors:	Kugler (1991) *Data:* US, Japan, Switzerland, West Germany, France, UK – qtr., seas. adj, 1970:87. Logs, real GDP & exports.
Method:	4-variable Granger; VECM for cointegrated countries, with constant.
Unit root test:	ADF (preset to 1&6; with constant)
Cointegration test:	JJ (AIC; Case 1). Cointegration for West Germany & France.
Lag selection:	AIC
Other variables:	Total real private consumption; real gross fixed capital business investment.
Results:	Based results on cointegration outcome; concludes *ELG* for West Germany & France but not for others.
Authors:	Kwan & Cotsomotis (1991) *Data:* China - annual, 1952:85 & 1952:78. Real per capita income & ratio of exports to income.
Method:	Bivariate Granger (LR); VARL & VARD (income second differenced) with constant.
Lag selection:	AIC
Results:	*BD:* 1952:85. *NC:* 1952:78.
Authors:	Nandi & Biswas (1991) *Data:* India - annual, 1960:85. Real GDP and export growth.
Method:	Bivariate Sims (F); VARL in growth variables with constant.
Lag selection:	n.s.
Results:	*ELG*
Authors:	Salvatore & Hatcher (1991) *Data:* 26 developing countries-annual, 1963:85.7 split as 1963:73 & 1973:85.
Method:	OLS & AUTO (real GDP growth on real export growth)
Other variables:	Gross fixed capital formation as % of GDP; real industrial production growth.
Results:	PEG for Chile, Malaysia, Tunisia, Turkey, Uruguay, Colombia, El Salvador, Honduras, Ivory Coast, Senegal, Argentina, Dominican Rep., India, Nigeria, Zambia. Insignificant for South Korea, Israel, Kenya, Mexico, Nicaragua, Philippines, Bagladesh, Peru, Pakistan. Significant negative for Yugoslavia, Singapore.
Authors:	Sharma et al. (1991) *Data:* West Germany, Japan, US, UK, Italy – qtr., 1960(1): 87(2). Logs; real GNP & exports.
Method:	4-variable Granger (LR). FEVDs (4 orderings; 8 & 20 quarter horizons). Constant included. Some first differenced, some first and seasonally differenced.
Lag selection:	FPE
Other variables:	Labor; real capital formation.
Results:	*ELG:* West Germany, Japan. *GLE:* US, UK. *NC:* Italy.
Authors:	Ahmad & Harnhirun (1992) *Data:* 5 ASEAN countries - annual, 1967:88. Real per capita exports & GDP.
Method:	Bivariate Granger (LR); VECM for cointegrated countries, VARD for noncointegrated, with constant.
Unit root test:	ADF (LM; with constant & trend)
Cointegration test:	EG-ADF (n.s.; no constant). Cointegration for Thailand; noncointegration for other countries.
Lag selection:	FPE
Results:	*GLE:* Malaysia, Philippines, Singapore, Indonesia. *NC:* Thailand.
Authors:	Egwaikhide (1992) *Data:* Nigeria - annual, 1973:88. Logs; nominal and real GDP & oil exports. component sectors of GDP.
Method:	OLS (GDP on current and lagged oil exports, with constant). 3 equation SEM (2SLS).
Lag selection:	Preset to 2.
Other variables:	Imports; export price of crude oil.
Results:	Marginal *ELG.*

Table A2 Time-series studies of exports and growth (continued)

Authors:	Giles et al. (1992) *Data:* New Zealand - annual, 1963:91. Logs; real exports, GDP and 7 sector decompositions (live animals, meat and edible meat offal; fish, crustacea, dairy produce, and other animal produce; vegetables, fruit, prepared foodstfuffs, beverages and tobacco; minerals, chemicals, plastic materials and their products; manufactures and goods classified by material (e.g., wool, paper pulp), excluding metals; metals and articles of metal; other exports)
Method:	Bivariate Granger (LR, Wald & Akaike FPE); VECM for cointegrated cases, VARD for noncointegrated, with constant.
Unit root test:	ADF (ACFs; with & without constant & trend).
Cointegration test:	EG-ADF (ACFs; Case 1*& Case 2*). Cointegration between GDP & live animals etc.; between GDP & manufactures and goods classified by material.
Lag selection:	FPE
Results:	*Wald & LR- ELG:* metals and articles of metals. *NC* for total and other categories. *Akaike FPE- BD*: live animals, meat and edible meat offal. *ELG*: metals and articles of metals. *GLE:* manufactures and goods classified by mateial (e.g., wool and paper pulp). *NC* : total exports and other categories.
Authors:	Hutchison & Singh (1992) *Data:* 34 developing countries - annual, periods within 1950:85. Logs; real GDP, non-export GDP & exports.
Method:	Bivariate & trivariate Granger (F); VARD with no deterministic terms.
Unit root test:	Undertaken but not specified.
Lag selection:	Preset to 2.
Other variables:	Real investment.
Results:	*Bivariate with economic growth as non-export GDP- ELG:* Argentina, Bolivia, Colombia, Costa Rica, El Salvador, Guatemala, Iran, Parguay, Taiwan, Uruguay, Venezuela. *GLE:* Ecuador, Jamaica. *NC:* Brazil, Chile, Dominican Rep., Egypt, Greece, Guyana, Honduras, India, Indonesia, Kenya, Korea, Mexico, Morocco, Nigeria, Pakistan, Peru, Portugal, Singapore, Sri Lanka, Thailand, Tunisia. *Trivariate with economic growth as non-export GDP-* same as bivariate except now *ELG:* Guyana. *GLE:* India, Kenya, Mexico. *NC:* Colombia, Costa Rica, Guatemala. *Bivariate with economic growth as total GDP-* same as bivariate with non-export GDP except now *ELG:* Guyana, Peru. *GLE:* Bolivia, Honduras, Kenya, Taiwan, Thailand. *BD:* Indonesia. *NC:* Argentina, El Salvador, Guatemala, Iran, Jamaica, Uruguay, Venezuela. *Trivariate with economic growth as total GDP-* same as bivariate with non-export GDP except now *ELG:* Colombia. *GLE:* Indonesia, Singapore, Taiwan. *NC:* Argentina, Bolivia, El Salvador, Iran, Mexico, Thailand, Uruguay, Venezuela.
Authors:	Marin (1992) *Data:* Germany, UK, US, Japan – qtr., 1960(1):87(2). Logs; real exports of manufacturing goods & labor productivity (manufacturing output per employee).
Method:	4-variable Granger (F); VECM for Germany, US & Japan, VARD for UK, with constant. Also tried with & without error correction term and linear time trend.
Unit root test:	DF & ADF (preset to 4; no deterministic terms).
Cointegration test:	CRDW; DF; EG-ADF (preset to 4; no deterministic terms). Cointegration except for UK.
Lag selection:	BIC for own lags, set to 4 for other variables.
Other variables:	Terms of trade (export unit value/import unit value for manufacturing goods); real OECD output.
Results:	*ELG:* Germany, US, UK. *BD:* Japan.
Authors:	Serletis (1992) *Data:* Canada - annual, 1870:85; 1870:44; 1945:85. Logs; real GDP & exports.
Method:	Bivariate & trivariate Granger (F); VARD with constant.
Unit root test:	PP (0, 12 [2]; with constant & trend and combinations thereof).
Cointegration test:	PO (0, 12 [2]; with constant). Noncointegration.
Lag selection:	SC
Other variables:	Real imports.
Results:	*ELG:* 1870:44; 1870:85. *NC:* 1945:85.
Authors:	Bahmani-Oskooee&Alse(1993) *Data:* 9 LDCs – qtr., 1973(1):88(4). Logs; real GDP & exports.
Method:	Bivariate Granger (F); VECM for cointegrated countries with constant.
Unit root test:	ADF (general to specific; with constant)
Cointegration test:	CRDW; EG-ADF (general to specific; with constant). Noncointegration for Malaysia so no further work undertaken. Cointegration for other countries.
Lag selection:	Specific to general.
Results:	*BD:* Colombia, Greece, South Korea, Pakistan, Philippines, Singapore, South Africa, Thailand.

Table A2 Time-series studies of exports and growth (continued)

Authors:	Dodaro (1993)	*Data:*	87 countries - annual, 1967:86. Real GDP growth, growth of real exports of goods & nonfactor services.
Method:	OLS simple regression between growth variables. Bivariate Granger (F); VARL in growth variables with constant.		
Lag selection:	Preset to 2.		
Results:	OLS contemporaneous - for over half no significant relationship. *Granger- ELG:* Bangladesh, Ethiopia, Uganda, El Salvador, Syrian Arab Republic, Malaysia, Costa Rica, Malta. *GLE:* Mali, Chad, Egypt, Ghana, Liberia, Zambia, Guyana, Nicaragua, Chile, Yugoslavia, Singapore, Turkey, Haiti, Guatemala. *BD:* Indonesia, Papua New Guinea, Israel. *NC:* Nepal, Somalia, Burundi, Burkina Faso, India, Malawi, Rwanda, Sri Lanka, Sierra Leone, Zaire, Niger, Benin, Pakistan, Tanzania, Gambia, Central African Rep., Madagascar, Mauritania, Lesotho, Sudan, Togo, Kenya, Senegal, Cameroon, Honduras, Zimbabwe, Thailand, Bolivia, Philippines, Yemen Arab Rep., Congo, Nigeria, Botswana, Swaziland, Morocco, Peru, Mauritius, Ivory Coast, Colombia, Paraguay, Ecuador, Dominican Rep., Tunisia, Jordan, Jamaica, South Korea, Algeria, Mexico, Panama, South Africa, Fiji, Brazil, Uruguay, Argentina, Barbados, Portugal, Cyprus, Suriname, Trinidad & Tobago, Venezuela, Hong Kong, Greece.		
Authors:	Ghartey (1993)	*Data:*	Taiwan, US, Japan – qtr., seas. adj., periods within 1955(1):91(2). Logs; real GNP & exports.
Method:	Bivariate Granger (Wald, LR) for US & Taiwan. 4-variable Granger (Wald, LR) for Japan. FPE & SC comparisons also. Log VARL for US (as data found stationary); D^2VAR for Japan & Taiwan, with no deterministic terms.		
Unit root test:	DF, ADF (n.s.; with constant)		
Lag selection:	FPE & SC		
Other variables:	Capital stock; terms of trade for Japan only.		
Results:	*ELG:* Taiwan. *GLE:* US. *BD:* Japan.		
Authors:	Gordon & Sakyi-Bekoe (1993)	*Data:*	Ghana - annual, 1955:87. Real export & GDP growth.
Method:	Bivariate & trivariate Granger, Sims, modified Sims, Akaike FPE, rank F-test (F); VARL in growth variables with no deterministic terms.		
Unit root test:	ADF (n.s.; with constant)		
Lag selection:	Preset to 3 & 5 for bivariate; preset to 5 & FPE for trivariate.		
Other variables:	Real investment growth.		
Results:	no *ELG* at 5% level; some *ELG, GLE & BD* in bivariate model at 10% level. Some *GLE* in trivariate Granger; *ELG* for rank-F test. Results method dependent.		
Authors:	Khan & Saqib (1993)	*Data:*	Pakistan - annual, 1972:88.
Method:	OLS & 3SLS (real GDP growth on real exports; real manufactured exports; real primary exports).		
Other variables:	World GDP index; capital stock series; employed labor force; ratio of domestic export prices to World export prices.		
Results:	PEG		
Authors:	Kugler & Dridi (1993)	*Data:*	11 LDCs (Argentina, Brazil, Chile, Egypt, Hong Kong, Korea, Malaysia, Mexico, Pakistan, Philippines, Thailand) - annual, 1960:89. Logs; real GDP & exports.
Method:	4-variable with conclusions based on cointegration results.		
Unit root test:	ADF (preset to 1&2; with constant & trend).		
Cointegration test:	JJ (AIC; Case 1). Cointegration for all except Egypt, Malaysia, Mexico, Thailand.		
Lag selection:	AIC		
Other variables:	Total private consuption expenditures; business-fixed investment.		
Results:	Conclude ELG for cointegrated countries; i.e., Argentina, Brazil, Chile, Hong Kong, Korea, Pakistan, Philippines.		
Authors:	Oxley (1993)	*Data:*	Portugal - annual, 1865:91. Logs; real GDP & exports.
Method:	Bivariate Granger (Wald); VECM with constant.		
Unit root test:	ADF (preset to 4; with & without trend).		
Cointegration test:	JJ (1,2,3; Case 1)		
Lag selection:	FPE		
Results:	*GLE*		
Authors:	Sengupta (1993)	*Data:*	South Korea, Taiwan, Japan, Philippines - annual, periods within 1961:87. Δreal GDP & exports; GDP growth & % share of changes in exports in GDP.
Method:	OLS - contemporaneous relationship in growth or change variables - aggregate production function.		
Other variables:	Real investment (capital); employment.		
Results:	PEG for Taiwan, South Korea but not for Japan or Philippines. Japan also if definition of export variable changes.		
Authors:	Supo Alege (1993)	*Data:*	Nigeria - annual, 1960:85. Logs; real GDP, oil exports & total exports.
Method:	Bivariate Granger (F); VARL with constant & linear trend.		
Lag selection:	Preset to 2.		
Results:	*NC* for total exports. *GLE* for oil exports.		

Table A2 Time-series studies of exports and growth (continued)

Authors:	Atesoglu (1994) *Data:* US - annual, 1963:89. Logs; real GNP & exports.
Method:	2SLS (3 equation model; ΔGNP on Δexports).
Other variables:	Δreal total government purchases of goods & services; Δbusiness sector compensation per hour; Δimplicit GNP deflator; Δimplicit import price deflator; Δreal world GNP; dummy variable for energy crises.
Results:	PEG
Authors:	Dutt & Ghosh (1994) *Data:* 26 low-, middle-, and high-income countries - annual, 1953:91. Logs; real GDP/GNP & exports.
Method:	Results based on cointegration outcomes.
Unit root test:	ADF (SC; with constant); PP & KPSS (ACF; with constant)
Cointegration test:	PO (ACF; with constant & trend and combinations thereof).
Results:	Cointegration for Australia, Canada, Colombia, Denmark, France, Germany, Guatemala, India, Mexico, Morocco, Netherlands, Pakistan, Philippines, South Africa, Sweden, Switzerland, Thailand, Turkey, USA, Venezuela. Noncointegration for Brazil, Israel, Italy, Japan, Korea, UK.
Authors:	Greenaway & Sapsford (1994a) *Data:* Brazil, Colombia, Greece, Israel, Korea, New Zealand, Pakistan, Peru, Philippines, Singapore, Spain, Sri Lanka, Turkey, Yugoslavia - annual, periods within 1957:85. Real GDP per capita growth & growth of exports. Repeated with (weighted) growth of non-export GDP. Also with export variable expressed as % share of changes in exports in GDP.
Method:	OLS simple regressions between variables.
Unit root test:	ADF (n.s.)
Other variables:	Share of investment in output; growth of the workforce.
Results:	No PEG for OLS with GDP; same with non-export GDP except significant for New Zealand (but negative). Significant negative for Spain and New Zealand with export variable expressed as % share of changes in exports in GDP.
Authors:	Greenaway & Sapsford (1994b) *Data:* South Korea, Chile, Colombia, Sri Lanka, Turkey - annual, 1957:85. Real GDP per capita growth & growth of export share of GDP.
Method:	OLS simple regressions between variables.
Unit root test:	ADF (n.s.)
Results:	PEG for Sri Lanka; not significant for South Korea, Chile, Colombia; negative significant for Turkey.
Authors:	Hansen (1994) *Data:* New Zealand - annual, 1968:91. Real GDP & exports of manufactures and services growth.
Method:	OLS multisector aggregate production function between variables.
Unit root test:	ADF (n.s.)
Cointegration test:	EG-ADF (n.s.) between %share of Δexports in GDP and % share of Δgovernent expenditure in GDP. Cointegrated.
Other variables:	%share of Δgovernent expenditure in GDP; labor force growth; gross investment as share of GDP; dummy variable for oil price shocks.
Results:	No PEG
Authors:	Karunaratne (1994) *Data:* Australia – qtr. seas. adj. (F), 1959(3):92(1). Logs; real GDP & exports.
Method:	Bivariate Granger (F); VARD, n.s.. 6-variable IRF & FEVDs (4^{th} Δs; 12 & 24 period ahead forecasts).
Unit root test:	ADF (AIC; n.s.)
Lag selection:	AIC
Other variables:	Real imports; terms of trade (ratio of price of exports to imports); proxies for capital & labor.
Results:	*Bivariate Granger - ELG. IRFs & FEVDs - NC* (or ≻low=causality).
Authors:	Love (1994) *Data:* 20 countries - annual, periods within 1960:90. Real export, GDP & non-export GDP growth.
Method:	Bivariate Granger (F); VARL or VARD in growth variables with constant.
Unit root test:	Undertaken as a t-test on growth variable against a linear time trend.
Lag selection:	FPE
Results:	*Economic growth as GDP - ELG:* Colombia, El Salvador, Guatemala, Honduras, Kenya, Lesotho, Pakistan, Sri Lanka. *GLE:* Ethiopia, Ghana, Paraguay. *BD:* Guyana, Ivory Coast, Malawi, Papua New Guinea, Sierra Leone, Uruguay. *NC:* Jordan, Mauritius, Zambia. *Economic growth as non-export GDP - ELG:* Colombia, El Salvador, Guatemala, Kenya, Lesotho, Malawi, Pakistan, Sri Lanka. *GLE:* Ethiopia, Ghana, Guyana, Paraguay. *BD:* Ivory Coast, Papua New Guinea, Sierra Leone, Uruguay. *NC:* Honduras, Jordan, Mauritius, Zambia.

Table A2 Time-series studies of exports and growth (continued)

Authors:	Onchoke & In (1994)	*Data:*	3 SPINS (Fiji, Papua New Guinea, Solomon Islands) - annual, periods within 1959:90. Logs; real GDP & exports.
Method:	Bivariate Granger (n.s.); VECM for cointegrated; not proceeded with for noncointegrated, with constant.		
Unit root test:	PP, ADF (n.s.)		
Cointegration test:	PP, EG-ADF, CCR (2,3; with constant & trend & combinations thereof). Mixed results. Proceeded by assuming cointegration for PNG & Solomon Islands; noncointegration for Fiji. No further work undertaken for Fiji.		
Lag selection:	AIC, SC		
Results:	*ELG:* PNG & Solomon Islands.		
Authors:	Sengupta & España (1994)	*Data:*	Taiwan, South Korea, Japan, Thailand, and Philippines - annual, periods within 1960:87. Δreal GDP & Δreal exports).
Method:	OLS simple regressions between variables.		
Cointegration test:	CRDW; EG-ADF for South Korea only. Cointegration.		
Other variables:	Δlabor force; real investment & (real investment)^2.		
Results:	PEG except for Japan.		
Authors:	Sharma & Dhakal (1994)	*Data:*	30 developing countries - annual, periods within 1960:88. Logs; real GDP & exports.
Method:	4-variable Granger (F); VARD & D^{2}VAR with constant.		
Unit root test:	PP (n.s.; with constant & trend)		
Lag selection:	FPE		
Other variables:	Population; real world output; real exchange rate; real gross fixed capital formation.		
Results:	*ELG:* Costa Rica, Greece, India, Mexico, Nigeria, South Africa. *GLE:* Dominican Rep., Egypt, El Salvador, Guyana, Iran, Morocco, Thailand, Tunisia. *BD:* Colombia, Jamaica, Peru, Philippines, Portugal. *NC:* Ecuador, Guatemala, Honduras, Kenya, South Korea, Pakistan, Paraguay, Sri Lanka, Turkey, Uruguay, Venezuela.		
Authors:	Suliman et al. (1994)	*Data:*	South Korea - annual, 1967:89. Logs; real GDP & exports.
Method:	4-variable Granger (LR); VARD with constant.		
Unit root test:	ADF (n.s.)		
Lag selection:	FPE		
Other variables:	Extent of devlopment expressed as the ratio of currency outside bank to IMF money supply data; import-competing (manufacturing) output.		
Results:	*BD*.		
Authors:	van den Berg & Schmidt (1994)	*Data:*	7 Latin American countries - annual, 1960:87. Real GDP & export growth.
Method:	Long run relationships for noncointegrated countries in either growth rates or Δgrowth rates or mixture. VECM for those countries which were cointegrated.		
Unit root test:	KPSS, PP (preset to 3; with constant & trend).		
Cointegration test:	PP (preset to 3; with constant). Cointegration for Guatemala, Mexico, Nicaragua.		
Lag selection:	AIC (for VECMs only)		
Other variables:	Ratio of real investment to real GDP; growth of labor.		
Results:	Significant positive relationships for noncointegrated countries - Costa Rica, Uruguay, Chile, Colombia, Dominican Rep., Honduras, Paraguay, Peru, Ecuador. Not significant - Argentina, Bolivia, Brazil, El Salvador, Venezuela. For cointegrated countries - *ELG:* Guatemala, Mexico, Nicaragua.		
Authors:	Ukpolo (1994)	*Data:*	8 African countries (Congo Rep., Kenya, Morocco, Nigeria, Senegal, Sierra Leone, Tanzania, Togo) - annual, 1969:88. Growth of real GDP on fuel exports growth, non-fuel primary exports growth, manufactured exports growth.
Method:	AUTO simple regressions between variables.		
Other variables:	Private & government consumption; population growth; ratio of investment to GDP growth.		
Results:	PEG for non-fuel; not significant for manufactured exports or fuels (except the latter for Nigeria).		
Authors:	Ahmad & Harnhirun (1995)	*Data:*	5 ASEAN countries (Indonesia, Malaysia, Philippines, Singapore, Thailand) - annual, 1966:90. Real per capita GDP & exports.
Method:	Bivariate Granger (LR) - only examined for Singapore as cointegrated; VECM with constant.		
Unit root test:	ADF (n.s.; with constant & trend)		
Cointegration test:	JJ (preset to 2; Case 1). Cointegration for Singapore only.		
Lag selection:	Preset to 2.		
Results:	*BD* for Singapore.		

Table A2 Time-series studies of exports and growth (continued)

Authors: Amirkhalkhali & Dar (1995) *Data:* 23 developing countries - annual, various periods within 1961:90.
Method: OLS (real GDP growth on real export growth).
Other variables: Real investment to output share; population growth.
Results: PEG for Bolivia, Colombia, Costa Rica, Guatemala, Honduras, Mexico, Philippines, Sri Lanka, Brazil, Chile, Malaysia, Tunisia, Uruguay, Korea, Singapore but not for Argentina, Ghana, India, Peru, Zambia, Pakistan, Thailand, Turkey.

Authors: Arnade & Vasavada (1995) *Data:* 16 Latin American & 17 Asian & Pacific Rim countries - annual, 1961:87. Real agricultural output & agricultural exports.
Method: Trivariate Granger (F); VECM for cointegrated countries, VARD for noncointegrated, with no deterministic terms. Also tries both for all countries.
Unit root test: ADF (preset to 3; no deterministic terms)
Cointegration test: JJ (preset to 3; Case 1*). Cointegration except for Uruguay, Nicaragua, Guatemala, Ecuador, Thailand, Taiwan, Nepal, Canada.
Lag selection: Preset to 3.
Other variables: Terms of trade (unit export value/unit import value).
Results: *ELG:* Bolivia, Colombia, Mexico, Pakistan, Philippines, Nicaragua. *GLE:* South Korea, Honduras, Taiwan, North Korea, Malaysia. *NC:* Argentina, Brazil, Chile, Costa Rica, Dominican Rep., Ecuador, El Salvador, Guatemala, Paraguay, Peru, Uruguay, Australia, Bangladesh, Canada, China, India, Indonesia, Japan, Nepal, Sri Lanka, Thailand, Vietnam.

Authors: Bahmani-Oskooee & Domac (1995) *Data:* Turkey - annual, 1923:90. Logs; real GNP & exports.
Method: Bivariate Granger (F); VECM with constant.
Unit root test: ADF (n.s.; with constant & trend)
Cointegration test: EG-ADF (n.s.; with constant & trend); JJ (preset to 4; Case 1*). Cointegration.
Lag selection: LR general to specific.
Results: *BD*

Authors: Holman & Graves (1995) *Data:* South Korea - annual, 1953:90. Logs; real GNP & exports.
Method: Bivariate Granger, Sims (F & Akaike FPE); VARD with constant.
Unit root test: DF(with constant)
Cointegration test: EG-ADF(n.s.; with constant) Noncointegration.
Lag selection: FPE
Results: *BD*

Authors: Jin (1995) *Data:* Hong Kong, Singapore, South Korea, Taiwan – qtr., seas. adj., 1973(1):93(2). Logs; real GDP & exports.
Method: 5-variable Granger; IRFs & FEVDs - 20 quarter horizon. VARD with constant.
Unit root test: ADF (preset to 4; with constant & trend).
Cointegration test: EG-ADF (preset to 4; with constant & trend). Noncointegration.
Lag selection: Preset to 8 except for South Korea - set to 12 to remove serial correlation.
Other variables: Industrial production index; world commodity price level for exports; real exchange rates.
Results: *BD*

Authors: Jin & Yu (1995) *Data:* Japan, Korea, Canada & US – qtr., seas. adj., 1960(1):87(4). Logs; real GNP/GDP & exports.
Method: Bivariate Granger (F & Akaike FPE); VARD with constant.
Lag selection: FPE
Results: *GLE:* Canada, US. *BD:* Korea, Japan.

Authors: Kwan & Kwok (1995) *Data:* China - annual, 1952:85. Logs; real national income & exports.
Method: Bivariate Granger (LR); VARL with constant. Exogeneity tests of EH & EHR.
Unit root test: ZA (n.s.)
Lag selection: FPE
Other variables: Population; ratio of domestic investment to national income.
Results: *ELG.* Results also suggest instantaneous causality from exports to growth.

Authors: McCarville & Nnadozie (1995) *Data:* Mexico - annual, 1926:88. Logs; real GDP & exports.
Method: Bivariate Granger (Wald & F); VARD with no deterministic terms.
Unit root test: ADF (SC, AIC; no constant)
Lag selection: AIC
Results: *ELG*

Table A2 Time-series studies of exports and growth (continued)

Authors:	Paul & Chowdhury (1995) *Data:* Australia - annual, 1949:91. Logs; real GDP & exports.
Method:	Bivariate Granger (F); VARD with constant.
Unit root test:	PP (1,3,5,7; combinations of constant & trend).
Cointegration test:	PO (1,3,5,7; with constant). Noncointegration.
Lag selection:	FPE
Results:	*ELG*
Authors:	Rashid (1995) *Data:* India - annual, 1960:89. Growth in real GDP and exports.
Method:	4-equation SEM
Other variables:	Growth of real investment; industrial production; imports; agriculture.
Results:	No positive significant export/economic growth effect.
Authors:	Abhayaratne (1996) *Data:* Sri Lanka - annual, 1960:92. Logs; real GDP & exports.
Method:	Trivariate Granger (Wald); VARD with constant.
Unit root test:	DF, ADF (preset to 2; with constant & trend)
Cointegration test:	JJ (SC; Case 0). Noncointegration.
Lag selection:	SC
Other variables:	Real imports.
Results:	*NC*
Authors:	Amoateng & Amoako-Adu (1996) *Data:* 35 African countries, pooled into 3 groups - annual, 1971:90. Logs; real GDP & exports
Method:	Trivariate Granger (Wald); VARD with constant.
Lag selection:	Preset to 4.
Other variables:	External debt servicing.
Results:	*BD*
Authors:	Bodman (1996) *Data:* Australia and Canada – qtr., seas. adj., 1960(1):95(4). Logs; real exports of manufactured goods; real total exports; manufacturing output per employee (labor productivity in the manufacturing sector); total output per employee (total labor productivity).
Method:	Bivariate Granger (F); VECM.
Unit root test:	ADF & PP (n.s.; with constant & trend)
Cointegration test:	JJ (LR, SC; Case 1) between exports and labor productivity in the manufacturing sector; total exports & total labor productivity; manufactured exports & total labor productivity. Cointegration.
Lag selection:	LR & SC
Results:	*ELG* for both countries for all cases except *BD* for Canada for manufacturing exports & manufacturing labor productivity.
Authors:	Boltho (1996) *Data:* Japan - annual, 1913:37; 1952:73; 1973:90. Growth of real GDP & exports; some sectors.
Method:	Bivariate Granger (F); VARL in growth variables with deterministic terms not specified.
Lag selection:	Preset to 3 & 4.
Results:	Some evidence of *GLE* for total exports; *BD* for cars.
Authors:	Cheng & Chu (1996) *Data:* US - annual, 1940:90. Logs; real GNP & exports.
Method:	4-variable Granger (Akaike FPE); VECM with constant.
Unit root test:	PP (n.s.)
Cointegration test:	JJ (FPE; Case 1)
Lag selection:	FPE
Other variables:	Labor force; capital.
Results:	*BD*
Authors:	Doraisami (1996) *Data:* Malaysia - annual, 1963:93. Logs; real GDP & exports.
Method:	Bivariate Granger (F); VECM with constant.
Unit root test:	ADF (ACFs; with constant)
Cointegration test:	CRDW; EG-ADF (ACFs; with constant). Cointegrated.
Lag selection:	Preset to 1.
Results:	*BD*

Table A2 Time-series studies of exports and growth (continued)

Authors:	Dutt & Ghosh (1996) *Data:* 26 low-, middle-, and high-income countries - annual, 1953:91. Logs; real GDP/GNP & exports.
Method:	Bivariate Granger (F); VECM for cointegrated countries with no deterministic terms.
Unit root test:	DF, PP (SC; with constant); KPSS (ACFs; with constant)
Cointegration test:	EG-ADF (SC; with constant & trend); PO (with constant & trend & testing downwards). Noncointegration for Denmark, Germany, Guatemala, India, Italy, Japan, Netherlands, South Africa, Sweden, Thailand, UK, Venezuela - no further work undertaken with these countries. Cointegration for other countries.
Lag selection:	SC
Results:	*ELG:* Israel, Mexico, Philippines, Switzerland, Turkey. *GLE:* Pakistan, US. *BD:* Colombia, France, Morocco. *NC:* Australia, Brazil, Canada, Korea.
Authors:	Henriques & Sadorsky (1996) *Data:* Canada - annual, 1877:45; 1946:91. Logs; real GDP & exports.
Method:	Trivariate Granger (F); VARL with constant.
Unit root test:	ADF, PP (highest significant lag from either AF or PAF of Δ time series; with constant)
Cointegration test:	JJ (various; Case 1). Cointegration.
Lag selection:	AIC; SC; HQ - adjusted when serial correlation detected.
Other variables:	Terms of trade (export unit value/import unit value)
Results:	*GLE*
Authors:	Islam & Iftekharuzzaman (1996) *Data:* Bangladesh - annual, 1971:90. Δreal GDP & exports.
Method:	OLS simple regression between variables.
Other variables:	Real investment; Δpopulation; Δreal government expenditure.
Results:	No positive significant export/economic growth effect.
Authors:	Jin & Yu (1996) *Data:* US – qtr., 1959(1): 92(3). Logs; real GDP & exports.
Method:	6-variable Granger. FEVDs; IRFs - 20 & 40 quarter horizons with 2 orderings tried. VARD with constant.
Unit root test:	ADF (n.s.)
Cointegration test:	EG-ADF; JJ & Hansen (1990) (n.s.; Case 0). Noncointegration.
Lag selection:	Preset to 4,6 & 8.
Other variables:	Real gross fixed capital formation; nonagricultural employment; industrial production index for all industrial countries; real exchange rate (CPI).
Results:	No *ELG*. IRF suggests some *GLE* at 2-quarter horizon.
Authors:	Karunaratne (1996) *Data:* Australia – qtr., seas. adj., 1971(2):94(2). Real GDP per capita & exports
Method:	4-variable Granger (F); VECM with constant.
Unit root test:	ADF (AIC; with constant & trend).
Cointegration test:	JJ (preset to 4; Case 1). Cointegration.
Lag selection:	SC & FPE.
Other variables:	Competitiveness index = terms of trade index (export price/import price deflator) H exchange rate; OECD industrial production index; regime shift dummy variable.
Results:	*ELG*
Authors:	Mallick (1996) *Data:* India - annual, 1951:92. Logs; real GNP & exports.
Method:	Bivariate Granger (F); VECM with constant.
Unit root test:	ADF (general to specific; with constant & trend).
Cointegration test:	CRDW; EG-ADF (general to specific; with constant). Cointegrated.
Lag selection:	1, 8 [2]
Results:	*GLE*
Authors:	Onafowora et al. (1996) *Data:* 12 sub-Saharan African countries - annual, 1963:91. Logs; real GDP per capita & ratio of merchandise exports to real GDP.
Method:	4-variable Granger. FEVDS from VECMs, with constant. 12-year horizon with 2 orderings tried.
Unit root test:	ADF (general to specific; with constant & trend)
Cointegration test:	JJ (preset to 3; Case 1). Cointegration.
Lag selection:	Preset to 3.
Other variables:	Ratio of gross domestic investment to real GDP; various trade policy dummy variables.
Results:	*ELG:* Cameroon, Cote d'Ivoire, Ethiopia, Ghana, Madagascar, Senegal. *GLE:* Burundi, Kenya, Sudan, Tanzania. *BD:* Nigeria, Zambia.

Table A2 Time-series studies of exports and growth (continued)

Authors: Piazolo (1996) *Data:* Indonesia - annual, 1965:92. Logs. Real GDP & exports.
Method: 6-variable Granger (Wald); VECM with constant.
Unit root test: ADF, PP (n.s.; with trend & constant testing downwards).
Cointegration test: EG-ADF (n.s.; with constant & trend) & JJ (preset to 1; Case 1). Cointegration.
Lag selection: Preset to 1.
Other variables: Real government consumption; population; real gross fixed capital formation; rate of inflation; real net foreign direct investment.
Results: *ELG*

Authors: Pomponio (1996) *Data:* 66 OECD & less developed countries - annual, periods within 1965:85. Nominal manufactured output & exports.
Method: Bivariate & trivariate Granger (F); VARD for noncointegrated countries, VARL cointegrated, no constant. Trivariate case tested as (investment+export) causes output (IELG) and (investment+output) causes exports (IGLE)).
Unit root test: n.s.
Cointegration test: n.s.
Lag selection: Preset to 2, some higher if correlation detected.
Other variables: Investment.
Results: *Bivariate - ELG:* Finland, Greece, Panama, Paraguay, US. *GLE:* Algeria, Tunisia, Burma, Thailand, Austria, Denmark, Germany, Canada. *BD:* Trinidad & Tobago. *NC:* Peru, Australia, Fiji, Indonesia, Botswana, Cameroon, Ethiopia, Ghana, Kenya, Lesotho, Liberia, Mauritius, Morocco, Nigeria, Rwanda, Senegal, South Africa, Sudan, Tanzania, Uganda, Zaire, Zambia, Zimbabwe, China, Japan, South Korea, Malaysia, Pakistan, Philippines, Saudi Arabia, Singapore, Sri Lanka, Austria, Cyprus, France, Italy, Norway, Turkey, Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Dominican Rep., Ecuador, El Salvador, Guyana, Honduras, Jamaica, Mexico, Nicaragua. *Trivariate - IELG:* Cameroon, Lesotho, Nigeria, Tunisia, Japan, Saudi Arabia, Sri Lanka, Thailand, Germany, Norway, Turkey, Canada, Dominican Rep., Jamaica, Paraguay, Trinidad & Tobago, Australia. *IGLE:* Algeria, Liberia, Senegal, Malaysia, Burma, Philippines, Cyprus, Greece, Brazil, Chile, Colombia, Costa Rica, Ecuador, El Salvador, Guyana, Nicaragua, Fiji, Indonesia. *BD:* Botswana, Kenya, South Africa, Tunisia, South Korea, Saudi Arabia, Austria, Denmark, Finland, France, Bolivia, Mexico, Peru, US. *NC:* Panama, Argentina, Italy, Singapore, Pakistan, China, Zimbabwe, Zaire, Uganda, Tanzania, Sudan, Rwanda, Morocco, Mauritius, Ghana, Ethiopia, Zambia, Honduras.

Authors: Riezman et al. (1996) *Data:* 126 countries - annual, 1950:90. GDP & export growth
Method: Bivariate & trivariate Granger (F). FEVDs - 5 & 16 year horizons, with 2 orderings tried. Geweke (1984) CLFs. No deterministic terms. 5-variable CLFs for Hong Kong, Indonesia, Japan, South Korea, Malaysia, Philippines, Singapore, Thailand.
Lag selection: n.s.
Other variables: Real import growth. For the 5-variable cases also: primary school enrolment as % of primary school age children(interpolated); total investment/output.
Results: *Bivariate* results consistent across methods when allow for ›generous=significance level - *ELG:* Algeria, Egypt, Gabon, Rwanda, Tunisia, Uganda, Zaire, Costa Rica, Haiti, Peru, Suriname, Uruguay, India, Myanmar, Nepal, Sri Lanka, Belgium, Finland, Hungary, Iceland, Malta, Sweden. *GLE:* Chad, Djibouti, Ethiopia, Gambia, Mozambique, Namibia, Somalia, Barbados, Mexico, Argentina, Bangladesh, Japan, South Korea, Philippines, Austria, France, Greece, UK, Australia. *BD:* Jamaica, Puerto Rico, Colombia, Syria, Taiwan. *NC:* Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde Island, Central African Rep., Comoros, Congo, Ghana, Guinea, Guinea-Bissau, Ivory Coast, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Morocco, Niger, Nigeria, Reunion, Senegal, Seychelles, Sierra Leone, South Africa, Sudan, Swaziland, Tanzania, Togo, Zambia, Zimbabwe, Canada, Dominican Rep., El Salvador, Guatemala, Honduras, Nicaragua, Panama, Trinidad & Tobago, US, Bolivia, Brazil, Chile, Ecuador, Paraguay, Venezuela, China, Hong Kong, Indonesia, Iran, Iraq, Israel, Jordan, Malaysia, Pakistan, Singapore, Thailand, Yemen, Cyprus, Czechoslovakia, Denmark, West Germany, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Switzerland, Turkey, Yugoslavia, Fiji, New Zealand, Papua New Guinea. *Trivariate* results depend on method & ordering used for FEVDs. Tendency to find more evidence of ELG with FEVDs & CLFs than with exclusion restrictions test. For latter changes are *ELG:* Chad, Ghana, Lesotho, South Africa, Sudan, Swaziland, Colombia, Ecuador, Indonesia, Jordan, South Korea, Taiwan, Italy, UK, *GLE:* Guinea, Zimbabwe, Nicaragua, Chile, Syria, Thailand, Belgium, Czechoslovakia, Denmark, Portugal, Yugoslavia. *BD:* Namibia, Somalia, Austria, *NC:* Algeria, Egypt, Gambia, Tunisia, Costa Rica, Haiti, Argentina, Suriname, Uruguay, Bangladesh, India, Sweden, Australia. For the trivariate 5-year FEVDs same as for Granger F tests except additional *ELG:* Angola, Cape Verde Islands, Djibouti, Guinea, Mauritania, Mozambique, Nigeria, Somalia, Togo, Tunisia, Uganda, Zaire, Zambia, Trinidad & Tobago, Argentina, Bolivia, Uruguay, Venezuela, Iraq, Cyprus, Czechoslovakia, Ireland, Norway, Sweden, Turkey, Australia, Papua New Guinea. CLF conclusions are as follows - *ELG:* Egypt, Gabon, Ghana, Ivory Coast, Mali, Mauritania, Morocco, Reunion, Rwanda, South Africa, Togo, Tunisia, Zambia, Costa Rica, Haiti, Honduras, Suriname, Uruguay, China, Iran, Iraq, Israel, Nepal, Taiwan, Thailand, Belgium, Iceland, Italy, Malta, Switzerland. *GLE:* Angola, Cameroon, Central African Rep., Gambia, Guinea-Bissau, Malawi, Mauritius, Seychelles, Sierra Leone, Swaziland, Zimbabwe, El Salvador, Argentina, Bolivia, Brazil, Chile, Bangladesh, Japan, South Korea, Pakistan, Yemen, Czechoslovakia, Portugal, UK, Papua New Guinea. Remaining countries show noncausality. For the 5-variables CLFs: *ELG:* Indonesia. *GLE:* Japan. *NC:* Hong Kong, Malaysia, Philippines, Singapore, Thailand, South Korea.

Table A2 Time-series studies of exports and growth (continued)

Authors:	Thornton (1996) *Data:* Mexico - annual, 1895:1992. Logs; real GDP & exports.
Method:	Bivariate Granger (F); VECM with constant.
Unit root test:	ADF (n.s.)
Cointegration test:	JJ (various; Case 0). Cointegrated.
Lag selection:	FPE
Results:	*ELG*
Authors:	Xu (1996) *Data:* 32 developing economies - annual, periods within 1951:90. Logs; real GDP & exports.
Method:	Bivariate Granger (F). VECM for cointegrated cases, VARD or D^2VAR for noncointegrated, with constant.
Unit root test:	ADF (preset to 3; combinations of constant & trend tried). Some Δ^2 used.
Cointegration test:	EG-ADF (preset to 3; no constant). Noncointegration except for Hong Kong, Indonesia, Korea, Malta, Peru.
Lag selection:	FPE
Results:	*ELG:* Colombia, India, Indonesia, Israel, Kenya, Korea, Malaysia, Malta, Mauritius, Mexico, Philippines, Taiwan. *GLE:* Nicaragua, Panama, Peru, Sierra Leone, Sri Lanka, Syria, Tunisia, Uruguay. *BD:* Brazil, Ecuador, Honduras, Hong Kong, Niger, Nigeria, Tanzania, Thailand, Turkey. *NC:* South Africa, Morocco, Paraguay.
Authors:	Ahmad et al. (1997) *Data:* 5 ASEAN countries (Indonesia, Malaysia, Philippines, Singapore, Thailand) - annual, 1966:93. Logs; real per capita GDP & exports.
Method:	Bivariate Granger (LR); VARD with constant.
Unit root test:	ADF (n.s.; with constant & trend)
Cointegration test:	EG-ADF (n.s.; no constant). Noncointegration.
Lag selection:	FPE
Results:	*ELG:* Thailand. *GLE:* Malaysia, Indonesia, Singapore, Philippines.
Authors:	Al-Yousif (1997) *Data:* Saudi Arabia, Kuwait, UAE, Oman - annual, 1973:93. Growth of real GDP, growth of real exports or % share of changes in exports in GDP.
Method:	OLS simple regressions between variables.
Cointegration test:	EG-ADF (n.s.; no constant). Noncointegration.
Other variables:	Labor force growth; gross domestic investment as % of GDP; growth of government expenditure; growth of terms of trade.
Results:	PEG.
Authors:	Amin Gutiérrez de PiÁeres & Ferrantino (1997) *Data:* Chile - annual, 1962:91. Logs; real GDP & exports.
Method:	Bivariate Granger (F); VARD with constant.
Unit root test:	Undertaken but not specified.
Cointegration test:	EG-ADF (n.s.)
Lag selection:	Preset to 2.
Results:	GLE
Authors:	Dhananjayan & Devi (1997) *Data:* 12 Asian & European countries (China, India, Indonesia, South Korea, Malaysia, Pakistan, Sweden, Spain, France, Germany, Italy, UK) - annual, 1981:94. Logs; real GNP growth, total exports, manufactured commodity exports, manufactured commodity exports as % of total exports.
Method:	OLS simple regressions between sets of variables; 6 different specifications.
Other variables:	Gross domestic investment.
Results:	PEG.
Authors:	Gani (1997) *Data:* Papua New Guinea - annual, 1970:92. Real per capita GDP growth on growth rate in real exports as a proportion of GDP).
Method:	OLS simple regressions between the specified variables.
Other variables:	% Δ in the weighted average of the real exchange rate of PNG=s main trading partners; % Δ in food production per capita; real GDP growth of OECD countries; % Δ in real gross domestic investment/ GDP ratio; % Δ in real education expenditure/ total government expenditure; % Δ in CPI; % Δ in real government consumption/GDP ratio; social & political instability dummy variable.
Results:	PEG.

Table A2 Time-series studies of exports and growth (continued)

Authors:	Ghatak et al. (1997) *Data:* Malaysia - annual, 1955:90 for aggregated analysis & 1966:90 for disaggregated part. Logs; real GDP, non-export GDP & exports.
Method:	Bivariate Granger for aggregated & 5-variable Granger for disaggregated. VARD for noncointegrated countries, VECM for cointegrated cases, with constant.
Unit root test:	ADF (preset to 1 or 2; with constant)
Cointegration test:	EG-ADF, JJ, Saikkonen (1991) (n.s.; with constant). Cointegration between real exports & GDP; between real exports & non-export GDP. Cointegration between disaggregated export groups, GDP (or non-export GDP) and other variables.
Lag selection:	FPE for bivariate; preset to 1 for 5-variable case.
Other variables:	Real gross domestic investment as % of real GDP; enrolment ratio in primary & secondary schools.
Results:	*ELG* at aggregate level for real GDP & real non-export GDP. *ELG* in disaggregated case for manufacturing exports & either GDP definition. *NC* for fuel exports & either GDP definition.
Authors:	Greenaway et al. (1997) *Data:* 30 post-1985 trade-liberalizing countries -annual, n.s.. % change in real GDP per capita on % change in exports.
Method:	Panel (IV), with & without country dummy variables. Het-consistent standard errors.
Other variables:	Lagged % change in real GDP per capita; % change in investment; % change in the labor force.
Results:	PEG.
Authors:	Karunaratne (1997) *Data:* Australia – qtr., seas. adj., 1971(1):92(4). Logs; per capita real GDP & exports.
Method:	6-variable Granger - IRFS and FEVDs, 12 & 24 quarter horizons. VECM with constant.
Unit root test:	ADF; PP (AIC; with constant)
Cointegration test:	JJ (AIC; Case 1). Cointegration.
Lag selection:	AIC
Other variables:	OECD production index; trade-weighted exchange rate; terms of trade index; technological innovation proxied by telephone penetration as measured by main lines per capita.
Results:	*BD*
Authors:	Liu et al. (1997) *Data:* China – qtr., 1983(3):95(1). Logs; real GNP, exports and (exp+imp).
Method:	Bivariate Granger, Sims, Hsiao (1979) & Geweke et al. (1983) (F); VARD with constant.
Unit root test:	ADF (AIC, SC; with constant and trend).
Cointegration test:	EG-ADF (AIC,SC; with constant and trend). Noncointegration,
Lag selection:	AIC, SC
Results:	*Granger & Hsiao - ELG. BD* for (exports+imports). *Sims - GLE. BD* for (exports+imports). *Geweke - NC. (Exports+imports)LG.*
Authors:	Thornton (1997) *Data:* Denmark, Germany, Italy, Norway, Sweden, UK - annual, periods within 1850:1913. Logs; real GDP & exports.
Method:	Trivariate Granger (F). VECM for cointegrated countries, VARD for noncointegrated, with constant.
Unit root test:	ADF, PP (n.s.; with constant & trend)
Cointegration test:	JJ (AIC; Case 0). Cointegrated except for Sweden.
Lag selection:	AIC
Other variables:	Ratio of total government revenue from import duties to total imports.
Results:	*ELG:* Italy, Norway, Sweden. *GLE:* UK. *BD:* Denmark, Germnay.
Authors:	Doyle (1998) *Data:* Ireland - annual, 1953:93. Logs; real GDP & exports.
Method:	Bivariate Granger (F); VECM with constant and trend.
Unit root test:	DF, ADF (preset to 2; with constant)
Cointegration test:	JJ (AIC, FPE; Case 2). Cointegration.
Lag selection:	AIC, FPE
Results:	*ELG*
Authors:	Ghatak (1998) *Data:* South Korea - annual, 1950:94. Logs; real per capita GDP & exports.
Method:	7-variable Granger (AIC); VARL, BVAR, VECM, with constant.
Unit root test:	ADF (n.s.; with constant)
Cointegration test:	EG-ADF (n.s.; with constant and trend). Cointegration.
Lag selection:	FPE
Other variables:	Real per capita investment; government spending; money supply; interest rate; exchange rate.
Results:	No *ELG* from VARL. *ELG* from BVAR and VECM.

Table A2 Time-series studies of exports and growth (continued)

Authors: Islam (1998) *Data:* 15 South East Asian countries - annual, 1967:91. Proportion of export earnings in GDP; change in share of nonexport component in GDP; real GDP.

Method: Bivariate & 5-variable Granger (F). VECM for cointegrated, VARD for noncointegrated, with constant.

Unit root test: ADF (n.s.)

Cointegration test: JJ (FPE; Case 1). Noncointegration except for Bangladesh, India, Nepal, Sri Lanka, Fiji.

Lag selection: FPE

Other variables: Share of non-defence expenditures in GDP; imports as a share of GDP; total investment share of GDP.

Results: *Bivariate - ELG:* Japan, Sri Lanka, Indonesia, Fiji, Bangladesh. *BD:* Nepal, Pakistan, Papua New Guinea. *NC:* Singapore, Hong Kong, South Korea, Malaysia, Philippines, Thailand, India. *Multivariate - ELG:* Japan, South Korea, Indonesia, Thailand, India. *GLE:* Malaysia. *BD:* Hong Kong, Singapore, Papua New Guinea, Pakistan, Sri Lanka, Fiji. *NC:* Philippines, Nepal, Bangladesh

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Authors: Shan & Sun (1998a) *Data:* Australia – qtr., seas. adj., 1978(3):96(3). Logs; real manuf. output & exports.

Method: 5-variable Granger (Wald); TYDL VARL with constant.

Unit root test: ADF (AIC & SC; with constant & trend)

Lag selection: AIC & SC

Other variables: Total employed persons; real imports; real gross fixed capital expenditure.

Results: *GLE*

Authors: Shan & Sun (1998b) *Data:* China – mth., seas. adj., 1978(5):96(5). Logs; real industrial output & exports.

Method: 6-variable Granger (Wald); TYDL VARL with constant.

Unit root test: ADF & PP (AIC & SC; with constant & trend and with constant only)

Lag selection: AIC & SC

Other variables: Energy consumption; labor force; real imports and capital expenditure.

Results: *BD*

Authors: Shan & Sun (1998c) *Data:* Hong Kong, Korea & Taiwan – qtr., seas. adj., 1978(1):96(3). Logs; real industrial output & export growth.

Method: 6-variable Granger (Wald); TYDL VARL in growth variables with constant.

Unit root test: ADF & PP (AIC & SC; with constant & trend and with constant only)

Lag selection: 2,8[1]

Other variables: Energy consumption; labor force growth; real import growth and real capital expenditure.

Results: *ELG:* Taiwan. *BD:* Hong Kong, Korea.

Authors: Tuan & Ng (1998) *Data:* Hong Kong - annual, 1961:85. Logs; real GDP, re-exports, domestic exports, total exports. Nominal also tried.

Method: Bivariate & trivariate Granger (Wald). VECM, with constant. For trivariate case exports are decomposed as re-exports & domestic exports.

Unit root test: ADF (1,2,3; with constant)

Cointegration test: JJ (Preset to 2 & 3; Case 1). Specification matters; cointegration between GDP, re-exports and domestic exports, so VECM.

Lag selection: Preset to 2 and 3.

Results: *ELG* for total exports and GDP and re-exports and GDP. *NC* for domestic exports and GDP.

Authors: Yamada (1998) *Data:* US, UK, Japan, Italy, Canada – qtr., seas. adj. 1975(1):97(2). France - 1977(4):97(2). Logs; real exports of goods & services and labor productivity (real GDP output per employee).

Method: 4-variable Granger (Wald); TYDL VARL with constant.

Lag selection: HQ, AIC.

Other variables: Terms of trade (export price deflator/import price deflator); real GDP of OECD countries.

Results: Only examined for ELG. *HQ: ELG* for Italy. *AIC: ELG* for Canada, UK.

Authors: Amin Gutiérrez de PiÁeres & Ferrantino (1999) *Data:* Colombia - annual, 1962:93. Logs; real GDP & exports.

Method: Bivariate & trivariate Granger & Sims (F); VARD with constant. 5 equation SEM (OLS & 3SLS).

Unit root test: DF (n.s.)

Cointegration test: EG-ADF (n.s.). Noncointegration.

Lag selection: Preset to 1.

Other variables: Real imports for trivariate Granger/Sims. Real imports; price of coffee; price of oil; world growth rates; effective export exchange rate; world interest rates; trade regime variable for SEM.

Results: *NC* from Granger/Sims analysis. PEG in GDP equation in SEM.

Endnotes

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[2] Some authors distinguish between a strategy of ELG and one of export promotion (e.g., Bhagwati, 1986). The former is one that gives primary emphasis to exports as opposed to production for the domestic market. Export promotion, on the other hand, is defined as a development strategy of eliminating biases against exports (for instance, removing quotas); it may include incentives to foster exports but production for the domestic market may also be encouraged. We recognize the validity of such a separation but it is a distinction that may be difficult to separate at the broad macro level we are studying empirically. Consequently, we do not distinguish between ELG and export promotion.

[3] This suggests that it may be important to disaggregate total real exports by commodity group. This is rarely undertaken in empirical work. Some exceptions are Giles et al. (1992) for New Zealand, Findlay and Watson (1996) for China, Boltho (1996) for Japan and Tuan and Ng (1998) for Hong Kong.

[4] Stability implies stationarity. This assumption can be relaxed for the setup of the models; the difficulty then is in the asymptotic distributions of the relevant test statistics. It is in dealing with possible nonstationarity issues that causes a number of the differences in the results of the empirical literature on ELG. We return to this issue.

[5] The restrictions involved in allowing for multi-step or long-horizon causality are typically nonlinear. Some testing suggestions are provided in Dufour and Renault (1998).

[6] For example, classical likelihood ratio tests (as in Johansen, 1988, 1991) consistently estimate the cointegrating rank (provided that the test size goes to zero as the sample size goes to infinity) and another possibility is to use an order selection method (e.g., Phillips, 1994). Note that consistent estimation of the lag order of the VAR is not necessarily required.

[7] The exception is Marin (1992: 685) who tries four different specifications for each country - with and without an error correction (EC) term and, with and without a linear trend term. He concludes ...the specification matters for the causality test results. The inclusion of the error-correction terms and/or the time trend have changed the p-values and the F-statistics considerably in most cases, although the basic results do not depend on the specification".

[8] We assume that where Korea is specified it is South Korea.

[9] Note that Atukeren (1994) shows that the accounting identity problem does not affect GNC tests.