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Export-led Growth : A Survey of the Empirical Literature and Some Noncausality Results[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. First, 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 which 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 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.

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KEYWORDS: economic growth, export promotion, causality, time series models, robustness, misspecification, model dimension, cointegration, innovation accounting.

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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 (for example, Mrydal, 1970; Little et al., 1970; Meier, 1984; Keesing, 1967; Bhagwati and Srinivasan, 1978; Krueger, 1978, 1980, 1985)[2]. Is export growth the Aengine@ of economic growth, is it only a Ahandmaiden@ or is there only a contemporaneous relationship between them? (Nurkse, 1961; Kravis, 1970). 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 [3]. For the export-led growth (ELG) studies outward orientation is measured by some function of the trade flow of exports. 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 Aopenness@.

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[4]. The neoclassical view has been that growth can be achieved by export-led growth (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: AChina=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; Sachs and Warner, 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 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 many studies show conflicting results. Our first aim in this paper is to provide a summary of the empirical literature, and we present information on more than one hundred and fifty papers. We concentrate on papers that are explicitly interested in

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[2] See Bhagwati (1986) for a survey and critique of this literature.

[3] See Södersten (1964), Haring (1963) and Balassa (1989) for discussions of some of the early contributions to the growth/trade debate.

[4] Some authors distinguish between a strategy of ELG and one of export promotion (e.g., Bhagwati, 1986, 1988b; Barnham et al., 1992). The former is one which 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.

the export-economic growth relationship rather than those which 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 naturally dated while the later papers are quite 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 studies use cross-country correlation coefficients to test the ELG hypothesis; these were followed by regression applications (typically least squares based) which 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. Our second aim is to 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 which may exist between exports and economic growth, and we describe and summarize our survey of the empirical literature to date in section 3. Further, section 3 presents discussions of the current time series techniques. Our illustrations of the conflicts that may result with the data from Portugal and Canada are given in section 4. The final section provides a summary, some suggestions for applied researchers, and our concluding remarks.

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

There are a number of reasons within trade theory to support the export-led growth proposition (see, for instance, Krugman, 1987; Havyrlyshyn, 1990 for a survey). 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., Caves, 1970; Hart, 1983; Krugman, 1987; Ben-David and Loewy, 1996; Lucas, 1988; Rivera-Batiz and Romer, 1993; Romer, 1990) which may result in further efficiency gains. Third, an increase in exports may loosen a foreign exchange constraint (see, for instance, McKinnon, 1964; Chenery and Strout, 1966; Esfahani, 1991) which makes it easier to import inputs to meet domestic demand and so allow for output expansion. Outward orientation makes it possible to use external capital for development and so not suffering from a debt servicing problem and, it is argued, export promotion may 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, export-led growth may be seen as part of the product and industry life-cycle hypothesis (e.g., Cornwall, 1977; Yarborough and Yarborough, 1994). 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 export-led growth 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. The dynamic general equilibrium model of a small open LDC developed by Buffie (1992) is supportive of this idea. He determines that whether an export boom acts as an engine of growth depends on the structural characteristics of the economy. Others question whether a reliance on exports to lead the economy will result in sustained long-term economic growth in the less developed countries 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 exports from further less developed countries (LDCs), or whether trade barriers will impede this route of development[5]. Some scholars support the counter development strategy of protectionism or import substitution (e.g., Prebisch, 1950, 1959; Singer, 1950. See also Bagchi, 1982; Prebisch, 1984; Bruton, 1989; Grabowski, 1994). 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: e.g., Brander and Spencer, (1985). See Krugman (1989) and Brander (1995) for surveys. Based on the experience of Latin American countries, in particular, it is argued that trade between the ANorth@ and the ASouth@ 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).[6] 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 and may lead to a country being stuck producing goods from which the economic gains have been exhausted (e.g., Young, 1991). 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 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

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[5] See, for example, Adelman (1984) and Cline (1984) and the references therein.

[6] This suggests that it may be important to dis-aggregate 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.

many countries promote exports in one or more sectors while protecting others. Export promotion and import substitution strategies may well be complementary, the latter may be a necessary step for export-based growth; e.g., Grabowski (1994) and Hamilton and Thompson (1994).

There is also potential for growth-led exports (GLE). Bhagwati (1988a) postulates that GLE is likely, unless antitrade bias results from the growth-induced supply and demand. Neoclassical trade theory supports this (e.g., Findlay, 1984) positing that other factors aside from exports are responsible for output growth (e.g., primary input growth and/or factor productivity growth). A growth-led exports (GLE) orthodoxy is justified by, for instance, Kaldor (1964), Lancaster (1980), Krugman (1984) and Stavrinos (1987): economic growth leads to enhancement of skills and technology with this increased efficiency creating a comparative advantage for the country which 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 (1988a) conjectures that increased trade (irrespective of cause) produces more income, and more income leads to more trade and so on. See also Cornwall (1977) and Grossman and Helpman (1991).

There is finally potential for no causal relationship between exports and economic growth: the growth paths of the two time series are determined by other, unrelated variables in the economic system (e.g., Pack, 1988, 1992; Yaghmaian, 1994).

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 1998 while Table A2 provides information on the literature between 1972 and 1998 that consider individual country analyses over time. One group of cross-section research looks at rank correlation coefficients or simple OLS regressions between exports and output (Maizels, 1963, 1968; Haring and Humphrey, 1964; Syron and Walsh , 1968; Kravis, 1970; Voivodas, 1973; Michaely, 1977; Balassa, 1978a,b, 1982; Heller and Porter, 1978; Tyler, 1981; Kavoussi, 1984, 1985; Rana, 1986; Gonçlaves and Richtering, 1987; Singer and Gray, 1988; Greenaway and Sapsford, 1994b). The number of countries dealt with varies from seven to more than one hundred; various time periods are investigated and several definitions of the Aexport@ and Aeconomic growth@ variable are adopted. The export-led growth hypothesis is supported if a positive, significant correlation is observed. The general conclusion from these simple cross-sectional correlation studies 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 Aaccounting identity@ effect leads some authors to use output net of exports or alternative export variables. Also arising from this research is that there may be a need for a minimum threshold of development before any association may exist. That is, export-led growth may only arise after a certain level of development (usually proxied by income) has been achieved.

As only exports and growth are investigated, any observed correlation may be reflective of underlying relationships via other economic variables. This concern results in a group of cross-sectional studies which estimate aggregate production functions that include exports as an explanatory variable along with other proposed economic growth determining fundamentals such as labor, capital, investment and so on: Emery, 1967; Michalopoulos and Jay, 1973; Papanek, 1973; Voivodas, 1973; Williamson, 1978; Balassa, 1978a, 1981, 1984, 1985; Tyler, 1981; Feder, 1983; Salvatore, 1983; Kavoussi, 1984; Kormendi and Meguire, 1985; Jaffee, 1985; Ram, 1985; Helliener, 1986; Rana, 1986, 1988; Kohli and Singh, 1989; Mbaku, 1989; Moschos, 1989; Fosu, 1990a, 1996; Otani and Villaneuva, 1990; Sheehey, 1990, 1992; Dodaro, 1991; Esfahani, 1991; Salvatore and Hatcher, 1991; Sawhney and DiPietro, 1991; Dollar, 1992; De Gregorio, 1992; Moore, 1992; Sprout and Weaver, 1993; Coppin, 1994; Greenaway and Sapsford, 1994b; Hotchkiss et al., 1994; Amirkhalkhali and Dar, 1995; Song and Chen, 1995; Yaghmaian and Ghorashi, 1995; Burney, 1996; Park and Prime, 1997; McNab and Moore, 1998.

Linear regression models are estimated in which a growth variable is regressed on an export variable. The export growth hypothesis is supported if the coefficient on the export variable is significantly positive. The growth variable is typically real GDP but in some studies is per capita GDP or manufacturing output or non-export GDP aiming to overcome the Aaccounting 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, though 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.

Exceptions 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). It is difficult to isolate why these investigations do not support export promotion while other studies do though different country sets, time periods and variable definitions are three obvious reasons. For example, Gonçlaves and Richtering find a significant positive export/economic growth effect when growth is measured via total GDP but not for non-export GDP - this may well be a reflection of the Aaccounting 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 whether the export/economic growth effect observed in other studies is spurious reflecting third variable effects. Sheehey (1990) observes positive correlations for other production categories; e.g., agriculture, manufacturing, construction, services. Since it is common to all or most other sectors it would seem that the framework may 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. Further, it is typically recognized that these studies fail to distinguish between statistical association and statistical causation[7]. Effectively, these studies take positive associations as evidence of causation. The 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 growth-led exports 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[8]; 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 which according to some criteria (e.g., income) may appear homogeneous. Many of the cross-country studies also use averaged growth rates which may introduce mis-specifications and parameter instabilities (see, for example, McDonald and Roberts, 1996) as the averages ignore changes which have occurred overtime for the same country.

The recognition of these described potential difficulties with this cross-sectional research in attempting to examine for export-led growth has led to the third group of studies which have reconsidered the ELG hypothesis by testing for causality in a formal way. Three time series methods are common, some more so than others: formal exclusion restrictions' hypothesis tests, generation of impulse response functions (IRFs), and forecast error variance decompositions (FEVDs)[9]. These properties are linked. Table A2 details the time series studies. Prior to comparing the results we first provide some necessary theoretical considerations on testing for causality. In this preliminary discussion we present some summary information from Table A2 and we employ example countries to illustrate some of the comments. We discuss the empirical research further in section 3.2.

3.1 Theoretical considerations

The most prevalent causality approach is grounded in Granger=s (1963, 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 studies in Table A2, 74% use some from of Granger=s causality to test for ELG; the other 26% use time series data to estimate regression models which do not incorporate dynamic effects. Granger's approach is Aatheoretical@ in the sense that no attempt is made to incorporate economic theory to impose any a

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[7] The cross-country researchers often recognize this. For example, Ram (1985) notes that Ait 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@ (p.416).

[8] This shortcoming was often noted. See, among others, Helleiner (1986), Feder (1983) and the references therein. 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.

[9] Also called innovation accounting.

priori restrictions upon the relationships between the variables of interest to the researcher. We say that y causes x if all available past information allows us to predict x better than we can when all past information except y is used. More formally, let Ω_t be the information set containing *all* relevant information available up to and including the time period [10]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, $M_x(1|\Omega_t) < M_x(1|\Omega_t \text{ excl.}\{y_t|s \leq t\})$, where Ω_t excl. $\{y_t|s \leq t\}$ is the set containing all 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 Apredict@ is not akin to Aforce,@ which is philosophically more parallel to Acause.@ Zellner (1979) for instance, argues against it on admissibility grounds; it is not practical to have all information at hand and so no globally optimal predictor is feasibly available. Consequently, implementation is usually undertaken by using the information in the past and present of the variables under study; Ω_t is replaced by $\{x_s, y_s|s \leq t\}$. Further, attention typically 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.

In order to define the links between causality testing, IRFs and FEVDs we suppose initially that a K-dimensional stable[11] process z_t possesses a moving average representation of the form:

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

where ϕ_i, $i \geq 0$, are $K \times K$ 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 [12]. Suppose z_t is partitioned as $z_t = (x_t', y_t')'$, 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 are involved in the causality under study: this is important. Partitioning the MA representation accordingly we write (1) as:

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

from which it follows that for forecasting x_t 1-step ahead y_t Granger non-causes 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

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[10] See, for example, Lütkepohl (1993a) for further details and discussion. We spend the 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.

[11] 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 non-stationarity issues that causes a number of the differences in the results of the empirical literature on ELG. We will return to this issue.

[12] This assumption too is not strictly necessary; see, for example, Dufour and Renault (1998).

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, 1981, 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 (1993a , pp.43-56). Then the impulse responses are 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 if there is no ELG in the Granger sense. Conversely, to continue this example, 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.

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: $\text{MSE}(z_{j,t}(h)) = \sum_{i=0}^{h-1}\sum_{k=1}^{K}\phi_{jk,i}^{2} = \sum_{k=1}^{K}\omega_{jk,h}$ where $\phi_{jk,i}$ is the jk^{th} element of ϕ_i and $\omega_{jk,h}/\text{MSE}(z_{j,t}(h))$ 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 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; see Sims (1972) and Pierce and Haugh (1977). However, orthogonalizing the error terms may result in non-zero FEVDs even if there is noncausality in the Granger sense; this will depend on the instantaneous causation in the system (see Lütkepohl, 1993a, p58).

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:

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

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 LR, Wald and F-tests, is the typical method adopted to test for Granger noncausality[13]. Many of the studies in Table A2 examine for causality within bivariate and higher order systems; allowing for this, 57% undertake bivariate analyses and of these all but one examine

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[13] The use of VARs themselves is controversial. Several scholars criticize their lack of foundation in theory and that they are data-driven in many ways. See, for example, Leamer (1985) and Cooley and Le Roy (1985).

for causality via restrictions tests on the AR representation. The implication of this discussion is that for these studies similar causality results would have been obtained if the MA representation had been used (subject to the provisos on orthogonalization given above).

Most of this discussion is couched in terms of 1-step Granger causality: indeed, for a bivariate or bivector system as described we can proceed directly to h-step Granger causality, h=1,2...∞; see Lütkepohl (1993a), Lütkepohl and Müller (1994) and Dufour and Renault (1998). That is, when z_t is partitioned as $z_t = (x_t', y_t')'$, then the following three statements are equivalent (Dufour and Renault, 1998, Proposition 2.3): (i) 1-step $y_t \nrightarrow x_t$; (ii) h-step $y_t \nrightarrow x_t$, $\forall$ h; (iii) ∞-step $y_t \nrightarrow x_t$. That is, 1-step $y_t \nrightarrow x_t$ implies that y does not Granger-cause x two periods ahead, three periods ahead and so on. Non-causality one-period ahead is a necessary and sufficient condition for non-causality 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 $z_t = (x_{1t}', x_{2t}', x_{3t}')'$, where x_{1t} has dimension $K_1 \geq 1$, x_{2t} has dimension $K_2 \geq 1$, x_{3t} has dimension $K_3 \geq 0$ and $K_1+K_2+K_3=K$. We consider Granger non-causality from x_{1t} to x_{2t}: in this system there are auxiliary variables in x_3 employed for prediction but which are not involved in the causality study. We write the MA representation and corresponding VAR(p) process, assuming invertibility, as:

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

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

1-step Granger noncausality from x_{1t} to x_{2t}, 1-step $x_{1t} \nrightarrow x_{2t}$, results when $\theta_{21,i} = 0$, i=1,...,p. However, when $m_3 \geq 1$, this does not correspond to $\phi_{21,i} = 0$, i=1,2,...in the MA representation (5); 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, which uses auxiliary variables for prediction purposes that are not involved in the causality question, the MA and

AR representations do not yield equivalent notions of Granger non-causality. A decision is required as to which concept is under study - zero impulse response (and correspondingly zero FEVDs) or exclusion restrictions on the AR representation. If the latter is chosen, then zero impulse responses are not evidence of non-causality and nor is the proportion of the variance of x_2 accounted for by the innovations of x_1 a measure of Granger causal priority from x_1 to x_2. 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 36 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 drawn upon in addition to those involved in the causality analysis (x_1 and x_2) , 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; see Sims (1980), Lütkepohl (1993b), Lütkepohl and Müller (1994) and Dufour and Renault (1998). For example, x_1 may help to predict x_2 two periods ahead, even though it is 1-step non-causal, 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[14]. Consequently, care is needed when interpreting non-causality in a multivariate system, incorporating additional variables, as opposed to a bivariate system: the latter is testing for causality at all horizons while the former is not. Indirect effects are real possibilities in an exports-economic growth system and are not allowed for in the currently used methods of detecting causality. This point too is clearly crucial when studying Table A2 as it implies that differences between the bivariate and higher-order systems may be a facet of the implicit time horizons of the causality 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 Granger causality in a bivariate or bivector system and in a system that does not involve all variables in the causality question. 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 replacement of all relevant information by that only for the variables in the system leads to one common source of misspecification in a Granger causal analysis whether undertaken as a formal test of exclusion restrictions or via IRFs and FEVDs: the results may change for the h-step forecast depending on the variables included in the information set. Aggregation of the data may also make a difference. If an annual system is studied and no causality is found from exports to GDP it does not follow that a corresponding 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 causality in Australia. Arnade & Vasavada=s (1995) study, which examines for

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[14] 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) and Lütkepohl and Müller (1994). Application of these to the ELG hypothesis is beyond the scope of this paper.

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; non-causality 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 non-causality 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 which exist and are bounded. Then, estimation of the parameters of the VAR(p) model by least squares (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 (or LM) 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 (1993a, Sec. 3.7). Consequently, the estimated impulse responses are asymptotically normal. Note however (Lütkepohl, 1993a, pp.101-2) that unfortunately this limiting distribution cannot be used for significance tests of the FEVDs: this perhaps limits their usefulness in causality testing, though some bootstrap to obtain standard errors.

Typically, of course, the VAR lag order is unknown. The usual approach is to either adopt an arbitrarily assigned value or to employ a data-based method. The choice of the lag length is important if we wish to avoid spurious causality (or spurious absence of causality). 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. See, for example, Lütkepohl (1993a). 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 Granger non-causality tests on the VAR parameters is evaluated by 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: parsimony in particular is not recommended. Giles and Mirza (1998), in their Monte Carlo investigation of the properties of Granger noncausality 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. Further, these distortions are less than those which can arise from other, as yet to be discussed, sources. Hong Kong is an example of a country that is well studied with different techniques and lag order methods. The ten investigations in Table A2 that examine for causality in Hong Kong have preset the lag order and used the FPE and AIC model - outcomes include non-causality, ELG, GLE and bidirectional causality. These differences may be due to lag selection methods as well as other reasons.

Our discussion of lag selection methods is brief short as the currently available Monte Carlo evidence suggests that the impact of a different data-based selection criteria on the empirical size and power of Granger noncausality tests is relatively minor. Overestimation of the lag-order seems preferable. This may suggest use of criteria such as the AIC and FPE rather than the SC and HQ, as the former move away from the lowest possible lag order at a slow rate as the sample size increases (though both are consistent estimators of the lag order). The AIC and FPE are asymptotically equivalent and have a positive probability of overestimating the true lag order: evidence from Gonzalo and Pitarakis (1996) suggests that this probability of overestimation is relatively small. A discussion and comparison of the many other lag selection methods is beyond the scope of this paper.

2. Non-stationarity: We have so far limited our attention to stationary, stable systems: that is, processes that have time invariant first and second moments. This excludes trends or shifts in the means or in the 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 noncausality either within the AR or MA representation, nor will the presence of unit roots change the relationship between VAR coefficients, IRFs and FEVDs.

Nonstationarity will alter the asymptotic distributional results of the LS estimators of the coefficients and so test statistics for causality may or may not have standard asymptotic distributions. These features have lead researchers away from the use of unrestricted VAR models to employing differenced VARs or error correction models (ECMs): however, how the nonstationarity is dealt with matters.

For this discussion we suppose that a Wald test is employed to test the validity of the exclusion restrictions in an unrestricted VAR (we call this a levels VAR or LVAR): a noncausality conclusion results from support for the null hypothesis. Unfortunately, the asymptotic null distribution of the Wald test statistic depends on the time series features in the LVAR system. LS estimation of the LVAR coefficients in the presence of unit roots is asymptotically efficient but second-order biased (Phillips, 1992a,b; 1995). The usual Wald statistic for noncausality may involve a singular covariance matrix which 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 unrestricted VARs with unit roots are also inconsistent; the estimates tend to random matrices (Phillips, 1998). These features suggest that noncausality testing should not be undertaken within a VAR model which may have unit roots (and cointegration) and nor should IRFs and FEVDs be generated from such unrestricted nonstationary VARs. Scholars responded by assuming explicitly that the time series under study were nonstationary and could be made stable by differencing or by introducing preliminary tests for unit roots into their analyses.

Engle and Granger=s 1987 paper changed the direction of empirical macroeconomics by introducing the concept of cointegration and the notion that variables which are cointegrated have an error correction representation. To formalize this we write the MA representation (1) in its LVAR(p) form, noting that for simplicity we have at this stage removed deterministic components:

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

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 K×K 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, defined by $\Delta z_t = z_t - z_{t-1}$, (7) can be written as a vector error correction model (VECM):

$$\Delta z_t = \Pi z_{t-1} + \Gamma_1 \Delta z_{t-1} + \ldots + \Gamma_p \Delta z_{t-p+1} + u_t$$

where, $\Pi = -(I - \theta_1 - \ldots - \theta_p)$, $\Gamma_i = \theta_{i+1} + \ldots + \theta_p$, $i = 1, \ldots, p-1$. We assume Δz_t is stationary and that $\det(I - \theta_1 w - \ldots - \theta_p w^p)$ has all its roots outside the complex unit circle except for possibly some unit roots. The nonstationary characteristics of z_t can be determined from the rank of Π (say r). There are three possibilities: (i) r=n; Π has full rank, z_t is integrated of order zero (I(0)). The LVAR system is stationary. (ii) r=0; Π is the null matrix; $z_t \sim I(1)$ with noncointegration. The LVAR system is nonstationary. (iii) 0<r<n; Π is of reduced rank and can be decomposed as $\Pi = \alpha\beta'$, where α and β are full-rank K×r matrices. β is the cointegrating matrix with $\beta' z_t$ stationary; α measures the rate of adjustment of the process z_t to the disequilibrium error $\beta' z_t$. This system has (n-r) unit roots and r cointegrating vectors. In this case the unrestricted LVAR may sometimes still be used for valid Wald testing of the noncausality hypothesis. Likewise, the ECM (8) may provide a means to consistently estimate the VAR coefficients, the IRFs and FEVDs and for valid testing of the noncausal null.

When there is cointegration, Toda and Phillips (1993, 1994) show that the Wald test for noncausality in the LVAR(p) will have its standard limiting χ^2 null distribution if there is Asufficient@ cointegration with respect to the causal effects being tested. Explicitly suppose as before, that z_t is partitioned as $z_t = (x_{1t}', x_{2t}', x_{3t}')'$, and we test 1-step $x_{3t} \not\rightarrow x_{1t}$ from the AR model. Then cointegration is Asufficient@ (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. So, for example, in a bivariate system the presence of cointegration is always sufficient and so estimation and testing for noncausality may be undertaken using an LVAR. The mere presence of cointegration in a trivariate or higher-dimensional system is not sufficient for valid use of an LVAR: there must be adequate cointegration of the right sort! AInsufficient@ cointegration results in the Wald statistic in an estimated LVAR 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 Asufficient@ cointegration. Consequently, attention has focused on testing for noncausality using the VECM. Note, first, that if there is noncointegration, (8) reduces to a classical first-differenced VAR, a DVAR(p-1). Second, note that estimation of a DVAR(p-1) when there is cointegration involves a misspecification: the omission of the relevant cointegration information. The effects on parameter estimates and test properties follow from the classical results on the exclusion of variables.

Under our assumptions, (8) is a stable, stationary system and the noncausality exclusion restrictions on (7) map directly to restrictions on the appropriate elements of Π, Γ_1 ... Γ_{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 $x_{3t} \nrightarrow x_{1t}$ on the VECM parameters will have its limiting χ^2 distribution provided rank(α_1)=K_1 or rank(β_3)=K_3. α_1 is the first K_1 rows of α. That is, any cointegration must be of an appropriate kind. In the bivariate case the mere presence of cointegration is sufficient but in higher-dimensional systems the causal variables must be adequately involved in the cointegration. If either of the rank conditions is not satisfied then nuisance parameters and nonstandard distributions enter the limit theory. Toda and Phillips provide sequential testing strategies for examining for Asufficient@ cointegration in the VECM.

Given the uncertainties of testing for noncausality within a LVAR, the usual route taken is to apply the following pretesting strategy: 1. Test for unit roots. 2a. If z_t is deemed stationary, then estimate an LVAR and proceed to the noncausality study. 2b. If z_t is determined nonstationary then test for cointegration. 3b(i). If no cointegration is found then estimate a DVAR model and proceed to the noncausality examination. 3b(ii). If cointegration is detected then study noncausality within a VECM or LVAR. 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) If cointegration is detected then test for Asufficient@ cointegration, and then noncausality (see Toda and Phillips, 1993, 1994). 54% of the papers in Table A2 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. This suggests that an appropriate model may not be used for the noncausality testing. Giles and Mirza=s (1998) Monte Carlo study on the properties of causality procedures indicates that often this pretesting route is not satisfactory. In many common types of situations the pretesting strategy leads to severe over-rejection of a noncausal null - often more so than in a classical standard LVAR, even if the processes are nonstationary! That is, pretesting for nonstationarity before the noncausality test can often lead to wrong conclusions of causality. Their results also demonstrate that the method adopted to pretest for nonstationarity is crucial.

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[15]. 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 alternatives? Toda and Yamamoto (1995) and Dolado and Lütkepohl (1996) propose a technique that avoids the preliminary tests for unit roots and cointegration and 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 LVAR process whose order exceeds the true order by the highest degree of integration in the system. If the true lag order is p we estimate an LVAR(p+1) if the highest degree of integration in the system is one, irrespective of the presence of cointegration. The test for noncausality then involves only the first p lags as the (p+1)=th coefficients are zero if they are indeed redundant: then the Wald test statistic

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[15] 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 order selection methods like those used in Phillips (1994) or Gonzalo and Pitarakis (1996). Note that consistent estimation of the lag order of the VAR is not necessarily required.

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 noncausality 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 (1998) also shows that this overfitting 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 which employ some form of VAR model to explore for causality between exports and economic growth. Of these, 10% adopt a VAR in the levels of the data; a differenced VAR 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 none test for Asufficient@ cointegration); while only 3 studies apply the overfitting method proposed by Toda and Yamamoto (1995) and Dolado and Lütkepohl (1996). The analyses that employ levels VAR 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 noncausality null distributions have been applied. Likewise, the application of first-differenced VAR models may be misspecified if the series are cointegrated as then potential causality from the long-run relationship has been omitted. The majority of studies adopt a pretesting approach typically estimating an ECM or a DVAR depending on the outcome of prior tests for unit roots and cointegration. Of those that specified their pretesting methods, the majority applied the Augmented Dickey-Fuller (ADF) test (Dickey and Fuller, 1979, 1981; Said and Dickey, 1981) 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.

<u>3. Deterministic terms:</u> This is an important question that is ignored by virtually all of the studies in Table A2[16]: what deterministic constants and trends should be included? How should they be included? What difference does it make? Needless to say, it matters and the economic implications differ. Limiting our attention to deterministic components that consist of constants and linear trend terms we can extend the LVAR and VECM process (7) as:

$$z_t = \mu + \delta t + \theta(L) z_{t-1} + u_t$$

and

$$\Delta z_{t-1} = \Pi z_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta z_{t-1} + \mu + \delta t + u_t$$

where μ and δ are $K \times 1$ parameter vectors and $t=1,2,\ldots$. Let the number of cointegrating vectors be $r>0$ so that $\Pi = \alpha\beta'$. Denote $\delta_t = \mu + \delta t + \alpha\beta' z_t$. The MA representation can be written as (see

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[16] The exception is Marin (1992) 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 (p685) A...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.@

Johansen, 1991, Theorem 4.1 and Johansen, 1994):

$$z_t = A + W_t + \tau_0 + \tau_1 t + 0.5\tau_2 t^2 + C\sum_{i=1}^{t} u_i$$

in which W_t is a stationary process; A is a vector such that $\beta' A=0$; $C = \beta_\perp(\alpha_\perp'\Theta\beta_\perp)^{-1}\alpha_\perp$ with $\Theta = I_K - \sum_{i=1}^{p-1}\theta_i$, $\beta_\perp$ a K × (K-r) matrix of full rank orthogonal to β, and $\alpha_\perp$ likewise defined. $\tau_2 = C\delta$. Comparing (9), (10) and (11) we see that a constant term in the nonstationary VAR gives rise to a linear trend in the process while a linear trend in the model results in a trend of either degree one or two depending on the relations between α and (μ+δt). That is, cointegration can lead to various different trending processes. Five cases are commonly considered:

Case 0: $\delta_t = \alpha\beta' z_{t-1}$. z_t has no deterministic terms and all of the stationary components have zero mean.

Case 1*: $\delta_t = \alpha(\beta', \beta_0)(z'_{t-1}, 1)'$; $\beta_0=(\alpha'\alpha)^{-1}\alpha'\mu$. z_t has neither a quadratic nor linear trend from (11) though z_t has a constant via the cointegrating relations, which here are given by $(\beta', \beta_0)(z'_{t-1}, 1)'$: each of the latter is a level stationary process, which is one that is composed of a stationary process and a constant term.

Case 1: $\delta_t = \mu+\alpha\beta' z_{t-1}$. z_t has a linear trend but it is not present in the cointegrating relations. The model consists of (K-r) variables that are comprised of I(1) variables and a linear trend, and r stationary variables.

Case 2*: $\delta_t = \mu+\alpha(\beta', \beta_0)(z'_{t-1}, t)'$. z_t has a linear trend which is also present in the cointegrating relations : each of the latter is a trend stationary process, which is one that can be decomposed as a stationary process plus a linear trend.

Case 2: $\delta_t = \mu+\delta t+\alpha\beta' z_{t-1}$. z_t has a quadratic trend but the cointegrating relations have a linear trend only.

The statistical analysis for cointegration, and therefore for causality, depends on which case is adopted. This choice needs to be made from economic considerations or, at least, from a statistical examination. We illustrate that the issue should not be ignored in section 4 .

3.2 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[17] and Japan, both of which are extensively represented in Table A2. Details are provided in Tables 1 and 2. In these tables we report information on method, estimation period, and results. Abbreviations adopted in the tables are described at the beginning of the appendix.

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

3.2.1 South Korea

Table 1 outlines thirty-six empirical works that examine for the relationship between exports and economic growth in South Korea. Of these, eleven estimate a form of aggregate production function models while the others examine for causality via a VAR framework. The former studies include bivariate and multivariate analyses with the multivariate work attempting to account for other factors which may contribute to economic growth, including investment, government spending, 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, which 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 distinguishes them 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. One might regard them as indicating patterns of instantaneous causality among the stationary representations, though it is usual to test for instantaneous causality conditional on the past history of the series and via the error terms. Many of the criticisms of the aggregate production function approach outlined in section 3 also apply here. In particular, the Aaccounting 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 five of these twenty-five case examinations use quarterly data. Interestingly, the five quarterly studies reach the same conclusion of BD causality. Restrictions tests on the VAR coefficients are undertaken by the four bivariate quarterly applications while the sole multivariate quarterly analysis evaluates FEVD & IRFs from the moving average representation derived from the estimated autoregressive model. Accordingly, these papers are effectively considering more that one-period ahead causality. The bivariate investigation of Gupta (1985) uses a Sims= test rather then the Granger test we outlined in section 3.1. 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 which 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 if the hypothesis that the parameters attached to the future values of x are simultaneously zero, is rejected. Sims=s test and Granger=s test may not give the same causality outcome but do so here. All except Gupta (1985) model effectively with the growth rates of real GDP and exports; Gupta uses an alternative ARIMA transformation to obtain stationarity[18]. Only two of the papers

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[18] Note that Atukeren (1994) shows that the Aaccounting identity@ problem does not affect Granger noncausality tests.

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 including1960 (1):1979(4) and 1973(1):1993(2). 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 determine GLE; five report BD causality and the remaining ten 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 if there is nonointegration and consequently conclude that there is no causality in these cases. It is clear, however, from section 3.1 that causality can arise from the short-run dynamics as well as from the long-run relationship. That is, it is a misconception to conclude that noncointegration implies noncausality. Secondly, some papers detect cointegration within a bivariate framework and then report noncausality: this is not a feasible outcome. Within the error correction framework, (linear) cointegration implies (linear) 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 connected with the noncausality 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: for example, 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 look at 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 DVAR 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 and 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) adopting 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. For example, Hsiao (1987) reports BD causality from Sims approach but noncausality from the Granger test. Time period may also be relevant; for example, Hodman and Graves (1995) determine BD causality from a bivariate DVAR over the period 1953:1990 applying Granger=s test in contrast to the similar models above which found noncausality.

Turning to the multivariate investigations, it is difficult to determine the reasons behind the various outcomes. Four papers model with DVARs without pretests for cointegration and each employs different sets of variables as well as time periods - two studies report noncausality; one ELG and the other BD causality from 1-step ahead Granger exclusion restriction tests. 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 they detect evidence of no causality - 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: two apply Johansen=s maximum likelihood approach and reach opposite conclusions, though one considers Case 1* while the other Case 1. 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 levels-VAR model. The latter result may be driven by misspecification of the null distribution of the noncausality test statistic in the nonstationary system as there is no discussion of whether the cointegration is Asufficient@ or not.

3.2.2 Japan

Twenty studies are presented in Table 2. Of these, four are OLS production function analyses while a VAR framework is adopted by the other applications. Six of the VAR investigations estimate DVAR models without prior testing for cointegration; five studies undertake a pretest for cointegration before deciding whether to employ a DVAR or ECM(or LVAR) model; FEVD=s from DVARs 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 overfitting method of testing for noncausality from the levels VAR 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 which 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 these remarks.

Seven VAR studies employ quarterly data with most covering the period from the late 1950s to late 1980s and one examining for causality from the mid 1970s to late 1990s. Bidirectional causality is the main outcome for the earlier time period and unfortunately the study which 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 adopt the same time period and 4-variable Granger causality but different information sets. Marin examines for causality 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 tests for causality within an ECM while Sharma et al. apply a DVAR 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 causality test to the variable specifications and to the adopted method/model.

The bivariate annual Granger causality 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 if the subgroup of car exports is studied rather than total exports, and Pomponio (1996) detects noncausality 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 others 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 noncausality 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 this may be so.

1. Sensitivity analysis: empirical examples of Portugal and Canada

Our discussion of some of the empirical work highlighted the potential sensitivity of the causality results to the estimation period, lag selection technique, economic growth and export growth definitions, auxiliary variables, and to other pretests undertaken to arrive at a final model specification. However, as most of the studies varied by more than one of these items it was not possible to strictly determine what was causing the change in the causality outcomes. Our aim in this section is to undertake a small sensitivity analysis for the Granger causality test in the ELG case. As a full sensitivity analysis would add substantially to an already long paper, we limit our attention to nonrobustness due to method and model; so we consider only one sample period, a limited information set and one lag selection method[19]. We restrict attention to Wald coefficient tests on the VAR formulation of the system, though our expectation is that similar nonrobustness results would occur from tests undertaken via the moving average representation such as those from IRFs and FEVDs.

To undertake this part of our study we reconsider the data used by Oxley (1993) for Portugal and Henriques and Sadorsky (1996) for Canada. That we draw upon these two studies should not be interpreted to imply our criticism of their work: on the contrary, both of these studies were quite rigorous in their investigations. They were chosen merely because the authors of these papers obligingly provided us with their data. It is our belief that the features we observe with these two data sets would result with any of the data sets in the literature. The Portugal data are bivariate while that for Canada are trivariate. For the latter we present bivariate and trivariate results. As our aim is to study robustness issues we do not spend space discussing the trade policies and relevant economic issues for these countries - we recognize the merits of this for a detailed individual country application.

4.1 Method matters

In this section we illustrate that modifying the testing method and information set can change the causality conclusion. We restrict our attention to pretests for cointegration. We recognize that unit root tests are typically undertaken as well but their impact is well researched in the literature.

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[19] Others have argued that noncausality tests are sensitive to the functional form structure of the estimating equations, to the lag structure specified, to the approach used to obtain white-noise, and to variable misspecification (e.g., Feige and Pearce, 1979; Jacob et al., 1979; Roberts and Nord, 1985; Sephton, 1989).

To limit scope we assume that the data series in their log-levels are integrated of order one: this is a reasonable assumption from prior research. We focus on three cointegration tests and we examine causality using a Wald test for exclusion restrictions from the VAR representation. For this exercise we adopt a χ^2 approximation for the finite sample null distribution - the results may differ with other finite sample approximations.

Given its popularity we examine Johansen=s maximum likelihood approach (JJML), limiting attention to the maximum eigenvalue test statistic and the Engle-Granger ADF approach (Engle and Granger, 1987). The null hypothesis is for noncointegration and so we include also a test which has cointegration as the null - McCabe et al.=s (1997) cointegration test (MLS test). Following recommendations in Leybourne and McCabe (1997) correlation in the system is allowed for via a data dependent parametric method. Due to space constraints we omit details of the tests here[20]. The usual approach with residual based cointegration tests is to include a constant in the static cointegrating regression and so we adopt Case 1* as outlined in section 3.1. That is, when cointegrated, z_t consists of (K-r) I(1) variables and r level stationary variables. For the trivariate model we present results for the JJML approach which does not test for sufficient cointegration and for the Toda and Phillips (1993, 1994) method which includes a pretest for sufficient cointegration: we call the latter TP. We follow the recommendation of Toda and Phillips (1994) and use their strategy P1[21].

We use the AIC[22], from the log-levels unrestricted VAR, to select the lag order - others have pointed out that this choice may affect the outcome of the cointegration and noncauasality tests. We compare the pretesting methods with the overfitting method suggested by Toda and Yamamoto (1995) and Dolado and Lütkepohl (1996) adding one additional lag given our assumption of I(1) variables. The Wald statistic for noncausality is then formed directly from the overfitted LVAR model. For the residual based cointegration tests we build the Wald statistic from either a DVAR model or from an ECM depending on the outcome of the cointegration test: for the latter, the residuals from the static cointegrating regression form the error correcting terms. In the case of Johansen=s approach the Wald statistic is generated from a DVAR model if no cointegration is detected, from a LVAR if full rank is supported and from an ECM model if reduced rank is favored. In the latter case the Wald statistic is constructed from the maximum likelihood estimates of the ECM, applying the normalization of Johansen (1988), by converting back to the LVAR estimates as outlined in Lütkepohl (1993a) for instance. The TP estimates are obtained from the same maximum likelihood estimates as JJML. We assume iid errors within equations of the VAR but we allow for contemporaneous correlation across equations.

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[20] They are available on request.

[21] Suppose we wish to test that x_{3t} noncauses x_{1t}. Let r* be the estimated cointegrating rank, α_1 be the first row of α and is of dimension r*, β_3 be the last row of β and let the relevant Γ parameters for the causal test be $\gamma_1 ... \gamma_{p-1.}$ Then strategy P1 of Toda and Phillips (1993) is test H_1: $\alpha_1=0$ via a Wald test statistic which is asymptotically $\chi^2(r^*)$ under the null. If H_1 is rejected, then test H_2: $\gamma_1=...=\gamma_{p-1}=0$ & $\alpha_1\beta_3=0$ via a Wald test statistic which is asymptotically $\chi^2(p)$ under the null; otherwise test H_3: $\gamma_1=\ldots=\gamma_{p-1}=0$ via a Wald test statistic which is asymptotically $\chi^2(p-1)$ under the null.

[22] Akaike=s (1973) information criterion. AIC(p) = log|w(p)| + 2(# of freely estimated parameters)/T, w(p) is the estimated matrix of scalar covariance terms with lag order p and T is the sample size. We allow for a maximum lag order of 8 years.

4.1.1 The Canadian data set

The Canadian data set is trivariate - real exports (X), real GDP (Y) and real terms of trade (T), defined as export unit value over import unit value. The annual data set, investigated in logarithmic form, spans 1877 to 1991: Henriques and Sadorsky (1996) study the periods 1877-1945; 1946-1991 and 1877-1991. We examine the latter period only, recognizing, though ignoring, potential problems of structural breaks. Table 3 summarizes the bivariate and trivariate results for testing for ELG and GLE using the Wald exclusions test within the autoregressive system. The AIC lag order is four for both the bivariate and trivariate models. The numbers in Table 3 are p-values for the Wald statistics assuming a limiting χ^2 null distribution.

The results are not dependent on dimension for the cases presented in Table 3. The overfitting method and MLS pretest approach favor no ELG or GLE. The EG-ADF procedure suggests no ELG but strong support for GLE while the JJML pretest method indicates strong evidence of bidirectional causality. One reason for the contradicting results is the different estimates of whether there is cointegration. The EG-ADF and JJML pretests imply cointegration and in the trivariate system there is evidence for two cointegrating vectors. Another source of explanation for the contrasting outcomes are misspecification errors - if there is cointegration then the MLS pretest technique is undertaking the noncausality tests in an underspecified model - the cointegration effects having been omitted. The noncausality outcome with this method could be due to this specification error. If so, then the overfitting results are also incorrect - this may arise from the loss in power in estimating a model with redundant lags.

However, the simulation experiments in Dolado and Lütkepohl (1996) and Giles and Mirza (1998) suggest that the loss in power, when overfitting, is quite small in samples of the size we are considering and in systems of the order being estimated here. Further, Giles and Mirza (1998), from the wide range of data generating processes considered, advocate that the overfitting method is more consistent at obtaining the correct causality conclusion than any of the studied pretest methods. Their simulation experiments show many cases when the EG-ADF and JJML methods obtain invalid cointegration conclusions. Consequently, the support for causality may be a consequence of such misspecifications. Irrespective of reasons, the results in Table 3 display the nonrobustness of causality conclusions to method.

4.1.2 The Portugese data set

Oxley=s 1993 annual data on real exports and real GDP for Portugal covers 1865 to 1991. We employ the full bivariate data set and transform each series into natural logarithms. The effects of structural breaks on the procedures are left for future work. The AIC implies five lags for the unrestricted log-levels bivariate system with a constant term. Table 4 reports the p-values from the three pretesting methods and the overfitting approach for the Wald noncausality tests assuming an asymptotic χ^2 null. We do not use the TP approach here as cointegration in a bivariate system is sufficient.

We again observe variation in outcome due to procedure. All four methods support GLE while the JJML technique is the only one to imply bidirectional causality. Interestingly, the MLS pretest suggests noncointegration while the EG-ADF and JJML both favor the presence of a cointegrating relationship: nevertheless, the MLS and EG-ADF procedures still reached the same causality conclusions.

4.2 Deterministic components

In this section we illustrate, by means of the Canadian and Portugese data, the impact of the choice of deterministic components. Our sensitivity analysis shows that changing the deterministic trends in the model specification can alter the causality outcome. We limit our attention here to the JJML and TP pretest approaches and to the overfitting method of Toda and Yamamoto (1995) and Dolado and Lütkepohl (1996), which remains valid with deterministic terms. We deal with Cases 0,1, 1*, 2 and 2* outlined in section 3.1. The AIC is again applied to select the lag order with the unrestricted log-levels VAR augmented by appropriate deterministic components. The optimal lag orders did not change for the two data sets.

4.2.1 The Canadian data set

Table 5 provides the estimated asymptotic p-values for the maximum eigenvalue likelihood ratio tests for cointegrating rank for both the bivariate and trivariate models. Irrespective of the choice of deterministic components, in the bivariate case there is strong support for one cointegrating vector. In the trivariate case, there is typically evidence for two cointegrating vectors - information set affects the cointegrating rank - however, allowing for trend terms can eliminate the basis for one of the cointegrating relationships. The p-values, assuming a limiting χ^2 null distribution, for the resulting Wald noncausality tests are presented in Tables 6a and 6b. We see that the overfitting method does not support a causal connection between gdp and exports for the several combinations of deterministic components and information set. The JJML and TP conclusions, on the other hand, vary with deterministic terms and information set. In the bivariate model all cases advocate GLE while ELG is endorsed for Case 0 and Case 1* but not for Cases 1, 2* and 2. The inclusion of the terms of trade variable eliminates backing for ELG in Case 0 and we no longer contend GLE for Cases 2 and 2*. Recall, though, that in the trivariate model we are limiting our attention to 1-step causality: the conclusions may change if multi-step causality were to be investigated. Nevertheless, across the trivariate cases we no longer support 1-step GLE when linear trends are included in the model.

4.2.2 The Portugese data set

Estimated asymptotic p-values for the maximum eigenvalue cointegrating rank test are reported in Table 7. These imply a strong basis for one cointegrating vector except for Case 2*: the latter imposes a trend stationary cointegrating relationship. We illustrate the effect on the noncausality tests of setting r*=1 or r*=0 for Case 2* by undertaking the noncausality tests employing a DVAR(4) and an ECM(4). The p-values for the Wald noncausality tests are given in Table 8: we assume a limiting χ^2 null distribution. Regardless of method and case, we conclude there is GLE. However, there is minimal evidence for ELG. There is some justification via the overfitting method when there are no deterministic terms in the model - this may be spurious causality from the omission of relevant deterministic components as inclusion of the latter eliminates the ELG support. All ECM models advocate bidirectional causality: the JJML approach is either overrejecting noncausality or the overfitting approach is lacking power. Both are possibilities here. Note additionally for Case 2* that the omission of the error correction term alters the ELG conclusion and illustrates the importance of the specification of the cointegrating rank.

5. 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. We have moreover demonstrated from applications for Canada and Portugal that the extensively used noncausality techniques to examine for causation between exports and overall economic activity are not robust. This is discouraging as it suggests that it is easy to obtain alternative outcomes. Furthermore, our sensitivity study implies that applied researchers need to exercise extreme care when testing for causality to avoid spurious results: indiscriminate application of such tests is not recommended. Hopefully, some of the information we provided will assist researchers in this direction.

Our examples in section 4 illustrated the effect of the choice of deterministic trending terms on the noncausality outcome. Part of the difficulty for the pretesting approaches that undertake a cointegration test, is that the result of the pretest crucially depends on the assumed deterministic trends in the system. It is even more complicated than we portrayed as the conclusions from the cointegration pretest and noncausality test are sensitive to the lag order. One practical way to proceed with the pretest strategy is to select simultaneously the cointegrating rank, the lag length and the applicable deterministic trends. The information criteria adopted to ascertain the lag order can be readily extended for this task. Let $P=K(r+(p-1)K+d)$ be the number of fitted parameters for the ECM with r denoting the cointegrating rank and d the number of parameters for the deterministic trending process including the constant term. Then we can augment the AIC and SC criteria, for example, as $AIC(p,r,d)=\log|w| + 2N/T$ and $SC(p,r,d)=\log|w| + N\log(T)/T$; where w is the estimate of the covariance matrix of the VAR. Phillips (1996) proposes a Bayesian model determination criteria explicitly for this problem. Phillips' posterior information criteria (PIC) is defined as $PIC(p,r,d)=\log|w|+(\log|\Theta|/T)$, where the penalty factor $|\Theta|$ is a function of the dimension of the model and the observed data. It would be straightforward to code the determination of p, r and d by such approaches into standard computer packages.

The sensitivity analysis showed as well that causality testing and innovation accounting are unlikely to be robust with the currently applied pretesting approaches. Accurate determination of the cointegrating rank is crucial for such methods to be useful and the currently popular tests do not seem adequate. Some hope may lie in the methods that avoid unit root and cointegration pretesting or in other more precise techniques to determine the cointegrating rank. Monte Carlo simulations suggest that the overfitting idea of Toda and Yamamoto (1995) and Dolado and Lütkepohl (1996) result in noncausality outcomes that are less sensitive than the commonly employed pretesting strategies. However, the overfitting procedure loses efficiency and power from the inclusion of the redundant lags. Other methods which may improve upon current techniques include proposals from Lütkepohl and Burda (1997), Phillips' (1995) FM-VAR method and its extensions (e.g., Kitamura, 1994; Quintos, 1998). Such methods may assist in obtaining more robust noncausality outcomes. Further, the time series models currently employed to test for export-led growth are dominated by linear VAR models and yet the theory is available to eliminate many of the limitations of these models. Examples include extensions to incorporate moving average terms and removal of the linearity assumption. It has long been recognized that moving average processes are common in economic systems and yet none of the export-led growth empirical literature allows for this. Testing for Granger causality in VARMA models involves nonlinear restrictions on the autoregressive and moving average parameters, though in some instances sufficient conditions for noncausality can be expressed as linear constraints (see, for instance, Lütkepohl, 1993; Boudjelleba et al., 1994). There are many nonlinear models of potential interest. Granger and Swanson (1996) and Balke and Fomby (1997), for instance, discuss nonlinear generalizations of cointegration and ECMs that may provide interesting possibilities for the export-led growth question. Other prospects include regime-switching VAR models (see Warne , 1996, for conditions for Granger 1-step noncausality in such models); smooth transition regressions (e.g., Teräsvirta, 1998); stochastic unit root models (e.g., Granger and Swanson, 1997; Swanson and Franses, 1997). McCabe and Leybourne (1997) allow for stochastic cointegration and Siklos and Granger (1997) propose regime sensitive cointegration. These relaxations of current assumptions in the linear VAR model may offer attractive options in the export-led growth debate. Extending beyond 1-step prediction in trivariate or higher dimensional systems would likewise appear obvious for future research. It is reasonable to believe that the cause and effect in any export growth - economic growth relation could take longer than a few quarters or even years..

The majority of papers in our survey focus on broad macroeconomic data and yet there is 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. Bernard and Jensen (1997) focus on firm data to ascertain whether good firms become exporters or whether exporting improves firm performances. We believe that much could be learned about the export-led growth question by assessing micro-based data.

Furthermore, 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). Non-causality 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. To quote Kindleberger=s (1961) study (p.305) AWe 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. Aside from the limitations of the methods that we have displayed in this paper, 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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Table 1 Time series analyses for South Korea

Authors	Data	Method	Other Variables	Result
Voivodas (1974)	annual, 1955:70	OLS (growth of real GDP on proportion of exports to output)		Significant export/economic growth relationship
Krueger (1978)	annual, 1954:71	OLS (log real GNP on log real exports relative to average exports over the entire period)	Time trend; dummy variables for trade regimes	Significant export/economic growth relationship
Schenzler (1982)	annual, 1950:79	OLS (real GDP growth on real export growth or export share)	Investment share; government spending share; foreign aid share.	Significant export/economic growth relationship
Gupta (1985)	quarterly, 1960(1):79(4)	Bivariate Sims (real GNP & exports); prewhitened via ARIMA transformations. Lags set to 4.		BD
Jung & Marshall (1985)	annual, 1953:80	Bivariate Granger (real GDP growth & export growth). LVAR in growth variables with constant. Lags preset to 2.		GLE
Darrat (1986)	annual, 1960:82	Bivariate Granger (LVAR in % change in real GDP & exports). Lags set to 2.		NC
Chow (1987)	annual, 1960:80	Bivariate Sims (data prefiltered by $(1-0.75L)^2$, LVAR in transformed real manufactured exports and output). Lags set to 3.		ELG
Darrat (1987)	annual, 1955:82	Real GDP growth on lagged & current export growth; real export growth on lagged & current GDP growth. Lags preset.		ELG
Hsiao (1987)	annual, 1960:82	Bivariate Sims & Granger (logs; real GDP & exports). DVAR with constant. Lags set to 3.		Sims - BD. Granger - NC
Ram (1987)	annual, 1960:82	OLS & AUTO (real GDP growth on real export growth or % share of changes in exports in GDP).	Population growth; real investment as share of output; dummy variable for 1973 oil crisis.	Significant export/economic growth effect.
Sung-Shen et al. (1990)	quarterly, seasonally adjusted, 1960(1):84(4)	Bivariate Granger (logs; real GDP & exports). DVAR with constant. DF for unit root. Lags by FPE.		BD
Bahmani-Oskooee et al. (1991)	annual, 1963:87	Bivariate Granger (real GDP & export growth). LVAR in Δgrowth variables (i.e. D^2VAR) with constant. Lags by FPE.		BD

Table 1 Time series analyses for South Korea

Salvatore & Hatcher (1991)	annual, 1960:85	OLS & AUTO (real GDP and export growth).	Gross fixed capital formation as % of GDP; real industrial production growth.	No significant export/economic growth effect.
Hutchison & Singh (1992)	annual, 1956:84	Bivariate & trivariate Granger (logs; real GDP, non-export GDP & exports). DVAR with no deterministic terms. Lags preset to 2.	Real investment.	NC irrespective of definition of economic growth.
Bahmani-Oskooee & Alse (1993)	quarterly, 1973(1):88(4)	Bivariate Granger (logs; real GDP & exports). ADF for unit roots; CRDW & EG-ADF for cointegration with constant - yes, so ECM with constant. Lags by specific to general.		BD
Dodaro (1993)	annual, 1967:86	Bivariate Granger (growth of real GDP & exports). LVAR in growth variables with constant. Lags preset to 2.		NC
Kugler & Dridi (1993)	annual, 1960:89	4-variables with conclusions based solely on cointegration outcomes. Logs; real GDP & exports. ADF for unit roots; JJML (Case 1) for cointegration with lags via AIC - yes.	Total private consumption expenditures; business-fixed investment.	ELG due to cointegration outcome.
Sengupta (1993)	annual, 1967:86	OLS (GDP growth & % share of changes in exports in GDP; Δreal GDP & exports).	Real investment; employment.	Significant export/economic growth effect.
Dutt & Ghosh (1994)	annual, 1953:91.	Bivariate with conclusions based solely on cointegration outcomes. Logs; real GDP & exports. ADF for unit roots; PO for cointegration with & without constant & trend - no.		NC based on cointegration outcome.
Greenaway & Sapsford (1994a)	annual, 1964:85	OLS (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). ADF for unit roots.	Share of investment in output; growth of the workforce.	No significant export/economic growth effect irrespective of specification.
Greenaway & Sapsford (1994b)	annual, 1957:85	OLS (real GDP per capita growth & growth of export share of GDP). ADF for unit roots.	Share of investment in output; growth of the workforce.	No significant export/economic growth effect.
Sengupta & España (1994)	annual, 1960:86	OLS (Δreal GDP & Δreal exports). CRDW & EG-ADF for cointegration - yes.	Δlabor force; real investment & (real investment)^2.	Significant export/economic growth effect.

Sharma & Dhakal (1994)	annual, 1963:88	4-variable Granger (logs; real GDP & exports). PP for unit roots; no cointegration test. DVAR with constant. Lags by FPE.	Population; real world output; real exchange rate; real gross fixed capital formation.	NC
Suliman et al. (1994)	annual, 1967:89.	4-variable Granger (logs; real GDP & exports). ADF for unit roots; no cointegration test. DVAR with constant. Lags by FPE.	Extent of development expressed as the ratio of currency outside bank to IMF money supply data; import competing (manufacturing) output.	BD
Amirkhal-khali & Dar (1995)	annual, 1961:90	OLS (real GDP growth on real export growth).	Real investment to output share; population growth.	Significant export/economic growth effect.
Arnade & Vasavada (1995)	annual, 1961:87.	Trivariate Granger (real agricultural output & agricultural exports). ADF for unit roots; JJML (Case 1*) for cointegration - yes, so ECM with no deterministic terms. Lags preset to 3.	Terms of trade (unit export value/unit import value).	GLE
Holman & Graves (1995)	annual, 1953:90.	Bivariate Granger & Sims (logs; real GNP & exports). DF for unit roots; EG-ADF for cointegration with constant - no, so DVAR with constant. Lags by FPE.		BD
Jin (1995)	quarterly, seasonally adjusted, 1973(1):93(2)	5-variable Granger - FEVDs & IRFs; 20 quarter horizon; logs; real GDP & exports). ADF for unit roots; EG-ADF for cointegration with constant & trend - no, so DVAR with constant. Lags set to 12.	Industrial production index; world commodity price level for exports; real exchange rates.	BD
Jin & Yu (1995)	quarterly, seasonally adjusted, 1960(1):87(4)	Bivariate Granger (logs; real GDP & exports). DVAR with constant. Lags by FPE.		BD
Dutt & Ghosh (1996)	annual, 1953:91	Bivariate Granger (logs; real GDP & exports). DF, PP and KPSS for unit roots; EG-ADF & PO for cointegration with constant & trend - yes, so ECM with no deterministic terms. Lags by SC.		NC

Pomponio (1996)	annual, 1965:85	Bivariate & trivariate Granger (nominal manufactured output & exports). Trivariate case is tested as (investment+export) causes output (IELG) and (investment+ output) causes exports (IGLE). Unit root & cointegration tests undertaken but not specified. LVAR in growth variables if integrated but not cointegrated; LVAR in levels if cointegrated. Lags set to 2.	Investment.	Bivariate - NC. Trivariate - BD.
Riezman et al. (1996)	annual, 1950:90.	Bivariate & trivariate Granger & FEVDs - 5 & 16 year horizons with 2 orderings tried. Geweke (1984) (1984b) CLFs. Also 5-variable CLF tried. LVAR in GDP & export growth in current international dollars with no deterministic terms. Lags not specified.	Real import growth. For 5-variable, also primary school enrolment as % of primary school age children; total investment/output.	GLE from bivariate analyses. ELG from trivariate restrictions test and FEVDs. CLF's suggest GLE for the trivariate system but NC for the 5-variable system.
Xu (1996)	annual, 1963:89	Bivariate Granger (logs; real GDP & exports). ADF for unit roots; EG-ADF with no constant for cointegration - yes, so ECM with constant. Lags by FPE.		ELG
Dhananjayan & Devi (1997)	annual, 1981:94	OLS (logs; real GNP growth, total exports, manufactured commodity exports, manufactured commodity exports as % of total exports).	Gross domestic investment.	Significant export/economic growth effect.
Ghatak (1998)	annual, 1950:94.	7-variable Granger (logs; real per capita GDP & exports). ADF for unit roots; EG-ADF for cointegration with constant and trend - yes, so ECM with constant. Also LVAR, BVARs with constant. Lags by FPE.	Real per capita investment; government spending; money supply; interest rate; exchange rate.	ELG from BVAR and ECM but not from LVAR.
Islam (1998)	annual, 1967:91	Bivariate & 5-variable Granger (proportion of export earnings in GDP; change in share of non-export component in GDP; real GDP). ADF for unit roots; JJML (Case 1) for cointegration - no, so DVAR with constant. Lags by FPE.	Share of non-defence expenditures in GDP; imports as share of GDP; total investment share of GDP.	NC from bivariate; ELG from multivariate.

Table 2 Time series analyses for Japan

Authors	Data	Method	Other Variables	Result
Blumenthal (1974)	annual, quarterly 1953:67	OLS (growth of real exports & growth of real GDP)		No significant export/economic growth effect.
Grabowski (1988)	annual, 1885:1940	OLS (growth of real GNE on exports or exports as share of GNE, or growth of per capita GNE & exports). Also 3 equation SEM.	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.	Significant export/economic growth effect.
Grabowski et al. (1990)	annual, 1885:1939 & 1952:80.	5-variable Granger (logs; real GDP & exports). DVAR with constant. Lags by FPE.	Real gross capital stock; labor force; agricultural productivity.	No ELG for 1885:1939; ELG for 1952:80.
Sung-Shen et al. (1990)	quarterly, seasonally adjusted, 1957(1):87(1)	Bivariate Granger (logs; real GDP & exports). DVAR with constant. DF for unit root. Lags by FPE.		BD
Afxentiou & Serletis (1991)	annual, 1950:85.	Bivariate Granger (logs; real GNP & exports). PP for unit root & cointegration - yes, so LVAR with no deterministic terms. Lags by SC.		GLE
Kugler (1991)	quarterly, seasonally adjusted, 1970:87.	4-variable Granger (logs; real GDP & exports). ADF for unit root; JJML (AIC, Case 1) for cointegration - no.	Total real private consumption; real gross fixed capital business investment.	Results based on cointegration outcome; so concludes no ELG.
Sharma et al. (1991)	quarterly, 1960(1):87(2).	4-variable Granger - FEVDs; 4 orderings; 8 & 20 quarter horizons; (logs; real GNP & exports). DVAR with constant. Lags by FPE.	Labor; real capital formation.	ELG
Marin (1992)	quarterly, 1960(1):87(2)	4-variable Granger (logs; manufacturing output per employee & real exports of manufacturing goods). DF & ADF for unit roots; CRDW & EG-ADF for cointegration with no deterministic terms -yes, so ECM with constant. Lags by BIC for own; set to 4 for other variables.	Terms of trade (export unit value/import unit value for manufacturing goods); real OECD output.	BD
Ghartey (1993)	quarterly, seasonally adjusted, 1955(1):91(2)	4-variable Granger (logs; real GNP & exports). DF & ADF for unit roots. No cointegration test. D^2VAR with no deterministic terms. Lags by FPE & SC.	Capital stock; terms of trade.	BD

Sengupta (1993)	annual, 1961:87	OLS (GDP growth & % share of changes in exports in GDP; Δreal GDP & exports).	Real investment; employment.	No significant export/economic growth effect but yes if definition of export variable changes.
Dutt & Ghosh (1994)	annual, 1953:91.	Bivariate with conclusions based solely on cointegration outcomes. Logs; real GDP & exports. ADF for unit roots; PO for cointegration with & without constant & trend - no.		NC based on cointegration outcome.
Sengupta & España (1994)	annual, 1960:85	OLS (Δreal GDP & Δreal exports).	Δlabor force; real investment & (real investment)^2.	No significant export/economic growth effect.
Arnade & Vasavada (1995)	annual, 1961:87.	Trivariate Granger (real agricultural output & agricultural exports). ADF for unit roots; JJML (Case 1*) for cointegration - yes, so ECM with no deterministic terms. Lags preset to 3.	Terms of trade (unit export value/unit import value).	NC
Jin & Yu (1995)	quarterly, seasonally adjusted, 1960(1):87(4)	Bivariate Granger (logs; real GNP & exports). DVAR with constant. Lags by FPE.		BD
Boltho (1996)	annual, 1913:37; 1952:73; 1973:90.	Bivariate Granger. LVAR in growth of real GDP & exports. Also some sectors.		Some evidence of GLE for total exports; BD for cars.
Dutt & Ghosh (1996)	annual, 1953:91	Bivariate Granger (logs; real GDP & exports). DF, PP and KPSS for unit roots; EG-ADF & PO for cointegration with constant & trend - no, so no further work undertaken.		NC because noncointegrated.
Pomponio (1996)	annual, 1965:85	Bivariate & trivariate Granger (nominal manufactured output & exports). Trivariate case is tested as (investment+export) causes output (IELG) and (investment+ output) causes exports (IGLE). Unit root & cointegration tests undertaken but not specified. LVAR in growth variables if integrated but not cointegrated; LVAR in levels if cointegrated; with constant. Lags set to 2.	Investment.	Bivariate - NC. Trivariate - IELG.

Riezman et al. (1996)	annual, 1950:90.	Bivariate & trivariate Granger & FEVDs - 5 & 16 year horizons with 2 orderings tried. Geweke (1984) CLFs. Also 5-variable CLF tried. LVAR in GDP & export growth in current international dollars with no deterministic terms. Lags not specified.	Real import growth. For 5-variable, also primary school enrolment as % of primary school age children; total investment/output.	GLE from bivariate analyses and from trivariate restrictions test & FEVDs. CLF's suggest GLE irrespective of included variables.
Islam (1998)	annual, 1967:91	Bivariate & 5-variable Granger (proportion of export earnings in GDP; change in share of non-export component in GDP; real GDP). ADF for unit roots; JJML (Case 1) for cointegration - no, so DVAR with constant. Lags by FPE.	Share of non-defence expenditures in GDP; imports as share of GDP; total investment share of GDP.	ELG from bivariate & multivariate.
Yamada (1998)	quarterly, seasonally adjusted, 1975(1):97(2).	4-variable Granger (real GDP per employee;real exports). OVER LVAR with constant. Lags by HQ and AIC.	Terms of trade (export price deflator/import price deflator); real GDP of OECD countries	Only examined for ELG. None detected for Japan.

Table 3 Canada : Wald Granger noncausality p-values (Case 1*)

	BIVARIATE MODEL				TRIVARIATE MODEL				
	OVER[a]	JJML[b]	MLS[c]	EG-ADF[d]	OVER[a]	TP[e]	JJML[f]	MLS[g]	EG-ADF[h]
exp $\nrightarrow$ gdp	0.659	<0.001	0.551	0.714	0.604	0.005	0.005	0.549	0.691
gdp $\nrightarrow$ exp	0.283	0.001	0.292	0.001	0.198	<0.001	<0.001	0.211	<0.001

1. One additional lag is included in the system based on our prior belief that the variables are integrated of order one.
2. The sample values of the maximum eigenvalue statistic are 19.156 and 10.758 for testing H_{01}: r=0 vs. H_{a1}: r=1 and H_{02}: r=1 vs. H_{a2}: r=2, respectively. Estimated asymptotic p-values are 0.001 and 0.270 respectively (MacKinnon et al., 1996). We reject H_{01} and support H_{02} suggesting one cointegrating vector. Noncausality testing is via an ECM(3).
3. The observed value of the test statistic is 0.704 which can be compared to a 10% critical value of approximately 0.097 (McCabe et al., 1997): we reject the null and support noncointegration. A DVAR(3) model, with unrestricted constant, is used to test for noncausality.
4. Eight augmentation terms are included as chosen via general to specific testing. The observed test statistic value of -3.846 has an estimated p-value of 0.015 (MacKinnon, 1994). An ECM(3) is then used to test for noncausality with the error correction term formed from the residuals from the static cointegrating regression.
5. From f. we have r*=2. For both causality tests we reject H_1, so the p-value in the table refers to that for testing H_2: both hypotheses are defined in footnote 21.
6. The sample values of the maximum eigenvalue statistic for testing H_{01}: r=0 vs. H_{a1}: r=1, H_{02}: r=1 vs. H_{a2}: r=2 and H_{02}: r=2 vs. H_{a2}: r=3 are 24.381, 16.240 and 12.395 with estimated asymptotic p-values of 0.0004, 0.044 and 0.616 respectively (MacKinnon et al., 1996). These results suggest two cointegrating vectors: we impose this and use the resulting ML estimates to convert back to the levels autoregressive model to undertake the noncausality tests.
7. Observed value of the test statistic is 0.594 compared to an approximate 10% critical value of 0.081 (McCabe et al., 1997). A DVAR(3) model, with unrestricted constant, is used to test for noncausality.
8. Eight augmentation terms (from a general to specific testing strategy) are included. The observed value of the test statistic is -3.749 which has an estimated p-value of 0.020 using MacKinnon (1994). The noncausality tests are undertaken via an ECM(3) with the residuals from the static cointegrating regression as the error correction terms.

Table 4 Portugal : Wald Granger noncausality p-values (Case 1*)

	OVER[a]	JJML[b]	MLS[c]	EG-ADF[d]
exp $\nrightarrow$ gdp	0.191	0.001	0.253	0.192
gdp $\nrightarrow$ exp	0.002	<0.001	0.003	0.003

1. One additional lag is included in the system.

2. The sample values of the maximum eigenvalue statistic for testing H_{01}: r=0 vs. H_{a1}: r=1 and H_{02}: r=1 vs. H_{a2}: r=2 are 19.325 and 9.676 with estimated asymptotic p-values of 0.001 and 0.365 respectively (MacKinnon et al., 1996). This cointegration is incorporated in an ECM prior to the noncausality tests.

3. The observed value of the test statistic is 0.779 compared to a 10% critical value of approximately 0.097 (McCabe et al., 1997): we reject the null and support noncointegration. The noncausality tests are undertaken using a DVAR(4) model.

4. General to specific testing indicated the need for five augmentation terms. The observed test statistic value of -3.302 suggests cointegration when compared with an estimated p-value of 0.062 from MacKinnon (1994). Causality testing then proceeded using an ECM(4) with the error correction term formed from the residuals from the static cointegrating regression.

Table 5 Canada : Estimated asymptotic p-values for maximum eigenvalue cointegrating rank test

Case	Bivariate		Trivariate			Conclusion	
	r=0 vs. r=1	r=1 vs. r=2	r=0 vs. r=1	r=1 vs. r=2	r=2 vs. r=3	Bivariate r*	Trivariate r*
0	<0.001	0.995	<0.001	0.006	0.999	1	2
1*	0.001	0.270	<0.001	0.044	0.616	1	2
1	<0.001	1.000	<0.001	0.049	1.000	1	2
2*	0.049	0.875	<0.001	0.221	0.990	1	1
2	<0.001	0.792	<0.001	0.117	0.965	1	1

Note: asymptotic p-values are generated from the Fortran code provided by MacKinnon et al. (1996).

Table 6a Canada : OVER Wald Granger noncausality p-values

Case	BIVARIATE		TRIVARIATE	
	exp $\nrightarrow$ gdp	gdp $\nrightarrow$ exp	exp $\nrightarrow$ gdp	gdp $\nrightarrow$ exp
0	0.682	0.356	0.604	0.198
1*&1	0.659	0.283	0.614	0.169
2*&2	0.607	0.341	0.567	0.208

Table 6b Canada : JJML and TP Wald Granger noncausality p-values

Case	JJML				TP	
	BIVARIATE		TRIVARIATE		TRIVARIATE	
	exp $\nrightarrow$ gdp	gdp $\nrightarrow$ exp	exp $\nrightarrow$ gdp	gdp $\nrightarrow$ exp	exp $\nrightarrow$ gdp	gdp $\nrightarrow$ exp
0	<0.001	0.006	0.657	0.012	0.657[a]	0.012[a]
1*	<0.001	0.001	0.005	<0.001	0.005[a]	<0.001[a]
1	0.561	0.002	0.531	0.001	0.590[b]	0.001[a]
2*	0.425	0.002	0.519	0.240	0.593[b]	0.255[b]
2	0.440	0.002	0.496	0.216	0.588[b]	0.250[b]

(a) Reject H_1. P-values are for testing H_2.

(b) Do not reject H_1. P-values are for testing H_3.

Table 7 Portugal : Estimated asymptotic p-values for maximum eigenvalue cointegrating rank test

Case	Bivariate		Conclusion
	r=0 vs. r=1	r=1 vs. r=2	r*
0	<0.001	1.000	1
1*	0.001	0.365	1
1	0.001	0.616	1
2*	0.104	0.834	0 or 1
2	0.001	1.000	1

Note: asymptotic p-values are generated from the Fortran code provided by MacKinnon et al. (1996).

Table 8 Portugal : OVER and JJML Wald Granger noncausality p-values

Noncausality	OVER			JJML					
	Case 0	Cases 1 & 1*	Cases 2 & 2*	Case 0	Case 1*	Case 1	Case 2*		Case 2
							r*=0	r*=1	
exp↛ gdp	0.095	0.191	0.181	0.008	0.001	0.009	0.144	0.011	0.011
gdp↛ exp	0.002	0.002	0.003	0.002	<0.001	0.005	0.001	0.005	0.003

Appendix

Notes to Tables A1 & A2

PEG	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.
D^{2}VAR	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 reports 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 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 test. The expressions in the parenthesis give the technique adopted to select the truncation lag and the deterministic components included in the relevant regression.
JJML	Johansen & Juselius 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.
CCR	Canonical cointegrating regression of Park (1992).
KPSS	Kwiatkowski et al.'s 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. (1993).
OVER	Overfitting method proposed by 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)
Other variables:	
Results:	PEG
Authors:	Haring & Humphrey (1964)
Data:	pooled - 1950:60
Method:	OLS (level of GNP on exports in current prices)
Other variables:	
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)
Other variables:	
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)
Other variables:	
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)
Other variables:	
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 countries.
Method:	rank correlation (averaged per capita GNP growth and averaged growth of export share)
Other variables:	
Results:	PEG - minimum threshold of development needed before associated.

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

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)
Other variables:	
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)
Other variables:	
Results:	PEG
Method:	OLS (averaged growth in real GNP on averaged growth in real exports)
Other variables:	
Results:	PEG
Authors:	Heller & Porter (1978)
Data:	pooled - 41 LDCs, 1950:73 & sub-sample of 24 middle-income countries.
Method:	rank correlation (averaged growth in per capita non-export real GDP on averaged growth in real exports)
Other variables:	
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)
Other variables:	
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)
Other variables:	
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)
Other variables:	
Results:	PEG

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

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)
Other variables:	
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.
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)
Other variables:	
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.

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

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)
Other variables:	
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.
Other variables:	
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 growth×export share of GDP.
Results:	PEG
Authors:	Singer & Gray (1988)
Data:	pooled - 52/51 developing countries, 1967:73 ; 1973:77; & 1977:83. Same countries as Kavoussi (1985). Various groups.
Method:	rank correlation (averaged real GNP growth & averaged real exports growth)
Other variables:	
Results:	PEG for most groups; some insignificant.
Authors:	Kohli & Singh (1989)
Data:	pooled - 31 countries, 1960:70 & 1970:81. Same countries as Feder (1983) excl. Taiwan.
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 orientation.
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 member 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)
Other variables:	
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

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

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
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)
Other variables:	
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 orientation.
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.

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

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 & quarterly, 1953:67
Method:	OLS (growth of real exports on growth of real GDP)
Unit root test:	
Cointegration test:	
Lag selection:	
Other variables:	
Results:	No significant relationship.
Authors:	Voivodas (1974)
Data:	Korea - annual, 1955:70
Method:	OLS (growth of real GDP on proportion of exports to output)
Unit root test:	
Cointegration test:	
Lag selection:	
Other variables:	
Results:	Significant export/economic growth relationship.
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)
Unit root test:	
Cointegration test:	
Lag selection:	
Other variables:	Time trend; dummy variables for trade regimes
Results:	Significant export/economic growth relationship
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)
Unit root test:	
Cointegration test:	
Lag selection:	
Other variables:	Trade balance; current account.
Results:	Significant export/economic growth relationship.
Authors:	Schenzler (1982)
Data:	Chile, India, South Korea - annual, 1950:79
Method:	OLS (real GDP growth on real export growth or export share)
Unit root test:	
Cointegration test:	
Lag selection:	
Other variables:	Investment share; government spending share; foreign aid share.
Results:	Significant export/economic growth relationship.
Authors:	Gupta (1985)
Data:	South Korea - quarterly, 1960(1):79(4) & Israel - quarterly, 1969(1):81(1). Real GNP & exports.
Method:	Bivariate Sims (F); prewhitened via ARIMA transformations; transformed VAR with trend & constant.
Unit root test:	
Cointegration test:	
Lag selection:	Preset to 4.
Other variables:	
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); DVAR & some D^{2}VAR with constant.
Unit root test:	
Cointegration test:	
Lag selection:	Preset to 2; increased to 3 if residuals correlated.
Other variables:	
Results:	*ELG:* Indonesia, Greece, Egypt, Costa Rica, Ecuador. *GLE:* Iran, Nigeria, Kenya, South Africa, Korea, Pakistan,

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

Jung and Marshall (1985) - continued	
	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); LVAR in specified variables.
Unit root test:	
Cointegration test:	
Lag selection:	Set to 2 after nonparametric test for serial noncorrelation.
Other variables:	
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 (1-0.75L)^2 ; transformed VAR with constant.
Unit root test:	
Cointegration test:	
Lag selection:	Preset to 3.
Other variables:	
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)
Unit root test:	
Cointegration test:	
Lag selection:	Preset - up to 4 lags.
Other variables:	
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); DVAR with constant.
Unit root test:	
Cointegration test:	
Lag selection:	Preset to 3 except 2 for Singapore.
Other variables:	
Results:	*Sims - GLE:* Hong Kong. *BD:* South Korea, Taiwan, Singapore. *Granger - GLE:* Hong Kong. *NC:* South Korea, Taiwan, Singapore.
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)
Unit root test:	
Cointegration test:	
Lag selection:	
Other variables:	Population growth; real investment as share of output; dummy variable for 1973 oil crisis.
Results:	Positive, significant, export/economic growth effect 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. Insignificant 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.

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

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).
Unit root test:	
Cointegration test:	
Lag selection:	
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; ∆growth of GNE; volume of world trade; time trend.
Results:	Positive, significant export/economic growth effect.

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.
Lag selection:	
Other variables:	Investment; government spending.
Results:	Positive, significant export/economic growth effect but ›declining: in importance over the different time periods.

Authors:	Kunst & Marin (1989)
Data:	Austria - quarterly, 1965(2): 85(4). Logs; real output per employee in manufacturing sector & real exports of manufactured goods.
Method:	4-variable Granger (F); DVAR with no deterministic terms.
Unit root test:	
Cointegration test:	
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); DVAR with constant.
Unit root test:	
Cointegration test:	
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 - quarterly, seasonally adjusted, periods within 1957(1):87(1). Logs; real GDP & exports.
Method:	Bivariate Granger (F; Akaike FPE); DVAR with constant.
Unit root test:	DF (with constant)
Cointegration test:	
Lag selection:	FPE
Other variables:	
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); DVAR for all countries except LVAR 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
Other variables:	
Results:	*GLE:* Norway, Japan, Canada. *BD:* US. *NC:* Austria, Belgium, Denmark, Finland, Germany, Iceland, Ireland, Netherlands, Spain, Sweden, Switzerland, UK.

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

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); LVAR in described variables with constant.
Unit root test:	
Cointegration test:	
Lag selection:	AIC
Other variables:	
Results:	No *ELG;* some *GLE* in pooled cases.
Authors:	Bahmani-Oskooee et al. (1991)
Data:	20 LDCs - annual, periods within 1951:87. Real GDP & export growth.
Method:	Bivariate Granger (Akaike FPE); LVAR in growth variables, some DVAR, with constant.
Unit root test:	
Cointegration test:	
Lag selection:	
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 - quarterly, seasonally adjusted, 1970:87. Logs, real GDP & exports.
Method:	4-variable Granger*;* ECM for cointegrated countries, with constant.
Unit root test:	ADF (preset to 1&6; with constant)
Cointegration test:	JJML (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); LVAR & DVAR (income second differenced) with constant.
Unit root test:	
Cointegration test:	
Lag selection:	AIC
Other variables:	
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); LVAR in growth variables with constant.
Unit root test:	
Cointegration test:	
Lag selection:	n.s.
Other variables:	
Results:	*ELG*
Authors:	Salvatore & Hatcher (1991)
Data:	26 developing countries - annual, 1963:85. 7 split up as 1963:73 & 1973:85.
Method:	OLS & AUTO (real GDP growth on real export growth)
Unit root test:	
Cointegration test:	
Lag selection:	
Other variables:	Gross fixed capital formation as % of GDP; real industrial production growth.

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

Salvatore & Hatcher. (1991) - continued	
Results:	Positive significant export coefficient 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 - quarterly, 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.
Unit root test:	
Cointegration test:	
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); ECM for cointegrated countries, DVAR 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
Other variables:	
Results:	*GLE:* Malaysia, Philippines, Singapore, Indonesia. *NC:* Thailand.
Authors:	Egwaikhide (1992)
Data:	Nigeria - annual, 1973:88. Logs; nominal and real GDP & oil exports. 7 component sectors of GDP.
Method:	OLS (GDP on current and lagged oil exports, with constant). 3 equation SEM (2SLS).
Unit root test:	
Cointegration test:	
Lag selection:	Preset to 2.
Other variables:	Imports; export price of crude oil.
Results:	AMarginal@ *ELG*.
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 foodstuffs, 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); ECM for cointegrated cases, DVAR 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
Other variables:	
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); DVAR with no deterministic terms.
Unit root test:	Undertaken but not specified.
Cointegration test:	
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.

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

Hutchison & Singh (1992) - continued.	
	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 - quarterly, 1960(1):87(2). Logs; real exports of manufacturing goods & labor productivity (manufacturing output per employee).
Method:	4-variable Granger (F); ECM for Germany, US & Japan, DVAR 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); DVAR 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 - quarterly, 1973(1):88(4). Logs; real GDP & exports.
Method:	Bivariate Granger (F); ECM 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.
Other variables:	
Results:	*BD:* Colombia, Greece, South Korea, Pakistan, Philippines, Singapore, South Africa, Thailand.
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); LVAR in growth variables with constant.
Unit root test:	
Cointegration test:	
Lag selection:	Preset to 2.
Other variables:	
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 - quarterly, seasonally adjusted, 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 LVAR for US (as data found stationary); D^2VAR for Japan & Taiwan, with no deterministic terms.
Unit root test:	DF, ADF (n.s.; with constant)
Cointegration test:	

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

Ghartey (1993) - continued.	
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); LVAR in growth variables with no deterministic terms.
Unit root test:	ADF (n.s.; with constant)
Cointegration test:	
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).
Unit root test:	
Cointegration test:	
Lag selection:	
Other variables:	World GDP index; capital stock series; employed labor force; ratio of domestic export prices to World export prices.
Results:	Significant positive export/economic growth effect.
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:	JJML (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); ECM with constant.
Unit root test:	ADF (preset to 4; with & without trend).
Cointegration test:	JJML (1,2,3; Case 1)
Lag selection:	FPE
Other variables:	
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.
Unit root test:	
Cointegration test:	
Lag selection:	
Other variables:	Real investment (capital); employment.
Results:	Significant positive export/economic growth effect 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); LVAR with constant & linear trend.
Unit root test:	
Cointegration test:	
Lag selection:	Preset to 2.
Other variables:	
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).
Unit root test:	
Cointegration test:	
Lag selection:	
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:	Significant positive export/economic growth effect.
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).
Lag selection:	
Other variables:	
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.)
Cointegration test:	
Lag selection:	
Other variables:	Share of investment in output; growth of the workforce.
Results:	Not significant positive export/economic growth effects 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.)
Cointegration test:	
Lag selection:	
Other variables:	
Results:	Significant positive export/economic growth effect 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.
Lag selection:	
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 significant export/economic growth effect.
Authors:	Karunaratne (1994)
Data:	Australia - quarterly, seasonally adjusted (F), 1959(3):92(1). Logs; real GDP & exports.
Method:	Bivariate Granger (F); DVAR, n.s.. 6-variable IRF & FEVDs (4^{th} Δs; 12 & 24 period ahead forecasts).
Unit root test:	ADF (AIC; n.s.)
Cointegration test:	

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

Karunaratne (1994) - continued	
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); LVAR or DVAR in growth variables with constant.
Unit root test:	Undertaken as a t-test on growth variable against a linear time trend.
Cointegration test:	
Lag selection:	FPE
Other variables:	
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.
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.); ECM 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
Other variables:	
Results:	*ELG:* PNG & Solomon Islands.
Authors:	Sengupta & España (1994)
Data:	Taiwan, South Korea, Japan, Thailand, Philippines - annual, periods within 1960:87. Δreal GDP & Δreal exports).
Method:	OLS simple regressions between variables.
Unit root test:	
Cointegration test:	CRDW; EG-ADF for South Korea only. Cointegration.
Lag selection:	
Other variables:	Δlabor force; real investment & (real investment)^2.
Results:	Significant positive export/economic growth effect 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); DVAR & D^2VAR with constant.
Unit root test:	PP (n.s.; with constant & trend)
Cointegration test:	
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); DVAR with constant.
Unit root test:	ADF (n.s.)
Cointegration test:	
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*.

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

Authors:	van den Berg & Schmidt (1994)
Data:	17 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. ECM 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 ECMs 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.
Unit root test:	
Cointegration test:	
Lag selection:	
Other variables:	Private & government consumption; population growth; ratio of investment to GDP growth.
Results:	Significant positive 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; ECM with constant.
Unit root test:	ADF (n.s.; with constant & trend)
Cointegration test:	JJML (preset to 2; Case 1). Cointegration for Singapore only.
Lag selection:	Preset to 2.
Other variables:	
Results:	*BD* for Singapore.
Authors:	Amirkhalkhali & Dar (1995)
Data:	23 developing countries - annual, various periods within 1961:90.
Method:	OLS (real GDP growth on real export growth).
Unit root test:	
Cointegration test:	
Lag selection:	
Other variables:	Real investment to output share; population growth.
Results:	Significant export/economic growth relationship 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); ECM for cointegrated countries, DVAR for noncointegrated, with no deterministic terms. Also tries both for all countries.
Unit root test:	ADF (preset to 3; no deterministic terms)
Cointegration test:	JJML (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.

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

Authors:	Bahmani-Oskooee & Domac (1995)
Data:	Turkey - annual, 1923:90. Logs; real GNP & exports.
Method:	Bivariate Granger (F); ECM with constant.
Unit root test:	ADF (n.s.; with constant & trend)
Cointegration test:	EG-ADF (n.s.; with constant & trend); JJML (preset to 4; Case 1*). Cointegration.
Lag selection:	LR general to specific.
Other variables:	
Results:	*BD*
Authors:	Holman & Graves (1995)
Data:	South Korea - annual, 1953:90. Logs; real GNP & exports.
Method:	Bivariate Granger, Sims (F & Akaike FPE); DVAR with constant.
Unit root test:	DF(with constant)
Cointegration test:	EG-ADF(n.s.; with constant) Noncointegration.
Lag selection:	FPE
Other variables:	
Results:	*BD*
Authors:	Jin (1995)
Data:	Hong Kong, Singapore, South Korea, Taiwan - quarterly, seasonally adjusted, 1973(1):93(2). Logs; real GDP & exports.
Method:	5-variable Granger; IRFs & FEVDs - 20 quarter horizon. DVAR 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 - quarterly, seasonally adjusted, 1960(1):87(4). Logs; real GNP/GDP & exports.
Method:	Bivariate Granger (F & Akaike FPE); DVAR with constant.
Unit root test:	
Cointegration test:	
Lag selection:	FPE
Other variables:	
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); LVAR with constant. Exogeneity tests of EH & EHR.
Unit root test:	ZA (n.s.)
Cointegration test:	
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); DVAR with no deterministic terms.
Unit root test:	ADF (SC, AIC; no constant)
Cointegration test:	
Lag selection:	AIC
Other variables:	
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); DVAR 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
Other variables:	
Results:	*ELG*

Authors:	Rashid (1995)
Data:	India - annual, 1960:89. Growth in real GDP and exports.
Method:	4-equation SEM
Unit root test:	
Cointegration test:	
Lag selection:	
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); DVAR with constant.
Unit root test:	DF, ADF (preset to 2; with constant & trend)
Cointegration test:	JJML (SC; Case 0). Noncointegration.
Lag selection:	SC
Other variables:	Real imports.
Results:	*NC*

Authors:	Amoateng & Amoako-Adu (1996)
Method:	35 African countries, pooled into 3 groups - annual, 1971:90. Logs; real GDP & exports.
Unit root test:	Trivariate Granger (Wald); DVAR with constant.
Cointegration test:	
Lag selection:	Preset to 4.
Other variables:	External debt servicing.
Results:	*BD*

Authors:	Bodman (1996)
Data:	Australia and Canada - quarterly, seasonally adjusted, 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); ECM with constant.
Unit root test:	ADF & PP (n.s.; with constant & trend)
Cointegration test:	JJML (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
Other variables:	
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); LVAR in growth variables with deterministic terms not specified.
Unit root test:	
Cointegration test:	
Lag selection:	Preset to 3 & 4.
Other variables:	
Results:	Some evidence of *GLE* for total exports; *BD* for cars.

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

Authors:	Cheng & Chu (1996)
Data:	US - annual, 1940:90. Logs; real GNP & exports.
Method:	4-variable Granger (Akaike FPE); ECM with constant.
Unit root test:	PP (n.s.)
Cointegration test:	JJML (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); ECM with constant.
Unit root test:	ADF (ACFs; with constant)
Cointegration test:	CRDW; EG-ADF (ACFs; with constant). Cointegrated.
Lag selection:	Preset to 1.
Other variables:	
Results:	*BD*
Authors:	Dutt & Ghosh (1996)
Data:	26 low-, middle-, and high-income countries - annual, 1953:91. Logs; real GDP/GNP & exports.
Method:	Bivariate Granger (F); ECM 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
Other variables:	
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); LVAR with constant.
Unit root test:	ADF, PP (highest significant lag from either AF or PAF of Δ time series; with constant)
Cointegration test:	JJML (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.
Unit root test:	
Cointegration test:	
Lag selection:	
Other variables:	Real investment; Δpopulation; Δreal government expenditure.
Results:	No positive significant export/economic growth effect.
Authors:	Jin & Yu (1996)
Data:	US - quarterly, 1959(1): 92(3). Logs; real GDP & exports of goods and services.
Method:	6-variable Granger. FEVDs; IRFs - 20 & 40 quarter horizons with 2 orderings tried. DVAR with constant.
Unit root test:	ADF (n.s.)
Cointegration test:	EG-ADF; JJML & 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.

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

Authors:	Karunaratne (1996)
Data:	Australia - quarterly, seasonally adjusted, 1971(2):94(2). Real GDP per capita & real exports of goods and services.
Method:	4-variable Granger (F); ECM with constant.
Unit root test:	ADF (AIC; with constant & trend).
Cointegration test:	JJML (preset to 4; Case 1). Cointegration.
Lag selection:	SC & FPE.
Other variables:	Competitiveness index = terms of trade index (export price/import price deflator) × 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); ECM 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]
Other variables:	
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 ECMs, with constant. 12-year horizon with 2 orderings tried.
Unit root test:	ADF (general to specific; with constant & trend)
Cointegration test:	JJML (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.
Authors:	Piazolo (1996)
Data:	Indonesia - annual, 1965:92. Logs. Real GDP & exports of goods and services.
Method:	6-variable Granger (Wald); ECM with constant.
Unit root test:	ADF, PP (n.s.; with trend & constant testing downwards).
Cointegration test:	EG-ADF (n.s.; with constant & trend) & JJML (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); DVAR for noncointegrated countries, ECM for cointegrated, with 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.

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

Authors:	Riezman et al. (1996)
Data:	126 countries - annual, 1950:90. GDP & export growth in current international dollars.
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.
Unit root test:	
Cointegration test:	
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.

Authors:	Thornton (1996)
Data:	Mexico - annual, 1895:1992. Logs; real GDP & exports.
Method:	Bivariate Granger (F); ECM with constant.
Unit root test:	ADF (n.s.)
Cointegration test:	JJML (various; Case 0). Cointegrated.
Lag selection:	FPE
Other variables:	
Results:	*ELG*

Authors:	Xu (1996)
Data:	32 developing economies - annual, periods within 1951:90. Logs; real GDP & exports.
Method:	Bivariate Granger (F). ECM for cointegrated cases, DVAR 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
Other variables:	
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.

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

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); DVAR with constant.
Unit root test:	ADF (n.s.; with constant & trend)
Cointegration test:	EG-ADF (n.s.; no constant). Noncointegration.
Lag selection:	FPE
Other variables:	
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.
Unit root test:	
Cointegration test:	EG-ADF (n.s.; no constant). Noncointegration.
Lag selection:	
Other variables:	Labor force growth; gross domestic investment as % of GDP; growth of government expenditure; growth of terms of trade.
Results:	Positive significant export/economic growth relationship.
Authors:	ňeres & Ferrantino (1997)
Data:	Chile - annual, 1962:91. Logs; real GDP & exports.
Method:	Bivariate Granger (F); DVAR with constant.
Unit root test:	Undertaken but not specified.
Cointegration test:	EG-ADF (n.s.)
Lag selection:	Preset to 2.
Other variables:	
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.
Unit root test:	
Cointegration test:	
Lag selection:	
Other variables:	Gross domestic investment.
Results:	Positive, significant, export/economic growth effect.
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.
Unit root test:	
Cointegration test:	
Lag selection:	
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:	Positive, significant, export/economic growth effect.
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. DVAR for noncointegrated countries, ECM for cointegrated cases, with constant.
Unit root test:	ADF (preset to 1 or 2; with constant)
Cointegration test:	EG-ADF, JJML, 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.

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

Ghatak et al. (1997) - continued	
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.
Unit root test:	
Cointegration test:	
Lag selection:	
Other variables:	Lagged % change in real GDP per capita; % change in investment; % change in the labor force.
Results:	Positive, significant, export/economic growth effect.
Authors:	Karunaratne (1997)
Data:	Australia - quarterly, seasonally adjusted, 1971(1):92(4). Logs; per capita real GDP & exports.
Method:	6-variable Granger - IRFS and FEVDs, 12 & 24 quarter horizons. ECM with constant.
Unit root test:	ADF; PP (AIC; with constant)
Cointegration test:	JJML (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 - quarterly, 1983(3):95(1). Logs; real GNP, exports and (exports+imports).
Method:	Bivariate Granger, Sims, Hsiao (1979) & Geweke et al. (1983) (F); DVAR 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
Other variables:	
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). ECM for cointegrated countries, DVAR for noncointegrated, with constant.
Unit root test:	ADF, PP (n.s.; with constant & trend)
Cointegration test:	JJML (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:	Amin Gutiérrez de Piňeres & Ferrantino (1998)
Data:	Colombia - annual, 1962:93. Logs; real GDP & exports.
Method:	Bivariate & trivariate Granger & Sims (F); DVAR 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. Significant positive export/economic growth effect in GDP equation in SEM.
Authors:	Doyle (1998)
Data:	Ireland - annual, 1953:93. Logs; real GDP & exports.
Method:	Bivariate Granger (F); ECM with constant and trend.
Unit root test:	DF, ADF (preset to 2; with constant)
Cointegration test:	JJML (AIC, FPE; Case 2). Cointegration.
Lag selection:	AIC, FPE
Other variables:	
Results:	*ELG*

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

Authors:	Ghatak (1998)
Data:	South Korea - annual, 1950:94. Logs; real per capita GDP & exports.
Method:	7-variable Granger (AIC); LVAR, BVAR, ECM, 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 LVAR. *ELG* from BVAR and ECM.
Authors:	Islam (1998)
Data:	15 South East Asian countries - annual, 1967:91. Proportion of export earnings in GDP; change in share of non export component in GDP; real GDP.
Method:	Bivariate & 5-variable Granger (F). ECM for cointegrated, DVAR for noncointegrated, with constant.
Unit root test:	ADF (n.s.)
Cointegration test:	JJML (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
Authors:	Shan & Sun (1998a)
Data:	Australia - quarterly, seasonally adjusted, 1978(3):96(3). Logs; real manufacturing output & exports.
Method:	5-variable Granger (Wald); OVER LVAR with constant.
Unit root test:	ADF (AIC & SC; with constant & trend)
Cointegration test:	
Lag selection:	AIC & SC
Other variables:	Total employed persons; real imports; real gross fixed capital expenditure.
Results:	*GLE*
Authors:	Shan & Sun (1998b)
Data:	China - monthly, seasonally adjusted, 1978(5):96(5). Logs; real industrial output & exports.
Method:	6-variable Granger (Wald); OVER LVAR with constant.
Unit root test:	ADF & PP (AIC & SC; with constant & trend and with constant only)
Cointegration test:	
Lag selection:	AIC & SC
Other variables:	Energy consumption; labor force; real imports and capital expenditure.
Results:	*BD*
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). ECM, with constant. For trivariate case exports are decomposed as re-exports & domestic exports.
Unit root test:	ADF (1,2,3; with constant)
Cointegration test:	JJML (Preset to 2 & 3; Case 1). Specification matters; cointegration between GDP, re-exports and domestic exports, so ECM.
Lag selection:	Preset to 2 and 3.
Other variables:	
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 - quarterly, seasonally adjusted, 1975(1):97(2). France - quarterly, 1977(4):97(2). Logs; real exports of goods & services and labor productivity (real GDP output per employee).
Method:	4-variable Granger (Wald); OVER LVAR with constant.
Unit root test:	
Cointegration test:	
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.