The causality nexus between Exports and Growth: The case of Hong-Kong

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Abstract

This article re-examines empirically the relationship between exports and growth for Hong Kong using annual and quarterly data over the period 1975-2007. Granger-causality is studied following two alternative approaches: the augmented lags method and the vector error correction model. The results obtained from both approaches are coherent for large samples (quarterly data), and reveal that the causal link between exports and GDP is bidirectional. However, the results obtained are contradictory when small samples (annual data) are used instead. This shows the importance of using sufficiently large samples in causality analysis.

1 Introduction

Two alternative hypotheses have been proposed in the literature to explain the relationship between exports and growth: the Export-Led-Growth (ELG) hypothesis and the Growth-Led-Export (GLE) hypothesis. The ELG hypothesis states that promoting the exports sector encourages economic growth, for example from productivity gains by learning through exporting (e.g., Blalock and Gertler, 2004). Participation in the exports markets can increase the benefits to the firms because it puts firms into contact with international best practice and promotes learning and productivity growth. According to the World Bank, "Improving the policy and business environments to create conditions favorable to trade, especially exports, is one of the most important ways for countries to obtain knowledge from abroad" (World Bank, 1998, p.18). In addition, in general, the production of export goods is focused on those sectors of the economy which are already more efficient. Thus, export expansion helps to concentrate investment in these sectors, which in turn augments the overall total productivity of the economy. The theory also recognizes that causality may run from output to exports (GLE). Lancaster (1980) and Krugman (1984), for example, justify GLE and argue that output growth has a positive impact on productivity. The consequence is a cost reduction in labor and capital that is expected to promote exports.

In a world-wide economic context, Hong Kong and the rest of the Asian newly industrializing countries (NICs) –Singapore, Korea, Taiwan and China– have got growth records over the last 30 years. They are commonly regarded as examples supporting the ELG hypothesis, in contrast to most Latin American and African countries, with relatively inwardly economies and very dismal growth rates. For example, Findlay and Watson (1996, p. 4) say that "China´s experience during the 1980s and 1990s, tends to support the argument that openness to trade is a mechanism for achieving more rapid and efficient growth and better distribution of domestic resources." Many studies contain similar assertions for other countries and different international organisms like the World Bank, the US Agency for International Development and the International Monetary Fund perceive the experiences of these countries as a model for development. However, the debates on the causal relation between exports and growth are, in the end, based on empirical analyses that often yield ambiguous results (see, e.g., the review in Giles and Williams, 2000a).

The evidence for the ELG/GLE hypothesis has also been ambiguous in the particular case of Hong Kong. The empirical literature has found evidence supporting the ELG hypothesis (e.g., Kugler and Dridi, 1993, and Tuan and Ng, 1998), supporting the GLE hypothesis (Hsiao, 1987), and supporting bidirectional causality (e.g., Chow, 1987, Jin, 1995, Yu, 1996, Islam, 1998, and Shan and Sun, 1998), while other studies concluded that there was no causal link (e.g., Darrat, 1986, 1987, Dodaro, 1993, Riezman et al., 1996, and Islam, 1998). The explanation to this dispersion of results is not simple because it depends on many factors as, for example, the sample size, the chosen period, the statistical technique used or the regressors sets included. Data aggregation may also make a difference. The fact that, using annual data, exports do not Granger-cause GDP does not necessarily entail that quarterly exports have also no impact on quarterly GDP.

The purpose of this paper is to contribute to the empirical investigation on the exports-growth nexus, improving the previous literature in the following ways.

First, with the aim of comparing the results obtained for small samples with those obtained for large samples, we use annual and quarterly series. Second, before verifying whether the series are I(1)[1] and searching to implement the corresponding tests in a reliable way, the quarterly series were seasonally adjusted and the study was carried out using adjusted series, with and without outliers corrected. Third, Granger-causality is studied following two alternative approaches: i) the augmented lags method of Toda and Yamamoto (1995) and Dolado and Lütkepohl (1996) (henceforth TYDL approach), and (ii) the vector error correction model approach outlined in Mosconi and Gianini (1992) and Hall and Milne (1994) (henceforth MGHM approach). The TYDL approach is useful because it avoids pre-test sequence and its derived problems (low power and their dependence on nuisance parameters), common to other formulations. The MGHM approach is also useful because it allows obtaining Granger-causality sources in the short and the long run, and verifying the coherence between the empirical results arising from both approaches.

In order to obtain a more complete analysis, two empirical models are considered. The first model only considers the variables GDP and exports (bivariate model). Nevertheless, when there are several factors influencing economic growths specification bias or spurious regression may arise if only causality between exports and economic growth is being tested. Hence, following Shan and Sun (1998), we consider a Model 2 (multivariate model) in which imports and gross fixed capital formation[2] are included in addition to GDP and exports.

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[1] Unit roots in levels and stationary after first differencing.

[2] The variable imports is widely used in previous literature. Imports and GFCF were recently used in Choong, C.K. et.al. (2003) and Choong, C.K. et al (2005).

Our results support the importance of using sufficiently large samples in causality analysis. While the results obtained from TYDL and MGHM approaches are coherent for large samples (quarterly data) they are contradictory when small samples (annual data) are used instead. In this respect, it is worthing to note that one should be careful with the sample size when analyzing causality because the modified Wald test used in TYDL approach tends to exhibit an incorrect size and display low power in small or even medium-sized samples (Shukur and Mantalos, 2000, and Mantalos, 2000), in addition to the well-known low power of cointegration test. Also it is necessary to emphasize that most of causality results on previous empirical literature were obtained with small or medium-sized samples. In particular, among the works for Hong Kong mentioned before, only Jin (1995) and Shan and Sun (1998) use medium-sized samples (quarterly data with 85 and 78 observations, respectively). In the rest of the works, the results were derived with small or even very small samples. However, a first differenced VAR model with 5 variables was used in Jin (1995) while, Shan and Sun (1998) only used TYDL approach from a VAR model in levels with 6 variables.

Empirical evidence with quarterly data from Granger causality tests based on both TYDL and MGHM approaches for Model 2, and only on TYDL approach for Model 1, indicates that the causal link between exports and GDP is bidirectional. With respect to the sources of short and long run, the findings from the MGHM analysis for the Model 2 show that both sources are bidirectional.

This paper is organized as follows. Section 2 briefly outlines the methodological lines that support the empirical application. Section 3 shows the empirical results. Finally, some concluding remarks are made in section 4.

2. Methodological Approach

The central tools used in this work are the Vector Autoregressive (VAR) models and the Vector Error Correction Model (VECM). From the VAR model, a cointegration study and TYDL approach are implemented, and from the VECM, the MGHM approach is carried out.

When we try to study the relationships of cointegration for more than two variables, it is not enough with the study of all and each one of the pairs of variables, because this may avoid the existing link between two of those variables and the rest. It is necessary, therefore, a multivariate cointegration analysis. Here we will follow the method developed by Johansen (1988), because it displays manifold comparative advantages when surpassing all the inherent limitations to OLS estimation of the cointegration regression.

Although cointegration implies the presence of Granger-causality it does not necessarily identify the direction of causality. On the other hand when we try to test the null hypothesis of absence of Granger-causality in integrated VAR models, a serious problem appears because the Wald statistic does not follow a standard distribution. In order to get asymptotic $?^2$ distribution of this statistic, we will follow the TYDL approach of Toda and Yamamoto (1995) and, Dolado and Lütkepohl (1996). These authors advise to fit a new VAR (k+1) to the data if the true generating process is a VAR (k), and perform a Wald test only on the coefficients of the first k lags

The TYDL approach is very simple and easy to apply. However, its drawback could be the possible inefficiency of the modified Wald test. In this sense, Shukur and Mantalos (2000) and Mantalos (2000) provide numerical evidence that the modified Wald test shows low power and does not exhibit the correct size in small or even in medium-sized samples (50, 100)). Mantalos (2000) in a Monte Carlo study illustrates the size and power of the Wald, LRE[3] and bootstrap tests for Granger-causality in integrated-cointegrated VAR systems. By using simple graphical techniques, the p-value plots, and power-size plots, properties of the tests in two different forms, the standard and the TYDL modified form, are studied. Regarding the size of the tests, the conclusion is that the modified Wald test performs badly in small and medium-sized samples, but for large samples, exhibits good performance. The bootstrap test showed the best performance in almost all situations. Regarding the power results, these depend on the order of the VAR model. While for the VAR (3) model, all the tests share the same power, for the VAR (2) model, the bootstrap test shows the best performance in all sample sizes. .

An alternative method applicable to the case of cointegrated VAR models is the MGHM approach proposed by Hall and Milne (1994), following Mosconi and Gianini (1992). These authors make the study of causality from the VECM representation of the cointegrated VAR:

$$\Delta Z_t = \Gamma_1 \Delta Z_{t-1} + \Gamma_2 \Delta Z_{t-2} + \ldots + \Gamma_{k-1} \Delta Z_{t-k+1} + \Pi Z_{t-k} + e_t$$

being $Z_t = \begin{pmatrix} Y_t \\ X_t \end{pmatrix}$ a p-dimensional variable where $p = p_1 + p_2$ is the total number of series and , p_1 and p_2 are the dimensions of Y_t and X_t, respectively. In this framework Y does not Granger cause X if,

i) $U' \ \Gamma \ V = 0$ and

ii) $U' \ \Pi \ U^{\perp} = 0$

[3] Edgeworth expansion corrected likelihood-ratio statistic.

where $U = \begin{pmatrix} 0 \\ I_{p_2} \end{pmatrix}$ is a ($p \times p_2$)–matrix, $U^{\perp} = \begin{pmatrix} I_{p_1} \\ 0 \end{pmatrix}$ is a ($p \times p_1$)–matrix, $V = I_{(k-1)} \otimes U^{\perp}$ is a ($p(k-1) \times p_1(k-1)$)–matrix, and $\Gamma = [\Gamma_1, ..., \Gamma_{k-1}]$ is a ($p \times p(k-1)$)–matrix that contains all the short run coefficients.

If the restriction $U' \; \Pi \; U^{\perp} = 0$ holds, then the long-run solution for X is not affected by the level of Y. In other words, departures from the equilibrium defined in the cointegrating vector will not determine X in the long run (absence of causality in the long run). On the other hand, through $U' \; \Gamma \; V = 0$ it is prevented that the dynamic terms of Y are significant in the equations of X (absence of causality in the short run). Granger causality is thus formally equivalent to strong exogeneity (Hall and Milne, 1994).

If only the restriction $U' \; \Pi \; U^{\perp} = 0$ holds, then weak causality takes place. This restriction is also the formal condition for the existence of weak exogeneity in the system.

In our case, the VCEM takes the following form:

$$\begin{pmatrix} \Delta LGDP_t \\ \Delta LEXP_t \\ \Delta LIMP_t \\ \Delta LGFCF_t \end{pmatrix} = \begin{pmatrix} m_1 \\ m_2 \\ m_3 \\ m_4 \end{pmatrix} + \sum_{i=1}^{k-1} \begin{pmatrix} g_{i,11} & g_{i,12} & g_{i,13} & g_{i,14} \\ g_{i,21} & g_{i,22} & g_{i,23} & g_{i,24} \\ g_{i,31} & g_{i,32} & g_{i,33} & g_{i,34} \\ g_{i,41} & g_{i,42} & g_{i,43} & g_{i,44} \end{pmatrix} \begin{pmatrix} \Delta LGDP_{t-i} \\ \Delta LEXP_{t-i} \\ \Delta LIMP_{t-i} \\ \Delta LGFCF_{t-i} \end{pmatrix}$$

$$+ \begin{pmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \\ a_{31} & a_{32} \\ a_{41} & a_{42} \end{pmatrix} \begin{pmatrix} b_{11} & b_{12} & b_{13} & b_{14} \\ b_{21} & b_{22} & b_{23} & b_{24} \end{pmatrix} \begin{pmatrix} LGDP_{t-k} \\ LEXP_{t-k} \\ LIMP_{t-k} \\ LGFCF_{t-k} \end{pmatrix} + \begin{pmatrix} e_{1t} \\ e_{2t} \\ e_{3t} \\ e_{4t} \end{pmatrix},$$

where $(m_1 \quad m_2 \quad m_3 \quad m_4)'$ is a constant terms vector and $(e_{1t} \quad e_{2t} \quad e_{3t} \quad e_{4t})'$ is a random shocks vector. The g_{ij} coefficients reflect the changes in the short run that are consequence of previous changes and do not have a permanent effect on the levels of the series. They define the causality in the short run. The b_{ij} are coefficients of the cointegration relations. They characterize the long-run relations between the levels of the variables. The a_{ij} coefficients are indicative of the speed whereupon the equilibrium recovers whenever an unbalance takes place; a_{ij} coefficients significantly different from zero will be indicative of long run causality among the variables.

3 Data and Empirical Results

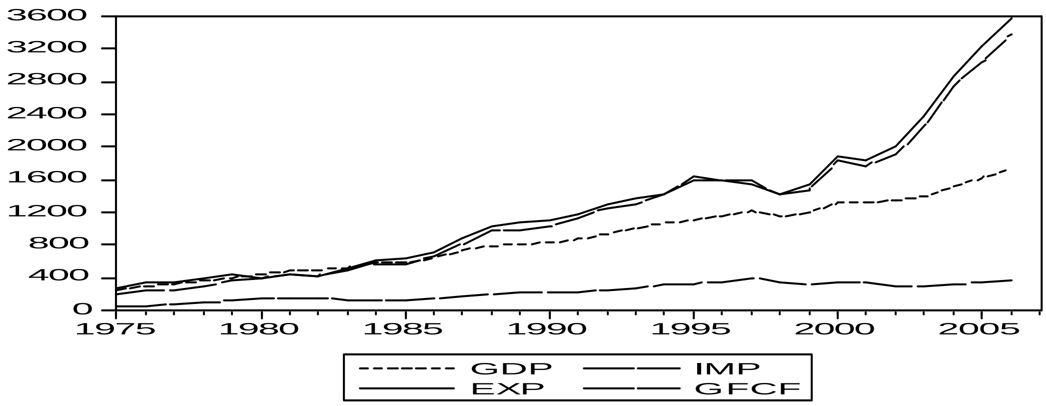
The empirical analysis is carried out using annual and quarterly data for Hong Kong during the period 1975-2007. All the original series –gross domestic product (GDP), exports, imports and gross fixed capital formation (GFCF) – are quantified in Hong Kong dollars at 2000 prices and are obtained from Data Service & Information (World Statistics)[4].

Figure 1 reflects that Hong Kong is highly dependent on foreign trade. This dependence has grown over time reaching in 2006 a dependency ratio[5] of 4. GDP, exports and imports, show very similar growth paths, with the exception of the year 1998 –the year of Asian financial crisis– during which the economy declined in a 5.4%. GFCF displays a sharp decline in the years 1998 and 1999, losing nearly 24 percentage points that no longer recover in the remainder of the period.

Fig 1: Annual series. Billions of Hong Kong dollars.

[4] www.statistischedaten.de

[5] (EXP+IMP)/GDP



Previous to the analysis, the series are transformed into natural logarithms. In the case of quarterly data, the series are seasonally adjusted by SEATS[6] program and, only in order to implement the unit roots tests in a reliable way, outliers effect corrected by TRAMO[7] program.

Two empirical models were considered. The first model (Model 1) only includes the variables GDP and exports, whereas the second model (Model 2) adds imports and gross fixed capital formation (GFCF).The existence of statistical relationship among the variables is carried out in four steps. Initially the order of integration of the variables is investigated using standard tests for the presence of unit roots. A good specification of an integrated VAR is developed in the second step. The third step involves testing for cointegration using the Johansen maximum likelihood approach. Finally, Granger-causality is studied from the integrated VAR model (TYDL approach) first and then from the VCEM (MGHM approach), obtaining in this way the Granger-causality sources of short and long run.

[6] Signal Extraction in Arima Time Series (Gómez and Maravall, 1996 Banco de España)

[7] Time Series Regression with Arima noise, Missing values and Outliers. (Gómez and Maravall, 1996 Banco de España)

.The combined results from all unit-roots tests performed (ADF and KPSS) suggest that all the series under consideration (LGDP, LEXP, LIMP and LGFCF) with annual data as well as with quarterly data, appear to be I (1) processes[8].

In order to choose the optimal lag length for the VAR model, first, we consider the annual data case (small sample of 33 observations). Table 1 summarizes the results following the advice of Lütkepohl (1993) that "in small samples Akaike´s Information Criterion (AIC) may have better properties (choose the correct order more often) than Hannan Quinn (HQ) and Schwarz (SC) criterions". The results indicate an optimal lag length of one for Model 1 and two for Model 2.

Table 1: Criteria for VAR Order Selection. Annual data.

	Model 1			**Model 2**		
#	**AIC**	**SC**	**HQ**	**AIC**	**SC**	**HQ**
1	**-12.08**	-11.71	-11.96	-24.51	-23.40	-24.51
2	-11.80	-11.23	-11.62	**-24.53**	-22.66	-23.93
3	-11.72	-10.97	-11.48	-24.27	-22.63	-23.44

Following the TYDL approach for integrated models, and considering that the series are I(1) and that the lag lengths for the original VARs models are one and two for Models 1 and 2 respectively, we implement in Model 1, a new VAR model with 2 lags and perform a Wald test only on the coefficient of the first one lag, whereas in the Model 2 we implement a new VAR model with 3 lags and perform a Wald test only on the coefficients of the first two lags. Table 2 displays the results obtained.

Table 2: TYDL approach. Causality tests between LGDP (1) and LEXP (2). Annual data.

	Model 1	**Model 2**

[8] Both tests suggest the presence of unit roots in levels and that all the variables are stationary after first differencing. The results for unit root tests are available from the author upon request.

H_0:	$W(\chi^2(2))$	[p-value]	$W(\chi^2(2))$	[p-value]
1 $non \to$ 2	0.50	[0.44]	1.26	[0.53]
2 $non \to$ 1	0.75	[0.38]	1.24	[0.53]

Table 3 summarizes the results of cointegration analysis for both models, employing the trace statistic.

Table 3: Johansen and Juselius cointegration test. Trace statistic. Annual data.

	Model 1		**Model 2**	
r H₀: rank = r	λ_{trace}	**[p-value]**	λ_{trace}	**[p-value]**
0	66.15	[0.00]	89.69	[0.00]
1	9.31	**[0.16]**	44.71	[0.03]
2			21.70	**[0.15]**

Contradictory results for both models are derived from Tables 2 and 3, because the existence of cointegration would have guarantee the existence of causality in at least one of the two directions in contradiction with TYDL approach that is not detecting that possibility (Table 2).

Now, we carry out the analysis using the quarterly data case. In this case, given that the systems are of low dimension, the sample is large (132 observations), and since, we will not use the VAR model with predictive aims, Lütkepohl (1993, p. 133) recommends using the HQ and SC criterions.

Table 4: Criteria for VAR Order Selection. Quarterly data

	Model 1			**Model 2**		
#	**AIC**	**SC**	**HQ**	**AIC**	**SC**	**HQ**
1	-15.62	-14.95	-15.35	-29.99	-28.74	-29.48
2	-15.64	-14.88	-15.34	-30.46	-28.84	-29.80
3	-15.93	**-15.16**	**-15.62**	-30.75	**-28.77**	**-29.95**
4	-15.93	-15.08	-15.59	-30.77	-28.42	-29.81

Following the advice of Lütkepohl, the results indicate an optimal length of 3 lags for both models. The adopted election does not exempt us, nevertheless, to verify the VARs models residuals specification in both models[9]. Hence following TYDL approach for integrated models, we implement in both models a new VAR model with 4 lags, and perform Wald test only on the coefficients of the first 3 lags. The results obtained appear in Table 5.

Table 5: TYDL approach. Causality tests between LGDP (1) and LEXP (2). Quarterly data.

	Model 1		**Model 2**	
H_0:	$W(\chi^2(3))$	**[p-value]**	$W(\chi^2(3))$	**[p-value]**
$1 \; non \rightarrow \; 2$	18.45	[0.00]	13.71	[0.00]
$2 \; non \rightarrow \; 1$	10.71	[0.01]	16.72	[0.00]

Table 6 summarizes the results of cointegration analysis for both models, using Johansen maximum likelihood approach and employing the trace statistic.

Table 6: Johansen and Juselius cointegration test. Trace statistic. Quarterly data.

	Model 1		**Model 2**	
r H_0: rank = r	$\lambda_{\textbf{trace}}$	**[p-value]**	$\lambda_{\textbf{trace}}$	**[p-value]**
0	88.64	[0.00]	126.80	[0.00]
1	17.84	[0.00]	58.81	[0.00]
2			19.30	**[0.11]**

The estimated cointegrating vectors in the identification process have statistically significant coefficients and correct signs for all the variables (Table 7)

Table 7: Estimated cointegrating vectors. Quarterly data. Model 2

	LGDP	**LEXP**	**LIMP**	**LGFCF**
First	-1.7069	1	0	0.74882

[9] All the results on the VAR model residuals (autocorrelation, normality and heteroscedasticity) are available from the author upon request.

	(0.021)	(0)	(0)	(0.022)
Second	1 (0)	-0.62254 (0.012)	0.030396 (0.015011)	-0.4591 (0.012)

After the process of identification of the cointegration relationships[10], in Model 2, MGHM approach was implemented from the VECM, in order to identify in each case the different sources of Granger-causality. The results obtained are shown in Table 8.

Table 8: Causality tests between LGDP (1) and LEXP (2). Quarterly data. Model 2.

H_0:	Short run	Long run
$1\ non \to\ 2$	$H_0: \gamma_{1.12} = \gamma_{2.12} = 0$ $\chi^2(2) = 15.74$ [0.00]	$H_0: \alpha_{21} = \alpha_{22} = 0$ $\chi^2(2) = 46.61$ [0.00]
$2\ non \to\ 1$	$H_0: \gamma_{1.21} = \gamma_{2.21} = 0$ $\chi^2(2) = 7.92$ [0.04]	$H_0: \alpha_{11} = \alpha_{12} = 0$ $\chi^2(2) = 19.09$ [0.00]

Bidirectional causality between GDP and exports is supported in both models, at 5% significance level. While for Model 1 this result is consequence of TYDL approach, for Model 2, it is obtained from both approaches. With respect to the sources of causality, the results obtained from Model 2 show that both sources are bidirectional. With quarterly data, the results are coherent and ELG and GLE hypotheses are supported.

[10] The results of identification process are available from the author upon request

4 Concluding Remarks

This article re-examines empirically the relationship between exports and growth for Hong Kong, using annual and quarterly data over the period 1975-2007.

Two empirical models were considered. The first model (Model 1) only includes the variables GDP and exports, whereas the second model (Model 2) adds imports and gross fixed capital formation (GFCF). The inclusion of additional variables was justified because all of them were statistically significant.

Granger-causality is studied following two alternatives: the augmented lags method of Toda and Yamamoto (1995) and Dolado and Lütkepohl (1996) (TYDL approach), and the vector error correction model approach outlined in Mosconi and Gianini (1992) and Hall and Milne (1994) (MGHM approach).

Our results support the importance of using sufficiently large samples sizes in causality analysis. While the results obtained from the TYDL and the MGHM approaches are coherent for large samples sizes (quarterly data), they are contradictory when small-sized samples (annual data) are used instead. Recent literature shows that causality analyses with small-sized or even medium-sized samples may be meaningless because the modified Wald test used in TYDL approach tends to exhibit an incorrect size and a low power, in addition to the well-known low power of cointegration tests. According to this literature one should be careful with the sample size when analyzing causality. It is important to emphasize that these theoretical drawbacks have usually been neglected by the empirical literature, which usually tests for causality in small and medium-sized samples.

The use of quarterly data provides evidence of bidirectional Granger-causality between exports and GDP in Model 2 -with TYDL and MGHM approaches- and in Model 1 -with TYDL approach-. The results of the MGHM approach for Model 2 imply that both, short- and long-run causality, are bidirectional. Our results suggest that in the period analyzed, Hong Kong experimented both, export-led growth and growth-led exports.

Acknowledgements

I gratefully thank Ricardo Cao, Manuel Gómez and Ana Sanjuán for their useful comments on an earlier version of the paper. Financial support from the Xunta de Galicia and FEDER through Grant PGIDIT06PXIB100074PR is gratefully acknowledged.

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