Causality between exports and economic growth: the empirical evidence from Shanghai

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Abstract

The export-led growth hypothesis is tested using monthly time series data for Shanghai (one of the major exporting provinces in China) using the Granger no-causality procedure developed by Toda and Yamamoto (1995) in a vector autoregresion (VAR) model. This paper builds on the existing literature in three distinct ways. This is the first study of the export-led growth hypothesis which employs a regional dataset (Shanghai). Second, the paper follows Riezman et al. (1996) in controlling for the growth of imports to avoid a spurious causality result; and finally, the use of the methodology by Toda and Yamamoto is expected to improve the standard F-statistics in the causality test process. The research finds one-way Granger causality running from GDP to exports

Keywords

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CAUSALITY BETWEEN EXPORT AND ECONOMIC GROWTH: THE EMPIRICAL EVIDENCE FROM SHANGHAI

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ABSTRACT

The export-led growth hypothesis is tested using monthly time series data for Shanghai (one of the major exporting provinces in China) using the Granger no-causality procedure developed by Toda and Yamamoto (1995) in a vector autoregresion (VAR) model. Three distinct features in this paper stand out: first, the study of the export-led growth hypothesis using the case of Shanghai is the first attempt. Second, the paper follows Riezman, Whiteman and Summers (1996) to test the hypothesis while controlling for the growth of imports to avoid a spurious causality result; and finally, the use of the methodology by Toda and Yamamoto is expected to improve the standard F-statistics in the causality test process. The research finds a one-way Granger causality running from GDP to exports.

I. INTRODUCTION

The export-led growth hypothesis has been the subject of considerable research in the last two decades. Yet the causal linkage between exports and economic growth remains the subject of debate. Two developments have added an additional twist to the literature on export-led growth study. First, the so-called "new growth theory" has resulted in some reappraisal of the determinants of growth in modelling the role played by exports in the growth process; Second, new developments in econometric theory, such as time series concepts of cointegration and causality testing, have further expanded the debate on the export-growth relationship.

This paper takes these developments as the motivations for testing the hypothesis of export-led growth using the case of Shanghai (one of the major exporting provinces in China). There are mainly three reasons for choosing Shanghai as a case study. First, building on its strong mercantile traditions as well as benefiting from receiving central government policies, Shanghai has been playing an increasingly important role, since the early 1990s, in economic development and export expansion in China. Second, because Shanghai has crucial importance for central government, particularly in terms of fiscal revenue, Shanghai presents a good case for testing the export-led growth hypothesis in a *transition economy*. Third, Shanghai's remarkable economic growth over the last two decades has been accompanied by persistent export expansion. During 1990-96, Shanghai recorded a high peak in its GDP growth. The annual growth rates of exports and GDP were 7 percent and 15 percent respectively. Figure 1 demonstrates GDP and exports growth since 1990[1] .

[Figure 1]

[1] These monthly data are taken from *Monthly Foreign Economic Data of Shanghai* and *Main Foreign Economic Data of Coastal and Border Area of China* (in Chinese language), compiled by Shanghai Municipal Statistics Bureau, and from *China's Latest Economic Statistics Monthly Report*, compiled by China's Statistics Information Consultancy Service Centre, Beijing.

Against this background, the export-led growth hypothesis is tested using monthly time series data for Shanghai using the Granger no-causality procedure developed by Toda and Yamamoto (1995) in a vector autoregresion (VAR) model. Three distinct features in this paper stand out: first, the study of the export-led growth hypothesis using a regional dataset (Shanghai) is the first attempt. In fact, The literature on China' export-growth nexus is limited. The noteworthy works are Kwan and Cotsomitis (1991), Kwan and Kwok (1995) and Shan and Sun (1997). Second, this paper follows Riezman, Whiteman and Summers (1996) to test the hypothesis while controlling for the growth of imports to avoid a spurious causality result; and finally, the use of the methodology by Toda and Yamamoto is expected to improve the standard F-statistics in the causality test process. The rest of paper progresses as follows: Section II provides the reader with a brief review of the empirical literature, followed by a discussion of the model employed in the paper, Section III demonstrates empirical results, and finally, Section IV concludes.

II. THE REVIEW AND MODEL

A. Review:

Broadly speaking, the empirical studies on the export-growth relationship can be categorised into two groups: (i) those based on cross-country data, and (ii) those based on time series data. However, an increasing number of studies has applied time series data[2].

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[2] See, eg., Marin (1992), Bodman (1996), Dutt and Ghosh (1996), Jin (1995), Jin and Yu (1996), Xu (1996), Bahmani-Oskooee and Alse (1993), Paul and Chowdhury (1995) and Riezman, Whiteman and Summers (1996).

Among time series data analysis, many researchers have directed the export-led growth studies towards the use of the Granger no-causality testing[3] procedure. However, these studies suffer from all or some of the following problems: first is their arbitrary choice of the lag length; Second, some scholars have applied F-test statistics for the causality test (see, eg., Chow (1987), Jin and Yu (1996), Marin (1992), and Xu (1996)). It is now well established in the literature of econometrics that the F-test statistic is not valid if times series are integrated (e.g., if they are $I(1)$ variables) as argued by Toda and Yamamoto (1995), Zapata and Rambaldi (1997) and Gujarati (1995); Third, some of these studies have used a simple two-variable relationship in the model specification. It is established in the econometrics literature that causality tests are sensitive to model selection and functional form (Gujarati, 1995 and Xu, 1996). In particular, Riezman, Whiteman and Summers (1996) have pointed out an important finding that "standard methods of detecting export-led growth using Granger-causality tests may give misleading results if imports are not included" (Riezman, Whiteman and Summers, 1996, p. 77). Fourth is the endogenous nature of a production function as argued by Greenaway and Sapsford (1994, p.160). Econometric modelling should therefore considers this problem to avoid a simultaneity bias. A VAR model, as argued by Zapata and Rambaldi (1997) and Gujarati (1995), have proved to generate more reliable estimates in an endogenous context.

B. The Data and model

The VAR model is estimated using monthly and seasonally-adjusted data, in logarithms and real terms (in 1990 prices) over the period 1990:1-1996:12. The size of the VAR model requires monthly rather than annual series to generate enough degrees

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[3] Granger (1988a and 1988b) has discussed the concept of causality in the framework of bivariate VAR, defining Y is said to be Granger-caused by X if the information in past and present X helps to improve the forecasts of the Y variable.

of freedom for estimation[4]. The VAR system is constructed upon the following six variables: exports (exp.), GDP, the total persons employed (lab.), imports (imp.), FDI and gross fixed capital expenditure (inv.). The monthly data of exports, GDP and FDI for Shanghai is taken from *Main Monthly Foreign Economic Data of Shanghai* (in Chinese language), 1990-1994 and *Main Foreign Economic Data of Coastal and Border Area of China* (in Chinese language), 1995 -1996, compiled by Shanghai Municipal Statistics Bureau. The monthly data of gross fixed capital expenditure, total persons employed and GDP is *from China's Latest Economic Statistics Monthly Report*, compiled by China's Statistics Information Consultancy Service Centre, Beijing.

Based upon the review in the previous section and incorporating the influence of the so-called "new growth theory"[5], a six-variable VAR model is built based upon the following augmented production function:

$$Y_t = f(Inv_t, Lab_t, Imp_t, FDI_t, Exp_t) \qquad \ldots \ldots \ldots \qquad (1)$$

where Y is real GDP; Inv_t, Lab_t, Imp_t, FDI_t, and Expt, respectively, are capital expenditure , labour, imports, FDI inflows and exports.

C. The Granger causality procedures:

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[4] However, the short length of the period of data is still a problem and we can do nothing about it as Shanghai started publishing monthly data since 1990 and we need 40 observations above. We have now 84 observations and our Granger causality test suggest that the "impact legnth(s)" of the variables in question are between 5-6 months, and hence the test does provide an indication of the relationship between exports and GDP.

[2] Some of the similar treatments incorporating new growth theory are Fosu (1990), Burney (1996), Tyler (1981) and Ram (1985).

The Granger no-causality test methodology applied in the paper is developed by Toda and Yamamoto (1995) and is extended and interpreted by Zapata and Rambaldi (1997) and Rambaldi and Doran (1996). Because the traditional F-Test in a regression context for determining whether some parameters of the model are jointly zero (in a stable VAR model) is not valid when the variables are integrated, the test statistic does not have a standard distribution. Hence several alternative procedures have been developed in an attempt to improve the size and power of the Granger no-causality test (see, e.g., Toda and Phillips, 1993; Johansen and Juselius, 1990). Unfortunately, these tests are cumbersome and "the simplicity and ease of application have been largely lost" (Rambaldi and Doran, 1996, p.1)[6].

A different procedure, developed by Toda and Yamamoto (1995), utilises a modified Wald test for restrictions on the parameters of a VAR(k), MWALD (where k is the lag length in the system). This test has an asymptotic χ^2 distribution when a VAR(k + d_{max}) is estimated (where d_{max} is the maximal order of integration suspected to occur in the system). A Monte Carlo experiment, presented in Zapata and Rambaldi (1997), provides evidence that the MWALD test has a comparable performance in size and power to the LR and WALD tests. The advantage of this procedure, as argued by Zapata and Rambaldi (1997), is that it does not require the knowledge of cointegration properties of the system and the test can be applied even if there is no cointegration and/or the stability and rank conditions are not satisfied, "so long as the order of integration of the process does not exceed the true lag length of the model" (Toda and Yamamoto, 1995, p. 225). Rambaldi and Doran (1996) have proved that this method can be computed by using a seemingly unrelated regression (SUR) form. We therefore, build the following VAR model:

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[6] There is growing concern among applied researchers that the cointegration likelihood ratio (LR) tests of Johansen and Juselius (1990) have often not provided the degree of empirical support that might reasonably have been expected and it is not practically simple in the case of more than two cointegrating vectors (see, e.g., Toda, 1994).

$$
\begin{bmatrix} GDP_t \\ Exp_t \\ Lab_t \\ Imp_t \\ Inv_t \\ FDI \end{bmatrix} = A_0 + A_1 \begin{bmatrix} GDP_{t-1} \\ Exp_{t-1} \\ Lab_{t-1} \\ Imp_{t-1} \\ Inv_{t-1} \\ FDI_{t-1} \end{bmatrix} + A_2 \begin{bmatrix} GDP_{t-2} \\ Exp_{t-2} \\ Lab_{t-2} \\ Imp_{t-2} \\ Inv_{t-2} \\ FDI_{t-2} \end{bmatrix} + A_3 \begin{bmatrix} GDP_{t-3} \\ Exp_{t-3} \\ Lab_{t-3} \\ Imp_{t-3} \\ Inv_{t-3} \\ FDI_{t-3} \end{bmatrix}
$$

$$
+ A_4 \begin{bmatrix} GDP_{t-4} \\ Exp_{t-4} \\ Lab_{t-4} \\ Imp_{t-4} \\ Inv_{t-4} \\ FDI_{t-4} \end{bmatrix} + A_5 \begin{bmatrix} GDP_{t-5} \\ Exp_{t-5} \\ Lab_{t-5} \\ Imp_{t-5} \\ Inv_{t-5} \\ FDI_{t-5} \end{bmatrix} + A_6 \begin{bmatrix} GDP_{t-6} \\ Exp_{t-6} \\ Lab_{t-6} \\ Imp_{t-6} \\ Inv_{t-6} \\ FDI_{t-6} \end{bmatrix} + \begin{bmatrix} \varepsilon_{GDP} \\ \varepsilon_{Exp} \\ \varepsilon_{Lab} \\ \varepsilon_{Imp} \\ \varepsilon_{Inv} \\ \varepsilon_{FDI} \end{bmatrix}
$$

$$\cdots \cdots (2)$$

Where: A_1-A_6 are six by six matrices of coefficients with A_0 as an identity matrix.

To test the hypothesis that "no Granger causality from exports to GDP", we test H_0: $\alpha_1^{(12)} = \alpha_2^{(12)}$,...,$= \alpha_5^{(12)} = 0$, where $\alpha_i^{(12)}$ are the coefficients of Exp_{t-1}, $Exp_{t-2,...,}$ Exp_{t-5} respectively in the first equation of system (2) where the system is being estimated as a VAR(6).

The existence of a causality from exports to growth can be established through rejecting the above null hypothesis which requires finding the significance of the MWALD statistic for the *group* of the lagged independent variables identified above. A similar testing procedure can be applied to the alternative hypothesis that "no Granger causality from GDP to exports", i.e., to test H_0: $\alpha_1^{(21)} = \alpha_2^{(21)}$,..., $= \alpha_5^{(21)} = 0$, where $\alpha_i^{(21)}$ are the coefficients of GDP_{t-1}, $GDP_{t-2,...,}$ GDP_{t-5} respectively in the second equation of system (2) where the system is being estimated as a VAR(6).

III. EMPIRICAL RESULTS

Prior to testing for non-causality, it is necessary to establish the order of integration present. To this end, an Augmented Dickey-Fuller (ADF) test was carried out on the time series in levels and differenced forms[7]. We carry out the tests on time series of each variable for Shanghai for the period 1990:1-1996:12. If the null hypothesis that a time series is non-stationary (has at least one unit root) can be accepted, the test procedures is then reapplied after transforming the series into first differenced form. If the null hypothesis of non-stationarity (when the time series is expressed in first differenced form) can be rejected, we then may establish that the time series is integrated of order one, I(1). The number of the lags included was determined using Akaike Information Criteria (AIC) and Schwartz Criteria (SC)[8]. After the ADF test, we proceeded to the Granger no-causality test. The results derived from these methods are presented in Table 1.

[Tables 1]

The results in Table 1 suggest, in the case of Shanghai, that the null hypothesis of "Grange no-causality from exports to growth" cannot be rejected at the 5% significance level; but that the alternative hypothesis that "Granger no-causality from growth to exports" can be rejected at the 1% significance level. These indicate that there is a one-way causality running from GDP growth to exports in Shanghai; but no causality, in the Granger sense, is found from exports to GDP. The export-led growth hypothesis is therefore not supported by the empirical evidence from Shanghai.

Even though we have used AIC and SC to aid in the choice of lag length, we have estimated the model using several different lag structures to ensure that results are not sensitive to the choice of the lag length. It is pointed out that "it is best to run the test

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[7] The ADF regression equation is:$\Delta Y_t = \alpha_0 + \alpha_1 Y_{t-1} + \alpha_2 t + \sum \gamma_j \Delta Y_{t-j} + \varepsilon_t$, where: ε_t for t=1, ..., N is assumed to be Gaussian white noise. This equation is with constant and trend denoted by α_0 and α_2 . The lag length, p, is chosen to ensure an approximate white noise and it was determined by AIC and SC. The results are not reported in this paper.

[8] Results are not reported in the paper.

for a few different lag structures and make sure that the results are not sensitive to the choice of m (lag length)" (Pindyck and Rubinfeld, 1991, p. 217). The results set out in Table 1 are robust to different lag structures (with one exception for the lag order 4 which is not the optimal lag choice), so we can conclude that our results are robust or sturdy, in a similar sense of Leamer's Extreme Bound analysis (EBA)[9], avoiding a fragile statistical inference.

The fact that the causality running from GDP growth to exports indicates that it is the rapid economic growth (from the supply side) proceeds the changes in exports growth, indicating that Shanghai produces goods and services that internationally competitive and hence induce further exports growth. Shan and Sun (1997a and 1997b), in their studies on China and on Australia, has also confirmed the findings in the paper that no causality, in the Granger sense, is found from exports to growth.

There appears to be evidence that growth in Shanghai was propelled by internal forces, foreign investment and by the adoption of the Pudong Policy[10], but *not* by an exports-led policy. Recent changes in a number of industrial sectors would support the growth-driven model for Shanghai. Fast economic growth during 1990-96, has resulted in swift structural changes within the Shanghai's economy[11]. Within the manufacturing sector, the gross value of six pillar industries (which include iron and

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[9] Leamer (1978 and 1983) has discussed the importance of the model selection and model search in his EBA analysis in which, he distinguishes between free and doubtful variables. He suggested the construction of a range or a bound for the estimates from a set of different combinations of free and doubtful variables. The smaller the bound, the more robust for the estimates or a fragile inference will arise.

[10] The policy was granted to Shanghai in order to resume Shanghai's previous role as a major international financial, trade, and economic centre, it has improved markedly Shanghai's economic and trade performance (Tian, 1996).

[11] The export-GDP relationship may change over time because of the structural change; It is impossible, though, to test for such a change due to limited data. We would like to thank one anonymous referee for point this out.

steel, automobiles, telecommunications, power station equipment, petrochemicals, and household electrical appliances) reached 120 billion yuan in 1994, or 36 percent of total production in Shanghai. However, export accounts for a small percentage of the output from these sectors, and Shanghai's imports still focus largely on these six pillar industries. Overall, the growth of production and foreign trade closely followed the import-substitution sequence. Table 2 shows that heavy industrial output increased from 90.5 billin yuan in 1990 to 216 billion yuan, or an increase, in a percentage terms, in total industrial output from 50 % to 56 % during the same time. In 1995, the exports only accounted for 12 % in heavy industry compared to 25 % in light industry. Overall, industries, particularly heavy industries are of a supply-led expansion. Sales abroad may follow only after a significant scale of production has been achieved at home and costs have been sufficiently reduced to withstand foreign competition.

[Table 2 here]

Lack of export-led growth in Shanghai's growth process can be also attributed to the China's existing industry policy. One important aspect of such policy includes a heavy use of import-substitution under which the distorted price system was in favour of the industries which are capital-intensive. However, the experience of the successful East Asian economies indicates that promoting specific industries generally does not work. The yardstick used to evaluate an industrial policy —mainly export performance— provides a market test of the success or failure of the policy instruments chosen (World Bank, 1993). Shanghai's case fits into this context. The creation of an advanced electronics industry in Caohejing Economic and Technological Development Zone (ETDZ) was regarded as a way to help Shanghai overcome some of its economic problems and promote export. However, the export volume in Caohejing was much smaller than that in Minhang ETDZ, a place in which many foreign enterprises, which are labor-intensive, are allocated.

Finally, in Table 3, we have also presented the significance of the causality for other factor inputs other than GDP and exports, in order to compare the significance of each

pair of the causality. The results reported in Table 3 indicate that the causalities between FDI and GDP, labour and GDP, and finally, between investment and GDP, are all strong at 5% significance level and/or 1%. This confirms the finding earlier in the paper that GDP is promoted by a set of internal factors and the inflow of FDI instead of exports.

[Table 3 here]

IV. CONCLUDING REMARKS.

The paper has used the methodology of Granger no-causality test developed by Toda and Yamamoto (1995) to examine the causality linkage between exports and GDP for Shanghai in the context of the export-led growth hypothesis. The test was based upon monthly time series data, in a six-variable VAR model, for the period of 1990-1996. The results indicate a one-way causality running from GDP to exports for Shanghai. The results reported here cannot offer the support, in the sense of a unidirectional causal ordering, for the export-led growth hypothesis. In other words, the exceptional economic performance in Shanghai during the 1990s was not propelled by export expansion, but by a set of domestic factors, foreign investment and the Pudong policy which enables Shanghai to retain most of its fiscal revenue in implementing rigorous economic reforms and to promote further economic growth.

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Table 1. Results of Granger Causality Test

H0: Lag structure (VAR order)	Exp. does not cause GDP	GDP does not cause Exp.
2(3)	0.4010	0.1319
3(4)	0.2656	0.0035
4(5)	0.0836	0.00003
5(6)*	0.5399	0.00002
6(7)	0.8704	0.00009
7(8)	0.3851	0.00004
8(9)	0.4562	0.00002

NOTE: GDP = GDP in real terms; Exp. = Export in real terms; * VAR(6) is the optimal lag length which is determined by AIC and SC. VAR order $= k + d_{max}$, where k is the lag length used in the system and d_{max} is the maximum order of integration in the system, which in our system is $I(1)$.

Table 2 Shanghai's GDP and exports by main industries, 1990 and 1995, at 1 mil. yuan

	1990			1995		
	Output	Exports	Exports as % of output	Output	Exports	Exports as % of output
Light Industries	89158	18351	20.6	167011	41163	25.0
- Industries based on agricultural materials	48169	12558	26.1	80454	25665	31.9
- Industries based on non-agricultural materials	40989	5793	14.1	86557	15498	17.9
Heavy industries	90454	7040	7.8	215892	26818	12.4
Manufacturing	48241	4776	9.9	123317	15631	12.7
Materials industry	42203	2264	5.4	92548	11183	12.1
Mining	9	0	0	27	3	11.1

Sources: 1991 figures from Shanghai gongye tongji nianjian 1992 (Statistics Yearbook for Shanghai Industries, Shanghai Municipal Bureau of Statistics), p. 17; 1995 figures from Data Collection on Industrial Census of People's Republic of China in 1995 (Shanghai), Beijing: Zhongguo tongji chubanshe, p. 43.

Table 3. *Results of Granger Causality Test*: Comparison of each causality pair

Ho:	P-values for MWALD (optimal VAR order)
Exp. does not cause GDP	0.5399 (6)
Lab. does not cause GDP	0.0325 (6)
Inv. does not cause GDP	0.0403 (7)
Imp. does not cause GDP	0.0369 (6)
FDI does not cause GDP	0.0104 (7)

NOTE: Variable definitions are the same as in Table 1.

Figure 1 Shanghai's GDP, Export and FDI growth