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Exports Led Investment Led Growth? Time Series Evidence from Chile

Rodrigo Navia Carvallo
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El autor es Ph.D in Economics, Tulane University, EEUU. Máster of Arts in Economics, Tulane University, EEUU. Licenciado en Ciencias en Administración de Empresas e Ingeniero Comercial de la Pontificia Universidad Católica de Valparaíso, profesor jornada completa de la misma Universidad

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1. INTRODUCTION

In the last decades, most of less developed countries (LDCs) have changed their economic strategy (Sachs and Warner,1995), with trade liberalization being one of the central element of the reforms. Theoretical and empirical work on the relationship between growth and liberalization is extensive, however empirical studies on how exports work to increase growth are limited.

There are two basic hypotheses that attempt to explain the relationship between exports and growth.. First, exports lead growth directly through different channels. Second, exports lead capital accumulation which leads economic growth.

The discussion of exports leading growth is extensive. Some economists argue that liberalization of the economy improves the efficiency of the country. Openness implies monopoly power of domestic firms is reduced, they start facing foreign competition then profits above normal decline[1]. This monopoly power is found in LDCs countries in many areas of the economy. Public companies are given this status by law or the domestic market is too small to allow competition and the possibility of economies of scale. Since, foreign markets are competitive and large, efficiency can be achieve; and it is required to stay in the market. Additionally, firms have access in the international market to marketing and production know how, and they need to satisfy high international standards in production (Stiglitz, 1996). Finally, many LDCs followed an import-substitution strategy for decades. This strategy imposes a high negative protection on the agricultural sector, then natural resources were not full employed. Liberalization eliminates that bias, and these resources start being employed more efficiently.[2]

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[1]Grether (1996) finds that foreign competition significantly reduced the profit rate of Mexican manufacturers.

[2]In 1970 Chile was a net importer of agricultural products, while, in 1990 was a net exporter of these goods. The same pattern can be found in the fishery and forestry sectors.

However, Levine's and Renelt's (1992) findings open a question. The relationship between exports and growth can be associated to the traditional capital-growth link. Exports could be capital intensive, then exports growth increase demand for capital; or, especially in LDCs, exports allow the countries to get resources to import capital goods.

This paper uses time series analysis to investigate the relationship between GDP growth, capital accumulation, and export growth. Using Chilean Data, weakly exogeneity is tested as suggested by Johansen(1992) and Granger and Lin (1995). Capital and exports are found to be weak exogenous, implying no causation from exports to capital in a VAR including GDP. Causation from exports to GDP does not disappear when capital is included in the VAR.

Few studies analyze the mechanism through which exports led growth. Levine and Renelt (1992) find that the correlation between GDP growth and openness disappears when investment is included, but openness is positively correlated with investment. Baldwin and Seghezza (1996) find that protection has a negative impact on investment and, therefore, on growth. In a system of equations, they find that trade protection does not belong in the growth equation, but it does belong in the investment equation. This result implies that trade does not induce technological change, but does induce investment, which leads growth. These previous studies have used cross country data. Granger-causality tests have been widely employed in the analysis of exports led growth literature, but they have not been used to evaluate if causation is through capital accumulation. Moreover, LDC countries have not been studied in particular. Levine and Renelt use a sample of 80 to 100 countries, and Baldwin and Seghezza include manufacture exporters.

The objective of this paper is to analyze if exports still do Granger-cause GDP when capital is included in the VAR system for the Chilean case, after the reforms in the mid 1970s. Chile is an appropriated scenario to investigate this question, since Navia (1997) shows that exports do Granger-cause GDP in the Chilean case when the sample is restricted to the export promotion period. Using the same technique, it is interesting to evaluate if the causation works directly from exports to GDP or the link is the capital.

This paper is structured as follows. In section 2.2, I describe econometric technique and data employed in the tests. Section 2.3 presents the empirical results. Finally, summary and final comments are in Section 2.4.

2. METHODOLOGY

In this paper I analyze time series for GDP, exports and capital in pesos of 1977 from Banco Central de Chile. The research is focused on the post reforms period (1975-1993), since Navia (1997) shows that in this period Granger causality is found from exports to GDP.

The first part of the analysis relies upon cointegration of non-stationary series, then the first step is to perform unit root tests. Two different tests are employed. First, the Augmented Dickey-Fuller (Dickey and Fuller, 1979) test and, second, a multivariate unit root test based on the Johansen Procedure are applied to all three series to evaluate if the series are trend stationary. The main difference between the tests is the null hypothesis; a unit root is the null hypothesis in the ADF test, and stationarity is the null in the second test. Moreover, the ADF uses the Dickey-Fuller distribution, while the second test is a chi-squared test which depends upon the number of cointegrating vectors that exist among the variables.

The second step in the analysis is the cointegration analysis. The Johansen Procedure (Johansen, 1988, Johansen and Juselius, 1990) is employed since it is based on a VAR implying that no particular variable needs to be designated as the dependent variable. The cointegration hypothesis is based on the rank of □.□Trace and □-max statistics can be used to evaluate the number of cointegrating vectors in the system. Both tests use a sequence of hypothesis about the number of cointegrating vectors (r), starting with the null hypothesis of no cointegration (r=0). The alternative hypothesis in the □□max□test is that there are r+1 cointegrating vectors, while in the Trace test the alternative is that the number of cointegrating is greater than r. The critical values are corrected for sample size (Reinsel and Ahn, 1988, 1992). The cointegration analysis is performed for the entire system, natural log of GDP (LGDP), natural log of capital (LCAP), and natural log of exports (LEXP), as well as the following partial systems: LGDP-LCAP, and LCAP-LEXP.[3]

If the variables are cointegrated, weak exogeneity can be tested using the error correction representation (Johansen, 1992) in which the lagged residual of the cointegration relationship is included in the VAR in differences. The system is represented as follows:

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[3]Navia (1997) analyzes the partial system: LGDP-LEXP.

$$\Delta Z_t = \gamma_0 + \sum_{i=1}^{q} \gamma_i \Delta Z_{t-i} + \alpha\beta' Z_{t-1} + \varepsilon_t \qquad (1)$$

where, $\mathbf{Z}_t$ is a px1 vector,

γ_i, i=0,...,q, are px1 vectors of coefficients,

β is (are) the cointegrating vector(s) (pxr),

α is a pxr matrix of coefficients,

ε_t is a px1 vector of residuals.

The hypothesis, that variable j is weakly exogenous, is tested evaluating the significance of the j-th row of coefficients in the α matrix. If α_{ji}, j=1,..,r, is (are) not significant, then Z_j is weakly exogenous with respect to the cointegrating vector, which means Z_j is not Granger-caused in the long run by Z_k, $k \neq j$ (Granger and Lin, 1995).

Additionally, the significance of the variables in the cointegrating vectors is tested by performing a log-likelihood ratio test. If Z_j is not significant ($\beta_j = 0$), the variable is not needed in the cointegration space, therefore it can not cause Z_k, $k \neq j$ in the long run.

In the second part, the VAR in levels is analyzed. There are two reasons to do this analysis. First, if cointegration is not rejected, the VAR in levels is consistent (Hamilton, 1994). Second, the literature on local to unit root (Elliott, 1994, Stock and Watson, 1996) points out the existence of bias in the size of significance tests of the cointegrating vector; thus, if the true data generating process of the variables is not I(1), a Granger-causality tests can be performed at the levels since the variables are stationary. A problem arises when there is no cointegration among the variables (then VAR in differences must be used), but the variables are local to unit root (VAR in levels must be used, but the true process is unknown).

The following representation is employed to analyze the VAR in levels:

$$Z_t = \phi_0 + \phi_1 t + \sum_{i=1}^{q} \lambda_i Z_{t-i} + \nu_t \qquad (2)$$

where, $\mathbf{Z}_t$ is a px1 vector,

ϕ_i, i=0,1, are px1 vectors of constants and trend coefficients.

λ_i, i=1,...,q, are px1 vectors of coefficients,

ν_t is a px1 vector of residuals.

Granger causality is tested using an F-test, where the null hypothesis is the coefficients of $Z_{j,t-i,}$ i=1,...,q, in the Z_k equation are equal to zero, for $k \neq j$. If the hypothesis is not rejected, then Z_j does not Granger-cause Z_k. Additionally, impulse response and variance decomposition are analyzed. Since, order matters, the order of one standard deviation shock to the variables in the system is decided according to the Granger-causality test. Variables found to be weakly exogenous go first.

3. EMPIRICAL RESULTS

3.1 Unit Root and Cointegration Tests

The results of the unit root tests are presented in Table 2.1. ADF and chi-squared tests give the same conclusion. The ADF test is sensitive to the lag length of the variable. I include significant lags of the first and second difference of the variable in the level and first difference unit root tests, respectively. At the level, all three variables are not stationary, but testing for unit root at the first difference, the hypothesis is rejected at 1%, and all three variables are I(1). The multivariate unit root test (χ^2-distribution) rejects stationarity of all three variables at the 1% level. Hence, the first part of the analysis is performed assuming that all three variables are I(1) [4].

Results of the cointegration tests are presented in Table 2.2. The first column presents the result of a partial system which includes the log of GDP (LGDP) and the log of Capital (LCAP). The hypothesis of no-cointegration (r=0) is rejected at the 5% level, and the existence of one cointegrating vector is not rejected. A similar conclusion is found in the partial system for LCAP and log of exports (LEXP), second column in Table 2.2, but in this case no-cointegration is rejected only at the 10% significance level. Finally, analyzing the whole system (LGDP, LCAP, and LEXP), no-cointegration is strongly rejected (1% level), and the hypothesis of one cointegrating vector is not rejected. Therefore, I can analyze weak-exogeneity of the variables, in the partial systems as in the full system, using an error correction representation (equation 1).

[4] For cointegration purposes, at least two I(1) variables are needed, the other(s) can be I(0). Since all three are I(1), analysis of partial systems can be done.

3.2 Weak-Exogeneity and Exclusion in the Long Run Relations

Estimation of the systems- partial and full- represented in equation (1) depends upon the lag structure. I use the Akaike Information Criterion to choose the lag length,[5] the same lag structure was tested for cointegration in the previous sub-section.

Table 2.3 presents the results for the null hypothesis: Z_j is weakly-exogenous. The log-likelihood ratio test has a χ^2 distribution with r degrees of freedom, where r is the number of cointegrating vectors. In the first column of Table 2.3, it can be seen that LGDP and LCAP are not weakly exogenous at the 1% and 5% significant levels, respectively, in the system which includes only these two variables. This conclusion is consistent for the different lag lengths analyzed. This result implies that capital does Granger-cause GDP in the long run. Also, GDP does Granger-cause capital in the long run, which implies that as the country grows, it is more attractive for investment and therefore the level of capital is endogenous too.

The second sub-system includes only LCAP and LEXP. Second column of Table 2.3 shows that LCAP rejects the weak-exogeneity hypothesis at the 1% level, while LEXP does not. Therefore, by analyzing partial systems, I can conclude that the causation from export to GDP found in Navia (1997) is perhaps a result of exports working through capital to lead GDP. However, the weak-exogeneity result in this partial system (LCAP-LEXP) is very unstable, depending upon the lag length in the system.

The last column of Table 2.3 presents the weak-exogeneity results for the full system. Only LGDP is found to be endogenous at the 1% level. LCAP and LEXP are weak-exogenous, so no causality exists between these two variables in the long run, and LGDP does not cause LCAP and LEXP. Therefore, causation from exports to GDP persists although significance of the LEXP coefficient in the cointegrating vector needs to be analyzed.

The significance of the coefficients in the cointegrating vector is tested with a log likelihood ratio test. This test has a χ^2 distribution with r degrees of freedom. Individually, each coefficient is tested.[6] Table 2.4 presents the results for the null hypothesis: β_i is equal to zero. For the cases of LGDP and LEXP the hypothesis is strongly rejected (1% level), while in the LCAP case is only rejected at the 5% level. Therefore, all three variables are needed in the cointegration space, and from the weak-exogeneity result, it can be said that LCAP and LEXP Granger-cause LGDP in the long run.

[5]The Schwarz Criterion gives same result.

[6]Elliot (1994) finds that small deviation from unit root can produce large size distortion in these type of tests.

3.3 VAR in Levels

Since the variables are cointegrated, a VAR in the levels can be analyzed. Moreover, if the true process followed by the variables is near I(1), the VAR in levels is the right specification. Therefore, if the analysis based on cointegration is distorted, because the true data generating process of the data is not I(1), it is useful to evaluate the VAR at the level.

In Table 2.5, the p-values for Granger-causality test are presented. The table should be read as follows. Lags of variable X are or are not significant in the equation for variable Y. Then, in the LGDP equation, LCAP is significant at the 10% level, while LEXP is significant at the 5% level. In the LCAP and LEXP equations, no variable is significant. Therefore, the same conclusion is found as in the cointegration analysis: LCAP and LEXP Granger-cause LGDP in the Chilean case. LCAP and LEXP are weak-exogenous, and exports impact on GDP is not mediated through capital.

Is the impact big or small? The response of LGDP to a one standard deviation shock to the system is shown in Figure 2.1. Since order matters, two different orders are presented. The LCAP, LEXP, LGDP order is shown in the top part of Figure 2.1, while the bottom part depicts the order: LEXP-LCAP-LGDP. LGDP is always at the end, because Granger-causality test concludes that this is the only endogenous variable in the system. The graphs exhibit a similar pattern.

In the case of LCAP for first two years, the impact is negative, followed by a positive effect thereafter. The result is striking. Capital is a variable found to have a strongly significant positive impact on GDP, but in this case, this result is not present. Why? Perhaps capital is not a good variable to perform the test. Since capital systematically increases as long as net investment in capital is positive. In Chile such is the case, but at the same time, two recessions occur in the country in the mid-70s and early 1980s when the GDP fell more than 10%, each time. Therefore, capital was increasing and GDP suffered two large contractions, so a negative relationship is found. I analyze two other variables instead of capital: fixed investment in capital goods and the ratio of fixed investment to GDP. In both cases, I get the same result: the impact is negative at the beginning, then positive, and finally zero. These results can be a consequence of the reforms in the country, privatization, openness of the capital account, modification of labor laws, etc. that have made investment attractive in spite of the recessions. These facts can explain the lower significance of LCAP in the cointegrating vector as well as in the VAR in the levels.

In the LEXP case, the impact on LGDP presents the same pattern as Navia (1997). The first years LEXP has a positive impact on LGDP and then no significant impact. Therefore, the effect of exports on GDP has not vanished as a consequence of including capital in the system.

Finally, Figure 2.2 exhibits the variance decomposition for one standard deviation shock to the system. The same order as the impulse response analysis is used. LCAP only explains between 0% to 30% of the LGDP variance, while LEXP explains between 70% to 90%. Therefore, LEXP is explaining a larger proportion of LGDP variance than LCAP.

4 SUMMARY AND FINAL COMMENTS

Time series analysis has been widely used to test Granger-causality between GDP and exports, in a bivariate system. Extensions that include additional variables have not been conducted. One contribution of this paper is the inclusion of capital in the system, to evaluate if the causation from exports to GDP vanishes. A second contribution is the test of the exports led capital accumulation led growth hypothesis using time series analysis.

The analysis is done using cointegration techniques as well as analysis of a VAR in levels. The result is consistent: first, causation from exports to GDP does not disappear, and second, there is not a link between exports and capital. Both variables are found to be weakly exogenous. Therefore, exports are not working through capital to generate growth in the Chilean case after the reforms. This finding could be a consequence of Chilean exports being labor intensive. The increase in exports does not generate a significant increase in the demand for capital. Another explanation eliminates the argument that LDC countries import capital from their exports. In late 1970s and early 1980s abundant capital was available for LDCs, so the exchange restriction was not binding. Perhaps, after the debt crisis, it would be possible to find some relationship between exports and capital, since foreign loans were restricted. Additional data is needed to evaluate this hypothesis. Analysis of other LCDs in which causation from exports to GDP has been found is necessary; however many of the countries changed their economic strategy in the 1980s and early 1990s so the time series are not long enough.

TABLE 2.1: Unit Root Tests
(sample period: 1975-1993)

	LGDP	LCAP	LEXP
ADF TEST [1]:			
-Level [2]	-1.94	-2.02	-1.42
-First Difference [3]	-4.29***	-5.18***	-5.03***
χ^2 TEST: -d.f. [4] = 2	49.50***	50.11***	44.18***

(1) Mackinnon Critical Values. *** significant at 1% level. ** significant at 5% level. * significant at 10% level.
(2) Include constant, trend, and lags of first difference.
(3) Include constant.
(4) Degree of Freedom = p - r, where p is the number of variables in the system and r the number of cointegrating vectors. *** significant at 1% level. ** significant at 5% level. * significant at 10% level.

TABLE 2.2: Cointegration Test
(sample period: 1975-1993)

Trace Test [1]	**LGDP-LCAP**	**LCAP-LEXP**	**LGDP-LCAP-LEXP**
r = 0. [2]	36.2**	29.8*	63.1***
r = 1.	6.2	7.1	10.2

(1) Critical values are corrected for sample size. *** significant at 1% level. ** significant at 5% level. * significant at 10% level.
(2) r is the number of cointegrating vectors.

TABLE 2.3: Weak-Exogeneity Test
(sample period: 1975-1993)

L.R. Test [1]	LGDP-LCAP	LCAP-LEXP	LGDP-LCAP-LEXP
LGDP	13.22***	----	21.75***
LCAP	4.46**	7.55***	0.14
LEXP	----	0.02	0.85

(1) χ^2 with 1 degree of freedom. *** significant at 1% level. ** significant at 5% level. * significant at 10% level.

TABLE 2.4: Exclusion of Variables in the Long-Run Relations (sample period: 1975-1993)

L.R. Test [1]	LGDP	LCAP	LEXP
$\chi^2_{(1)}$	34.01***	6.55**	40.67***

(1) *** significant at 1% level. ** significant at 5% level. * significant at 10% level.

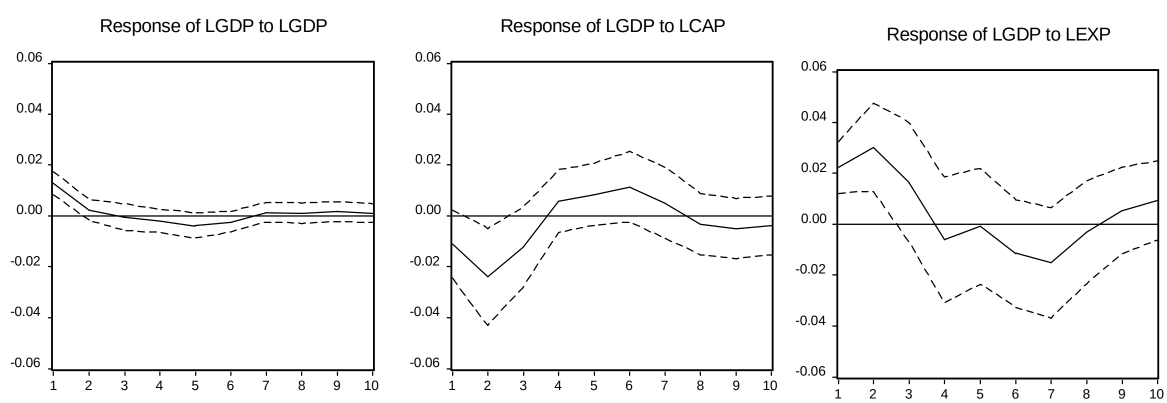
TABLE 2.5: Causality Test. VAR at the Level [1] p-values for F-test.

Lags of X ==> Y	LGDP	LCAP	LEXP
Lags of LGDP	----	0.590	0.843
Lags of LCAP	0.095	----	0.509
Lags of LEXP	0.048	0.950	----

(1) System includes constant, time trend, and three lags of the variables.

FIGURE 2.1: Response to One S.D. Innovations +/- 2 S.E.

1. Order: LCAP, LEXP, LGDP.



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2. Order: LEXP, LCAP, LGDP.

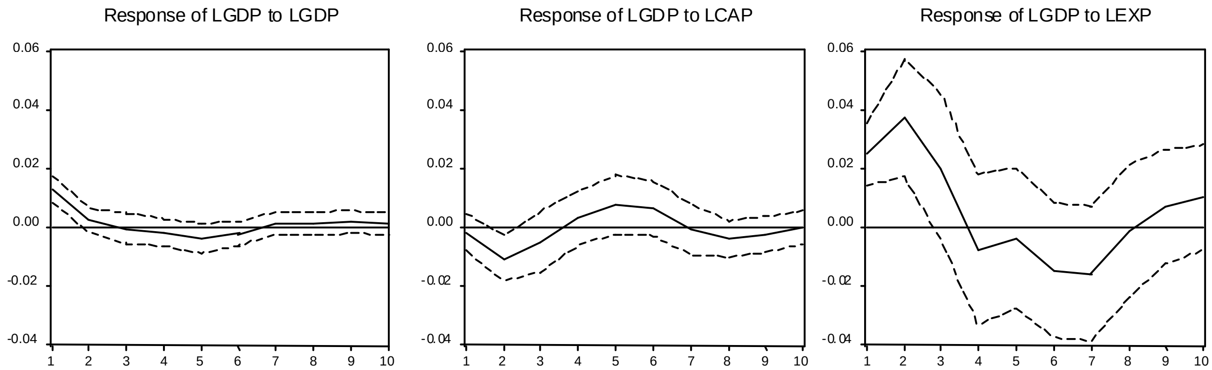
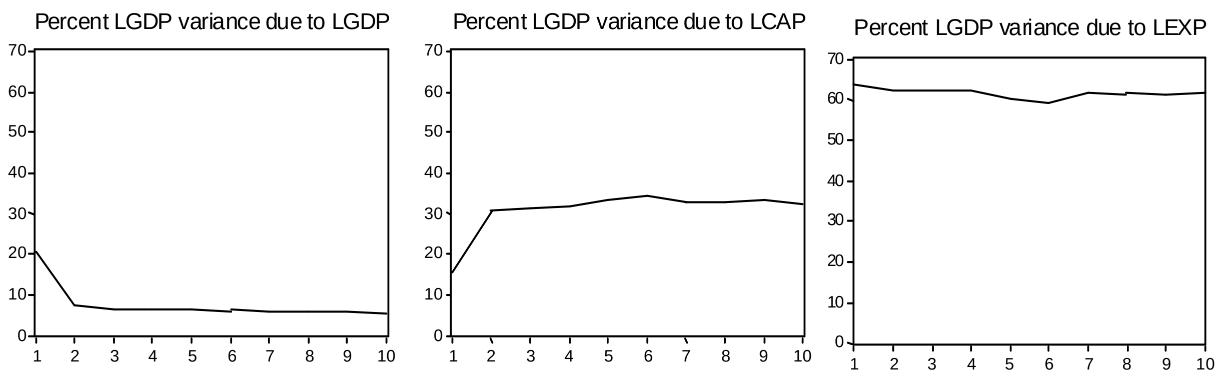


FIGURE 2.2: Variance Decomposition

1. Order: LCAP, LEXP, LGDP.



2. Order: LEXP, LCAP, LGDP.