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**Export-led growth hypothesis:  
Evidence for Chile**

**Boriss Siliverstovs  
Dierk Herzer**

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# Export-led growth hypothesis: evidence for Chile

Boriss Siliverstovs \*

Dierk Herzer\*\*

*DIW Berlin*

*IAI Göttingen*

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## Abstract

This study examines the export-led growth hypothesis using annual time series data from Chile. It addresses the problem of specification bias under which previous studies have suffered and focuses on the impact of manufactured and primary exports on the economic growth. In order to investigate if and how manufactured and mining exports affect economic growth via increases in productivity, the study uses the Toda and Yamamoto (1995) procedure for testing for Granger non-causality in Vector Autoregressive models that involve variables that are integrated of an arbitrary order and that are possibly cointegrated. The estimation results support the export-led growth hypothesis for Chile and at the same time point out to the differentiated impact of manufactured and primary exports on the economic growth.

*Keywords: Export-led growth, Chile, cointegration*

*JEL code: O47, F43, C32.*

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\*DIW Berlin, Königin-Luise Straße 5, 14195 Berlin, Germany, e-mail: [bsiliverstovs@diw.de](mailto:bsiliverstovs@diw.de),  
tel. +49 30 89789 333, fax. +49 30 89789 108

\*\*IAI Göttingen, Platz der Göttinger Sieben 3, 37073 Göttingen, Germany e-mail: [dierkherzer@gmx.de](mailto:dierkherzer@gmx.de),  
tel. +49(0)551 39 8167, fax: +49 551 39 7302

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# 1 Introduction

One of the fundamental economic questions is how countries can achieve economic growth. One of the answers to this question relies on the export-led growth (ELG) hypothesis which postulates that export expansion, especially of manufactured goods, is a key factor in promoting economic growth. There exist a vast literature that explores the link as well as direction of causation between exports and economic growth. However, it seems that overall conclusions are, at best, mixed and contradictory (Ahmad and Kwan, 1991).

In this study, we attempt to shed an additional light on this important research topic by testing the ELG hypothesis for Chile. Chile is an interesting case study because of its recent economic history<sup>1</sup>. During the last four decades Chile experienced a pattern of high economic growth, which was accompanied by a significant increase of manufactured exports both in relative and absolute terms. Chilean exports grew particularly rapidly after 1974, when a comprehensive program of economic stabilisation and restructuring was initiated. Particularly, in less than four years (1975-1979), Chile has abolished practically all quantitative import restrictions and exchange rate controls, as well as it drastically reduced imports tariffs as a part of a trade liberalisation program. Bergoening et al. (2002) argue that these structural reforms not only significantly contributed to the export growth in the late 1970s but also these reforms have laid a sound foundation that helped the domestic economy recover from the severe economic crisis that hit most Latin American countries in 1982.

Among the few studies that have examined the causal relationship between this export performance and the Chilean economic growth, Figueroa and Letelier (1994), Amin Gutiérrez de Piñeres and Ferrantino (1997), and Agosin (1999) find evidence of export-led growth. However, these studies suffer from several methodological shortcomings: Amin Gutiérrez de Piñeres and Ferrantino (1997) can be criticised for using a simple two-variable framework in their causality test. Admittedly, causality tests are extremely sensitive to omitted variables. Even if exports are found (not) to cause growth in bivariate models, this same inference does not necessarily hold in the context of larger economic models that include other relevant variables such as capital and labour (Awokuse, 2003). Indeed, Figueroa and Letelier (1994), and Agosin (1999) estimate a larger model, but they fail to incorporate imports along with exports in their estimates. According to Riezman et al. (1996), omitting the import variable can result in spurious conclusions regarding the ELG hypothesis, because particularly capital goods imports are necessary inputs for enhancement of export and domestic production. Furthermore, export growth may relieve the foreign exchange constraint, allowing capital goods to be imported to boost economic growth. Another problem that is ignored by Figueroa and Letelier (1994), Amin Gutiérrez de Piñeres and Ferrantino (1997), and Agosin (1999) is that exports, via the national income accounting identity, are themselves a component of gross domestic product. Accordingly, exports are partly endogenous within an output equation. The

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<sup>1</sup>For a survey on the evolution of growth and exports in Chile, see, for example, Agosin (1999).

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outcome of this is a strong bias in favour of a correlation between these two variables, whatever actual causal relationship may exist between them (Greenaway and Sapsford, 1994). Finally, it should be pointed out that Figueroa and Letelier (1994), Amin Gutiérrez de Piñeres and Ferrantino (1997), and Agosin (1999) focus on ‘aggregate’ exports only. This may mask important differences between different export categories. Even if there is evidence in favour of the ELG hypothesis relating to certain export categories, this may not be reflected at the aggregate level, and spurious conclusions may be drawn when disaggregated exports are not examined (Ghatak et al., 1997).

The objective of this paper is to re-examine the evidence found in previous studies on the Chilean economy by carefully addressing the problematic issues pointed out above. The paper contributes to the existing literature in the following ways: First, in order to tackle the possible specification bias, we go beyond the two-variable causality relationship and address the causality issue using a VAR model with the six variables. Second, we test the ELG hypothesis while controlling for capital goods imports in order to capture the role of exports in financing capital goods imports, which in turn are expected to promote growth. Third, we separate the ‘economic influence’ of exports on output from that incorporated into the ‘growth accounting relationship’ by defining the output variable net of exports. Fourth, we do not focus on total exports, but we decompose Chile’s exports into its main export categories. That is to say, we examine the separate effects of primary and manufacturing exports on Chilean economic growth. Fifth, we address the Granger causality in the Toda and Yamamoto (1995) framework, that allows us to conduct the standard statistical inference in the presence of integrated variables that also may be cointegrated without explicit considerations of the restrictions imposed by the presence of cointegration on the VAR model.

Our main finding is that we find empirical support for the ELG hypothesis in Chile with the unidirectional Granger causality running from the manufactured exports to the output but not vice versa. At the same time we record differentiated impact of the main Chilean export categories (manufactured and primary) on the output.

The rest of the paper is organised as follows. Section 2 describes the data used in this study and presents econometric methodology employed. The empirical results are presented in Section 3. Section 4 summarises our findings.

## 2 The data and model

In light of discussion above, we have selected the following variables in our study:  $x_t = (\ln NY_t, \ln K_t, \ln L_t, \ln IX_t, \ln PX_t, \ln CM_t)'$ . The non-export output,  $NY_t$ , is measured by real Chilean GDP net of primary and manufactured exports.  $K_t$  is the Chilean capital stock in real terms, which was computed on the basis of accumulated capital expenditure using the perpetual inventory method. The labour variable,  $L_t$ , represents the total number of people employed each year. The variables  $CM_t$ ,  $IX_t$ , and  $PX_t$  represent

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real imports of capital goods, real exports of manufactured goods, and real exports of primary products, respectively. All variables except  $L_t$  are measured in Chilean pesos at constant 1996 prices. The annual data span the period from 1960 till 2001. They were gathered from the *Indicadores económicos y sociales de Chile 1960-2000* and the *Boletines mensuales* published by the Chilean Central Bank.

Our subsequent analysis is based on the VAR model which is built upon the following augmented production function:

$$NY_t = A_t K_t^\alpha L_t^\beta, \quad (1)$$

where  $A_t$  is the level of total factor productivity which can be expressed as a function of manufactured exports,  $IX_t$ , mining exports,  $MX_t$ , capital goods imports,  $CM_t$ , and other exogenous factors,  $C_t$ :

$$A_t = g(IX_t, PX_t, CM_t, C_t) = CM_t^\delta IX_t^\gamma MX_t^\rho C_t. \quad (2)$$

Next we combine equation (2) with equation (1) and obtain

$$Y_t = C_t K_t^\alpha L_t^\beta CM_t^\delta IX_t^\gamma MX_t^\rho, \quad (3)$$

where  $\alpha$ ,  $\beta$ ,  $\delta$ ,  $\gamma$ , and  $\rho$  are the elasticities of output with respect to  $K_t$ ,  $L_t$ ,  $CM_t$ ,  $IX_t$ , and  $MX_t$ .

Taking natural logs,  $\ln$ , of both sides of equation (3) results in the following linear function:

$$\ln Y_t = c + \alpha \ln K_t + \beta \ln L_t + \delta \ln CM_t + \gamma \ln IX_t + \rho \ln MX_t + e_t, \quad (4)$$

in which all coefficients are constant elasticities,  $c$  is a constant parameter, and  $e_t$  is the usual error term, which reflects the influence of all other factors. Observe that equation (4) has an interpretation of the long-run equilibrium relation between the net-of-exports GDP on the one hand and the other explanatory variables on the other, or in terms of cointegration terminology, all these variables form a cointegration set provided that all of them are integrated of the same order, e.g. I(1).

In order to address the export-led growth hypothesis for Chile we employ the procedure of Toda and Yamamoto (1995), that allows us to conduct the standard statistical inference in the VAR models with integrated and possibly cointegrated variables. As noted in Toda and Yamamoto (1995), the advantage of using this procedure is that in order to test economic hypotheses of interest (in our case, tests of Granger causality in the VAR framework) it is not necessary to pretest the variables for the integration and cointegration properties and therefore avoiding the possible pretest biases.

This procedure is based on estimating an augmented VAR( $k + d_{max}$ ) model, where  $k$  is the lag length in the original system and  $d_{max}$  is the maximal order of integration of the variables in question. Toda and Yamamoto (1995) suggest to employ the usual Wald test for zero restrictions of the first  $k$  autoregressive coefficients of a variable in question that under the null hypothesis does not Granger cause a dependent variable in the respective VAR equation. This test has an asymptotic  $\chi^2(k)$  distribution. Observe that in testing for Granger causality the remaining  $d_{max}$  autoregressive coefficients are ignored as they are regarded as zeros in the original VAR( $k$ ) model.

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### 3 Results

In order to conduct the Granger causality analysis in the augmented VAR( $k + d_{max}$ ) model, we need to establish the lag order of the original VAR model,  $k$ , as well as the maximum order of integration of the variables in question,  $d_{max}$ . The lag order of the VAR model is addressed by using several lag order selection criteria such as the sequential modified likelihood ratio LR test (LR), discussed in Lütkepohl (1991), the Akaike- (AIC), the Schwarz- (SC), and the Hannan-Quinn (HQ) information criteria. Given rather large number of explanatory variables  $n = 6$  for the available sample size  $T = 42$ , we allow for maximum of three lags in order to ensure sufficient degrees of freedom in our testing procedure.

The results of the lag selection procedure are reported in Table 1. As seen, the lag length  $k = 2$  is selected by all of the lag selection criteria except for AIC, which selects  $k = 3$ . In order to choose between these models we have conducted the standard diagnostic tests, reported in Table 2. These tests include the LM test of no residual autocorrelation, the Doornik-Hansen test of residual normality, and the LM test of no residual heteroscedasticity. Based on these test results, we have opted for a more parsimonious model with the lag length  $k = 2$  as all the tests report no signs of model misspecification<sup>2</sup>.

At the next step we address the maximum order of integration of the time series in question. Since it is well-known that the power of unit root tests is rather low against the alternative hypothesis of (trend-) stationarity, and in order to avoid the pretest biases in deciding upon the order of integration as well as cointegration properties of the time series in question, we have chosen to impose the integration order in accordance with the theoretical economic considerations which imply existence of the long-run equilibrium relation between the considered variables as specified above in equation (4). In addition, when specifying the maximal order of integration for the time series under consideration we take into account other studies that addressed the ELG hypothesis for Chile (Figueroa and Letelier, 1994; Amin Gutiérrez de Piñeres and Ferrantino, 1997; Agosin, 1999) and as well as for other countries (Ghatak et al., 1997; Awokuse, 2003, *inter alia*), which have assumed that the relevant variables are I(1). Hence, in the subsequent analysis we set  $d_{max} = 1$ .

Based on the results of the lag length and the integration order determination, we proceed with testing for Granger causality in the augmented VAR(3) model, see Table 3. As seen, the null hypothesis that the manufacturing exports does not Granger cause output ( $\ln IX_t \not\Rightarrow \ln NY_t$ ) is decisively rejected. At the same time the null hypothesis that the output does not Granger cause the manufactured exports ( $\ln NY_t \not\Rightarrow \ln IX_t$ ) is accepted at the usual significance levels. Thus, there exists the uni-directional

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<sup>2</sup>In order to achieve an approximate residual normality the following vector of dummy variables has been used  $D_t = (Dit63_t, Dit71_t, Di74_t, Di82_t)'$ . These dummy variables account for the effects of agrarian reform in 1963, for the effects of the Allende government (1970-1973) which persuaded inward policy as well as start of the economic liberalisation reforms, and for the effects of the recession in 1982 accompanied by the overevaluation of peso, rising international interest rates, and falling commodity prices, respectively. The intervention dummies  $Dixx_t$  take value of 1 in 19xx and zero otherwise, whereas the intervention dummies  $Ditxx_t$  take value of 1 in 19xx and -1 in 19xx + 1 and zero otherwise.

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Granger causality from the manufactured exports to the output. We interpret it as empirical evidence in favour of the export-led growth hypothesis. Our findings support the results on the applicability of the ELG hypothesis to Chile that have been reported earlier in the relevant literature (Figueroa and Letelier, 1994; Amin Gutiérrez de Piñeres and Ferrantino, 1997; Agosin, 1999). Moreover, it appears that this finding is rather robust to application of different methodological approaches as well as inclusion of different variables while addressing the ELG hypothesis for Chile.

Next we test the null hypothesis that the primary exports does not Granger cause output ( $\ln PX_t \not\Rightarrow \ln NY_t$ ) and *vice versa* ( $\ln NY_t \not\Rightarrow \ln PX_t$ ). In this case the obtained results suggest that there is no Granger causality from the primary exports to the output, but the output Granger causes the primary exports. Hence, we record differentiated relation between the manufactured goods exports and the output on the one hand, and between the primary goods exports and the output on the other. This result supports the approach advocated in Ghatak et al. (1997) that one should treat different export categories uniformly while testing the ELG hypothesis.

## 4 Conclusion

We have addressed the question on whether the export-led growth hypothesis, that stipulates importance of manufactured goods exports in promoting economic growth, is relevant for Chile. In contrast to other previous studies, that addressed this question, our paper is distinguished by several features. First, we go beyond the two-variable setup (exports and output) and address the causality issue in a VAR model with six variables. Second, we include the capital goods imports in the number of considered variables in order to capture the role of exports in financing capital goods imports, which in turn are expected to promote growth. Third, we separate the ‘economic influence’ of exports on output from that incorporated into the ‘growth accounting relationship’ by defining the output variable net of exports. Fourth, we do not focus on total exports, but we decompose Chile’s exports into its main export categories, the primary and the manufactured goods. This helps us to unmask important differences between various types of export goods in their relation to output. Fifth, we address the Granger causality in the Toda and Yamamoto (1995) framework, that allows us to conduct the standard statistical inference in the presence of integrated variables that also may be cointegrated without explicit considerations of the restrictions imposed by the presence of cointegration on the VAR model.

Our main results is that we establish the uni-directional Granger causality running from manufactured exports to the net-of-exports GDP. We interpret it as a supportive empirical evidence in favour of the export-led growth hypothesis. Hence our findings are in line with those reported in the existing literature (Figueroa and Letelier, 1994; Amin Gutiérrez de Piñeres and Ferrantino, 1997; Agosin, 1999). It also shows that empirical support of the export-led growth hypothesis for Chile is rather robust to application of different methodological approaches as well as inclusion of different variables into the estimated models.



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We also record the failure of the primary exports to Granger cause output. The latter result reinforces the idea that while testing the export-led growth hypothesis it is important to differentiate between the various types of exports, i.e. exports of primary and manufactured products, for example (see Ghatak et al., 1997).

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Table 1: Lag length selection

Lag length $k$	$\ln L$	LR	AIC	SC	HQ
0	111.89	NA	-4.20	-2.92	-3.74
1	457.89	496.82	-20.10	-17.28	-19.09
2	533.99	<b>85.86</b>	-22.15	<b>-17.80</b>	<b>-20.60</b>
3	578.73	36.70	<b>-22.60</b>	-16.71	-20.49

*Notes:* Bold font indicates the selected lag length in the VAR model.  $\ln L$  denotes the reported value of the log-likelihood function.

Table 2: Specification tests

	$\ln IX_t$	$\ln CM_t$	$\ln K_t$	$\ln NY_t$	$\ln PX_t$	$\ln L_t$	Vector
$F_{AR(1)}(1,21)$	[0.8626]	[0.1487]	[0.2544]	[0.5305]	[0.4742]	[0.4232]	[0.6607]
$F_{AR(2)}(2,21)$	[0.8447]	[0.0764]	[0.0674]	[0.3399]	[0.1279]	[0.1831]	[0.3749]
$\chi^2_{Normality}(2)$	[0.5041]	[0.3355]	[0.1502]	[0.1131]	[0.9657]	[0.6796]	[0.4978]
$\chi^2_{Heterosc.}(24)$	[0.1280]	[0.4910]	[0.1688]	[0.1026]	[0.4940]	[0.1332]	

*Notes:* Table entries are the  $p$ -values of the corresponding test statistics of no residual autocorrelation of up to the first and up to the second order  $F_{AR(1)}$  and  $F_{AR(2)}$ , respectively, of residual normality  $\chi^2_{Normality}$ , and of no residual heteroscedasticity  $\chi^2_{Heterosc.}$ .

Table 3: Results of Granger causality test

$H_0 :$	$\ln IX_t \not\Rightarrow \ln NY_t$	$\ln NY_t \not\Rightarrow \ln IX_t$	$\ln PX_t \not\Rightarrow \ln NY_t$	$\ln NY_t \not\Rightarrow \ln PX_t$
p-value	[0.0033]**	[0.2165]	[0.8475]	[0.0002]**

*Notes:* Table entries report the  $p$ -values of the Granger causality test in the augmented VAR(3) model. The test statistic has an asymptotic  $\chi^2(2)$  distribution. \*\*\* indicates significance at the 1% level.