Departamento de Economía Aplicada
Universidad de Oviedo

DPAE/09/09

Discussion Papers on Applied Economics.

Department of Applied Economics. University of Oviedo.

Openness and growth in Latin America. A cointegration anaylisis

David Matesanz Gómez (matesanzdavid@uniovi.es)*

Guadalupe Fugarolas Álvarez-Ude (guadafugarolas@gmail.com)**

* Avenida del Cristo s/n. Facultad de CC. Económicas y Empresariales. Departamento de Economía Aplicada. Universidad de Oviedo, 33006, Oviedo.

** GAME-IDEGA. University of Santiago de Compostela and Banco Popular (Spain)

Abstract:

This study re-examines the openness growth hypothesis for four Latin American countries in the spirit of the balance of payments constraint. Using the Toda and Yamamoto (1995) and Dolado and Lütkepohl (1996) methodology 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 in Argentina, Brazil and Chile while an import led export phenomenon is addressed for the mexican case

Keywords: Openness and growth, Latin America, Balance of payments constrained approach, Granger causality.

JEL Classification: C22, C32, C52, F31, F43.

1. Introduction

Connections between openness and growth have been an issue of interest since the ninetieth century. The basic idea that is commonly assumed by economists is that international trade is a mean of promoting economic growth. However, the magnitude of the effects and the casual direction between both variables still remain as a source of debate and controversy. Most of the empirical studies have been centred in the role of exports as an engine of economic growth and precisely the main question is whether causality goes from exports to economic growth, labelled Export-led Growth (ELG) hypothesis or, contrary, if causality flows from economic growth to exports, namely Growth-led Exports (GLE) hypothesis. The establishment of the direction of this causal relationship has important implications for economic policy strategies.

Different connections between exports as generator of economic growth have been identified in the theoretical literature (see, Krugman (1987); McCombie and Thirlwall (1994) and Giles and Williams (2000) for a survey). First, the rate of growth of exports, as a determinant of aggregate demand, affects directly to output growth; Second, the increase of exports can indirectly raise output growth based on the assumption of increasing returns to scale and spill-over effects from exports to other sectors of the economy. These externalities can produce a more efficient resource allocation, moving resources from relatively inefficient non-tradable sectors to the higher productive export sector promoting the diffusion of improved techniques, exploitation of economies of scale, learning by doing gains, greater capacity utilization and improved technological and management abilities due to more competitive markets faced by export sectors. Third, exports provide foreign exchange that allows imports of capital and intermediate goods affecting capital formation and, therefore, increasing rates of growth. Fourth, the smaller is the domestic market, the greater is the importance of the external demand to achieve economies of scale and to obtain capital and intermediate goods as was suggested by Adam Smith more than two centuries ago. Precisely, the third and fourth connections exposed are extremely important for Latin American countries as long as domestic markets are economically small and capital and intermediate goods have no comparative advantage and are mostly imported.

Other theoretical approaches have emphasized the potential existence of a bi-directional causality between exports and growth: economic growth creates the opportunity for exports and exports produce more income resulting in a virtuous circle (Helpman and Krugman, (1985); Grossman and Helpman (1991)).

A vast amount of studies have been dealing with the export-growth nexus but the literature has shown mixed and sometimes conflicting evidence. Three essential problems in the export output nexus are identified in the empirical literature (Edwards (1993); Awokuse and Christopoulos (2009). Firstly, spurious results can be achieved in the traditional bivariate correlation analysis between exports and economic growth because of the bias in favour of correlation and because they are ignoring the role of other potential key factors including in growth theory. Secondly, previous works do not take into account the dynamical properties of the time series. Thirdly, the assumption of linear relationship among the variables in most of the models could not be accurate enough.

In this study, our aim is focused on adding new evidences on the first shortcoming. As long as an increasing number of studies have extended the traditional bivariate export-growth nexus by including the role of potential factors suggested by neoclassical growth theory (Awokuse and Christopoulos, (2009); Awokuse (2007); Herzer et al. (2006); Siliverstovs and Herzer (2006), are only some of the recent ones) our major contribution in this paper is based on adding other key factors from a demand side approach. In so doing, we empirically analyze the casual relationship between exports and economic growth in the spirit of the balance of payments constrained (BPC) growth model exposed in the seminal study of Thirwall and Hussain (1982)[1].

We analyze the ELG demand model for Argentina, Brazil, Chile and Mexico. During the 1980´s and 1990´s all of these countries have implemented a liberalization policy towards a more outward oriented development strategy[2]. Some of the arguments for this kind of policies were related to the fact that an increase in international competition was suppose to generate a more efficient use of resources affecting global productivity and export opportunities. Exports would be the engine of Latin American economic growth as in the case of the Asian tigers. As a result, economic growth and social welfare was expected to improve.

In keeping with our set of countries, we stress that there is not a great amount of recent empirical studies including Latin American countries and none is dealing with a causal analysis in a BPC context. Chilean economy is an exception where several single country studies have been developed. Herzer et al. (2006) and Siliverstovs and Herzer (2006) analyze the ELG hypothesis for the economy of Chile in the long period from 1960 to 2001. A Granger causality test is applied to an augmented production function where output is expressed net of exports and exports are divided in primary and manufactured showing that causality is running from manufactured exports to output. Amin Gutiérrez de Piñeres and Ferrantino (1997) carry out a causality analysis for Chilean economy from 1962 and to 1991 including three exports diversification measures in the bivariate export growth nexus. In their study the ELG hypothesis is not supported for the bivariate model but they find that export diversification has caused output expansion supporting the ELG hypothesis through the diversification process for exports. Finally, Agosin (1999) find evidence for causality running from export and investment to output growth in Chile during the period 1960-1995 by using cointegration methods.

---

[1] Thirlwall (1979) and Thirlwall and Hussain (1982) models have been successfully applied to developed and developing countries showing that, in the long run, the predicted economic growth is not only consistent with the balance of payments equilibrium but also is fitted to the actual ones. Regarding Argentina, Brazil, Chile and Mexico, empirical validations of BPC model have shown that their economic growth path have been balance of payments constrained as Thirlwall´s hypothesis suggests (see for instance, Moreno-Brid (1999 and 2001); López and Cruz (2000); Holland, Vilela and Canuto (2002); Pacheco-López and Thirlwall (2004 and 2006); Matesanz et al. (2007); Fugarolas and Matesanz (2008).

[2] The implementation of liberalization policies was faced in different moments of time in these countries, meanwhile Chile was the first in opening their economy in the late seventies, Brazil outward policy begun later during the first years of the 1990´s. Argentina and Mexico opened up their economies in the late 80´s.

Regarding Mexico, Thornton (1996) finds evidence of an ELG model in the long run by using cointegration and Granger causality test in the long period from 1895 to 1992 carrying out a simple bivariate model in which real exports and output are included.

Awokuse (2008) analyse the ELG hypothesis for Argentina, Colombia and Peru including real exports and imports in the neoclassical production function. By using Granger causality test and impulse response function in quarterly data from 1993 to 2002 he finds evidence of bi-directional causality in the long run going from imports to output and vice versa for Argentina. However, by means of error correction modelling the ELG hypothesis is supported in the short run for Argentina.

Other studies have included several Latin American countries. For instance, Maneschiöld (2008) finds support for bidirectional causality between export and output in Argentina and Mexico but not in Brazil. In this work, a bivariate model is implemented using quarterly data from 1993 until 2006 for Argentina, 1980-2006 for Mexico and 1991 to 2006 in Brazil. Cuadros et al. (2004) analyze a VAR model including exports, Foreign Direct Investment (FDI) and domestic and foreign income for Argentina, Brazil and Mexico using quarterly data from 1977-2000 (Brazil and Argentina) and 1980-2000 (Mexico). For Argentina and Mexico not only the ELG hypothesis is supported but also causality goes from FDI to economic growth. Results for Brazil do not suggest either ELG or FDI growth hypothesis. Other studies have included Latin American countries in panel data validations where no individual results are presented, such as Bahmani-Oskooee et al. (2005). Finally, Amin and Cantavella-Jordá (2007) compare different trade data and methodologies in the ELG hypothesis for sixteen Latin American countries. Their results show inconsistencies because of selection of data and methodologies.

As we can observe, conflicting results are achieved for our set of countries because of different model specifications, different time periods included and different variables specifications. In this sense, the empirical literature conclusion is that results critically depend on variables included, periods span considered and methodologies (Amin Gutiérrez de Piñeres and Cantavella-Jordá (2007) Bahmani-Oskooee, et al. (2005), Cuadros et al. (2004).

In this scenario, we test ELG hypothesis including output, exports, imports, terms of trade and capital flows in the analysis within the BPC model exposed by Thirlwall and Hussain (1982) In this fashion, we firstly introduce a demand side formalization alternative to the traditional neoclassical production function approach. In so doing, we jointly analyze casual linkages among output growth, trade variables and capital flows focusing in the principal economic aspects of globalization. From the empirical point of view, in this study we address new insights in the openness growth linkages for Argentina, Brazil, Chile and Mexico in the last decades to show future guidelines for external economic strategies related to development performance. As far as we know, this BCP approach in the augmented ELG hypothesis is a novelty in the empirical literature and it is especially relevant for most Latin American countries as long as long term economic growth have shown their limits in the balance of payments position. In so doing, Granger causality is tested by means of the multivariate augmented level VAR technique with integrated and cointegrated process of Toda and Yamamoto (1995) and Dolado and Lütkepohl (1996) (TYDL henceforth).

The rest of the paper is organized as follows. The second section is dealing with the modelling specification and the econometric methodology. Section III presents the estimations and discusses the empirical results. Finally, Section IV concludes the paper.

2. Modelling specifications and econometric techniques

2.1. Dataset specifications

The database consists of annual time series for Argentina, Brazil, Chile and Mexico. The time period goes since late seventies or the early eighties up to nowadays depending on the data availability[3]. The variables considered in our modelling are real gross domestic product (*Y*), nominal exports (*X*), nominal imports (*M*), the real exchange rate (*RER*) and net nominal capital flows (*F*). *X, M* and *F* are expressed in U.S. dollars. As usual, RER is computed multiplying the nominal exchange rate of the domestic currency with U.S. dollar and the ratio of foreign price proxied by U.S. consumer price to domestic consumer price. Data have been drawn from International Financial Statistics in the IMF database available online. All the variables but net capital flows are expressed in logarithmic terms.

2.2. The underlying framework

Departing from the seminal study by Thirlwall (1979), Thirlwall and Hussain (1982) developed a model of BPC including the role of capital flows in the determination of a theoretical economic growth rate consistent with the balance of payments equilibrium in the long run. The basic conclusion of the model is that the long term economic growth has a ceiling given by the country´s ability to get foreign exchange. This ability is determined by the dynamics of the main elements of the balance of payments: exports, the income elasticity for imports, net capital flows and the key international price of a country, the real exchange rate. Moreover, exports and imports need to include all components of the current account: goods, services, income and transfers.

The Thirlwall and Hussain (1982) framework is defined by the following system of equations

$$P \cdot X + E \cdot F = P^{*} \cdot E \cdot M \qquad (1)$$

$$x = \eta\left(p - p^{*} - e\right) + \varepsilon y^{*} \quad \text{with } \eta < 0, \pi > 0 \qquad (2)$$

$$m = \gamma\left(p^{*} + e - p\right) + \pi y$$

[3] Period span is: Argentina (1976-2008: 32 observations), Brazil (1980-2008: 28 observations), Chile (1975-2007: 32 observations) and Mexico (1979-2007: 28 observations)

with $\gamma < 0, \varepsilon > 0$ (3)

$$\theta = \frac{P_{\cdot} \cdot X}{P \cdot X + E \cdot F} \quad (4)$$

$$\theta(p + x) + (1 - \theta) \cdot (f + e) = p^{*} + e + m \quad (5)$$

standing the upper case for variables in levels and the lower case for rates of change. Equation (1) represents the standard balance of payments identity and equation (*2*) and (*3*) are the standard dynamic export and import demand functions with *y*, *y** standing for national and world's real income, respectively, *p* and *p** for domestic and foreign prices and *e* for nominal exchange rate. Meanwhile, ε and η represent the income and price elasticities for exports and π and γ the same elasticities for imports. Equation (4) defines θ as the ratio of exports over the amount the exports and net capital flows, *F,* and represents the share of exports in the total availability of foreign exchange. Equation (5) is obtained by differentiating equation (1) with respect to time and represents the continuous- time expression of the balance of payments.

Solving the system of equations (1)-(5) in terms of growth of domestic income results in the expression that constitutes the theoretical balance of payments equilibrium rate of economic growth identified as the model of Thirlwall and Hussain

$$y_{BP} = \frac{\theta}{\pi} \varepsilon y^{*} + \frac{(1 - \theta)}{\pi}(f + e - p) + \frac{\theta \cdot \eta + \gamma + 1}{\pi}(p - p^{*} - e) \quad (6)$$

If the expression of $\varepsilon \cdot y^{*}$ given in expression (2) is substituted into equation (6), the balance of payments constrained rate of economic growth is defined by

$$y_{BP} = \frac{\theta}{\pi} x + \frac{(1 - \theta)}{\pi}(f + e - p) + \frac{\gamma + 1}{\pi}(p - p^{*} - e) \quad (7)$$

Hence, the long-run rate of growth of domestic income y_{BP} is defined as a linear function of exports, the foreign capital flows and the evolution of terms of trade with the weights of aggregation of the three terms given by the price and income elasticity of imports and of exports and the percentage of exports in the foreign exchange.

A log-linear version of equation (7) is used in the analysis. To conclude, we note that our information set in the causal analysis is enlarged by including imports in order to catch up their indirect effects in complete and well-defined openness information set. In this fashion our major concern is trying to capture all the possible interrelations among those variables involved in the Thirlwall and Hussain's model. Our motivation in

adding the imports variable is that the equilibrium growth defined by equation (7) is taking into account in the weights of aggregation the income elasticity of imports and as long as we are testing for causality we need to include them directly in our model. In addition, imports are essential in a not spurious openness information set connected with growth. Theoretically, Grossman and Helpman (1991) showed that protection of key sectors in economies with comparative disadvantage may lead to higher economic growth. Technological approaches of international trade based on absolute advantage support this possibility of negative effects of openness in growth depending on the absolute advantage of tradable sectors (see, for instance, Dosi and Soete (1998) and Krugman (1996). Moreover, the role of imports as an engine for long-run economic and export expansion have been emphasized into the endogenous growth models (Coe and Helpman (1995). Imports serve as a channel to get foreign R&D knowledge and more advance capital and intermediate goods suggesting Import-led Growth (ILG) alternative causality relationship that have been revealed in empirical validations by Awokuse (2007 and 2008).

2.3. Methodology

The main objective of this study is to investigate the causal relationship between the external sector and economic growth in the spirit of Thirlwall and Hussain (1982)'s model enlarging the basis information set in a formal causality modelling by including imports of goods and services. Henceforth, our causality analysis runs over the expanded model defined by

$$Y_t = h\left[X_t, RER_t, M_t, F_t\right] \qquad (8)$$

By causality, it is meant causality in the Granger (1969) sense, that is, the purpose is to find out whether one variable precedes another variable or not. For this purpose, the following vector autoregressive model of order *p*, VAR(*p*) is utilized:

$$y_t = v + A_1 y_{t-1} + \ldots + A_p y_{t-p} + \varepsilon_t \quad (9)$$

being y_t the integrated and possible cointegrated variables, v the vector of intercepts, A_i the vector parameter for lag *i* ($i = 1, \ldots, p$) and ε_t the vector of error terms. It is well known in the econometric literature that if the variables are integrated, asymptotical distributions cannot be used to test for restrictions in the VAR. In particular, Wald tests for Granger causality are known to result in non-standard limiting distributions depending on the cointegration properties of the system and possibly in nuisance parameters (see Toda and Phillips (1993). In order to find a solution to this problem, Toda and Yamamoto (1995) and Dolado and Lütkepohl (1996) proposed following augmented VAR models in order to test causality if the variables are integrated and if the assumption of normality of the error term vector is fulfilled

$$y_t = v + A_1 y_{t-1} + \ldots + A_p y_{t-p} + \ldots + A_{p+d} y_{t-p-d} + \varepsilon_t \qquad (10)$$

where *d* is equal to the integration order of the variables involved in the VAR system. The k^{th} element of y_t does not Granger-cause the j^{th} element of y_t if the following hypothesis is not rejected at a given significance level:

H_0: the row *j*, column *k* element in A_i equals zero for $i = 1, \ldots, p$

Hence, the TYDL procedure consists on over-fit a levels VAR specification with a total of *p=(k+dmax)* lags being *k* the lag-length chosen by using some information criteria and *dmax* the maximal order of integration for the time series data involved in the system. The asymptotic chi-squared distributed MWald test proposed is applied to the first *k* VAR coefficient matrix while the coefficient matrices of the last *dmax* lagged vectors in the model are ignored. More precisely, the underling intuition of this approach to Granger causality is that whenever the elements in at least one of the coefficient matrices A_i are not restricted at all under the null hypothesis (for instance, the non causality restriction which involves in a VAR modelling elements from all A_i, $i = 1, \ldots, k$) it is enough to add extra and redundant lags in estimating the parameters of the structure to ensure the standard asymptotic properties of the Wald statistic which maintain its usual limiting χ^2 distribution. The test has to be performed on the A_i, $i = 1, \ldots, k$ only with the last redundant lags ignored. Therefore, the TYDL enables the proposed MWALD statistic to test linear or nonlinear restrictions on these *k* coefficient matrices using the standard asymptotic theory.

It is important to note that the TYDL procedure does not call for pre-testing unit roots and cointegration before causality testing avoiding results that may suffer from size distortions and inference biases leading to an over rejection of the non-causal null hypothesis. Of course, there may be a loss of power due to over-specifying the lag length. The loss in power may not be substantial if the true order *p* is large and the dimension *k* is small or moderate because of the relative reduction in the estimation precision due to one extra lag.

3. Econometric estimates and empirical results

3.1. Integration properties of the time series

Most of the economic time series are nonstationary and its use can falsely imply the existence of a meaningful economic relationship. In this paper the data univariate characteristics are examined using the Dickey-Fuller (DF) and the Augmented Dickey Fuller (ADF) unit root approaches. On the basis of independently not serial correlated and identical distributed errors, this parametric procedure is assuming a stochastic part modelled by an autoregressive representation testing the null hypothesis of a unit root against the alternative of stationary. Lag-length is selected to ensure non-autocorrelated error terms and the decision tree proposed by Charemza and Deadman (1992) is implemented to check the significance of time trend and drift terms together with non-stationary.

The results of the univariate Dickey and Fuller test applied to the level and the first differenced data are summarized in Table 1 assuming that the optimal lag length minimizes information criteria of Akaike and Schwarz and avoids residual autocorrelation. We observe that at 5% or even 1% levels of significance not only neither trends nor drifts should be entered in the cointegration space but also that almost all the variables are found to be not level stationary but they are integrated of order one, that is, I(1).

Table 1. Augmented Dickey-Fuller unit root test (adf).

$H_0 : \delta = 0$

$H_1 : \delta < 0$

(i) $\Delta y_t = \beta_1 + \beta_2 t + \delta y_{t-1} + \sum_{i=1}^{m} (\alpha_i \Delta y_{t-i}) + \varepsilon_t$

(ii) $\Delta y_t = \beta_1 + \delta y_{t-1} + \sum_{i=1}^{m} (\alpha_i \Delta y_{t-i}) + \varepsilon_t$

(iii) $\Delta y_t = \delta y_{t-1} + \sum_{i=1}^{m} (\alpha_i \Delta y_{t-i}) + \varepsilon_t$

variable	lag	Model (i)		Model (ii)		Model (iii)
		$\tau_{\beta\delta}$	t_{tc}	$\tau_{\alpha\mu}$	t_c	t_{nc}
ARGENTINA (1976-2008)						
$\ln GDP$	0	0.559	-2.145	-1.383	-2.096	-1.578
$\Delta \ln GDP$		n.a	n.a	n.a	n.a	-5.211 * **
$\ln X$	1	-0.837	-3.121	0.184	-3.118	-3.196 * **
$\Delta \ln X$	n.a	n.a	n.a	n.a	n.a.	
$\ln RER$	0	0.710	-2.249	2.235	-2.246	-0.214
$\Delta \ln RER$		n.a	n.a	n.a	n.a	-5.678 * **
$\ln M$	1	2.706	-2.963	1.197	-1.090	1.394
$\Delta \ln M$		n.a	n.a	n.a	n.a	-3.056 *
$\ln F$	1	-1.138	-3.460	-0.663	-3.303	-3.294 * **
$\Delta \ln F$		n.a	n.a	n.a	n.a	n.a.
BRAZIL (1980-2008)						
$\ln GDP$	2	2.260	-3.093	1.604	2.063	0.473
$\Delta \ln GDP$		n.a	n.a	n.a	n.a	-2.790 *
$\ln X$	1	1.987	-1.429	-0.725	0.901	2.523
$\Delta \ln X$		n.a	n.a	n.a	n.a	-2.927*
$\ln RER$	2	-0.201	-3.127	2.891	-3.255	-1.308
$\Delta \ln RER$		n.a	n.a	n.a	n.a	-3.022*
$\ln M$	1	2.438	-1.929	-0.741	0.830	1.598
$\Delta \ln M$		n.a	n.a	n.a	n.a	-2.015*
$\ln F$	0	1.723	-3.530	1.570	-3.008	-2.523
$\Delta \ln F$		n.a	n.a	n.a	n.a	-7.994 * **

CHILE (1975-2008)

$\ln GDP$	3	1.638	-2.880	-1.132	-1.174	-0.816
$\Delta \ln GDP$		n.a	n.a	n.a	n.a	-2.474*
$\ln X$	1	3.474	-3.458	0.492	-0.234	1.997
$\Delta \ln X$		n.a	n.a	n.a	n.a	-2.547*
$\ln RER$	1	0.801	-2.175	2.292	-2.280	0.442
$\Delta \ln RER$		n.a	n.a	n.a	n.a	-3.264* **
$\ln M$	2	3.270	-3.230	0.367	-0.165	1.912
$\Delta \ln M$		n.a	n.a	n.a	n.a	-2.062 *
$\ln F$	1	0.150	1.784 * **			
$\Delta \ln F$	n.a	n.a				

MEXICO (1979-2007)

$\ln GDP$	0	2.396	-2.569	-0.839	-0.964	-1.034
$\Delta \ln GDP$		n.a	n.a	n.a	n.a	-4.902 * **
$\ln X$	1	2.820	-2.754	0.098	0.195	3.046*
$\Delta \ln X$		n.a	n.a	n.a	n.a	n.a
$\ln RER$	1	-1.344	-3.079	2.752	-2.755	-0.149
$\Delta \ln RER$		n.a	n.a	n.a	n.a	-5.529* **
$\ln M$	1	3.580	-3.459	0.064	0.095	2.072
$\Delta \ln M$		n.a	n.a	n.a	n.a	-4.115 * **
$\ln F$	0	1.197	-3.145	2.228	-2.884	-1.730
$\Delta \ln F$		n.a	n.a	n.a	n.a	- 5.383* **

Notes: *k i*s the lag structure order chosen to guarantee white noise residuals*;* subscripts *tc*, *c* and *nc* indicate if trend and intercept. intercept or none is included in test model (i), (ii) and (iii) respectively. $\tau_{\beta\delta}$, $\tau_{\alpha\mu}$ denote statistics for individual or joint significance of trend and intercept assuming unit root. *, **, *** show 5% ,1% and 10% significance level in accordance to MacKinnon (1996) critical values; n.a is non available.

3.2. Augmented VAR modelling and MWALD causality tests

The augmented VAR procedure proposed by Toda and Yamamoto (1995) and Dolado and Lutkepohl (1996) which allows for causal inference (by testing general restrictions on the parameter matrices) on the basis of an augmented level VAR with integrated and cointegrated vectors is then implemented. Before testing for Granger causality an essential issue is to specify the lag-length in each country. The general approach is to fit VAR(*k*) models with orders $k = 0,\ldots, j_{\max}$ and to choose an estimator of the order j that minimizes the criterion. In so doing, the distance between the "true" model and the Kullback-Leiber quantity of information contained in a proposed model is measured by the log-likelihood function with *h* parameters given by

$$l = -\frac{TR}{2}(1 + \ln 2\pi) - \frac{T}{2}\ln\det(\hat{\Omega}(m))$$

Where $\det(\cdot)$ denotes the determinant, *R* is the number of equations and $\hat{\Omega}(m) = T^{-1}\sum_{t=1}^{T}\hat{e}_t\hat{e}_t'$ is the residual covariance matrix estimator for a VAR of order m. In measuring the goodness of fit and parsimonious of a model specification, the information criteria of Akaike (AIC), Schwartz (BIC) and Hannah-Quinn (HQ) are defined on the basis of -2 times the average log-likehood function adjusted by a penalty function. Table 2 shows the optimal lag selection in the four vector autoregressive structures estimated by ordinary least squares over each of the considered periods. In this fashion, we prefer lag structures which are the more parsimonious but still long enough to whiten the residuals. Lag selection is based on the AIC and HQ[4] criteria which indicate one lag for Argentina, Brazil and Mexico and two for Chile. Under these lag structures well-behaved white and gaussian residuals are found in all countries.

TABLE 2. VAR model. Lag selection and residuals

	Information criteria				residual diagnosis				
					no autocorrelation		normality		homocedasticity
COUNTRY	*Lag*	*l*	*AIC*	*SC*	*HQ*	Q_{por}	*LM*	JB_{chol}	JB_{urz}	*White*
ARGENTINA	1	-181	0.55*	14.96*	14.033*	225.69	25.47	11.03	136.77	177.68
BRAZIL	1	-129.03	11.78*	13.21*	12.20*	179.84	10.58	16.32	59.61	153.60
CHILE	2	-52.66	6.94*	9.49	7.77*	205.45	12.66	20.59	68.57	321.08
MEXICO	1	-105.15	10.01	11.45*	10.43*	181.46	9.44	14.85	127.95	166.04

Notes: * indicates lag-order selected by the criterion; *l* is the log of the likelihood function with *h* parameters estimated using *T* observations and the information criteria of Akaike, Schwarz and Hannah-Quinn are defined by

$$AIC = -2(l/T) + 2(h/T)$$

$$BIC = -2(l/T) + h\log(T)/T$$

$$HQ = -2(l/T) + 2h\log(T)/T$$

Given that VAR(k) has been selected, the last point is to determine the maximal order of integration that might occur in the process. As long as all the variables have been found to be at most I(1), an extra lag may be added in each VAR.

[4] In the mexican case the lag selection is based in both SC and HQ criteria as long as better gaussian residuals are obtained

To conclude, and overfitting the true VAR order, we estimate a levels VAR with a total of *p=(k+dmax)* lags. For the Granger-Causality tests, we apply standard Wald test to the first *k* VAR coefficient matrix excluding the extra parameters in testing for Granger causality. To sum up, the conclusive specification tested is defined by the following five variable *(k+dmax)* order VAR modelling linking economic growth, exports, real exchange rate, imports and financial account for each country

$$\begin{bmatrix} \ln GDP_t \\ \ln X_t \\ \ln RER_t \\ \ln M_t \\ \ln F_t \end{bmatrix} = \begin{bmatrix} \alpha_{10} \\ \alpha_{20} \\ \alpha_{30} \\ \alpha_{40} \\ \alpha_{50} \end{bmatrix} + \sum_{i=1}^{k} \begin{bmatrix} \alpha_{11,i} & \alpha_{12,i} & \alpha_{13,i} & \alpha_{14,i} & \alpha_{15,i} \\ \alpha_{21,i} & \alpha_{22,i} & \alpha_{23,i} & \alpha_{24,i} & \alpha_{25,i} \\ \alpha_{31,i} & \alpha_{32,i} & \alpha_{33,i} & \alpha_{34,i} & \alpha_{35,i} \\ \alpha_{41,i} & \alpha_{42,i} & \alpha_{43,i} & \alpha_{44,i} & \alpha_{45,i} \\ \alpha_{51,i} & \alpha_{52,i} & \alpha_{53,i} & \alpha_{54,i} & \alpha_{55,i} \end{bmatrix} \begin{bmatrix} \ln GDP_{t-i} \\ \ln X_{t-i} \\ \ln RER_{t-i} \\ \ln M_{t-i} \\ \ln F_t \end{bmatrix} +$$

$$+ \sum_{j=k+1}^{k+1+d\max} \begin{bmatrix} \alpha_{11,j} & \alpha_{12,j} & \alpha_{13,j} & \alpha_{14,j} & \alpha_{15,j} \\ \alpha_{21,j} & \alpha_{22,j} & \alpha_{23,j} & \alpha_{24,j} & \alpha_{25,j} \\ \alpha_{31,j} & \alpha_{32,j} & \alpha_{33,j} & \alpha_{34,j} & \alpha_{35,j} \\ \alpha_{41,j} & \alpha_{42,j} & \alpha_{43,j} & \alpha_{44,j} & \alpha_{45,j} \\ \alpha_{51,j} & \alpha_{52,j} & \alpha_{53,j} & \alpha_{54,j} & \alpha_{55,j} \end{bmatrix} \begin{bmatrix} \ln GDP_{t-j} \\ \ln X_{t-j} \\ \ln RER_{t-j} \\ \ln M_{t-j} \\ \ln F_{t-j} \end{bmatrix} + \begin{bmatrix} \varepsilon_{GDP_t} \\ \varepsilon_{X_t} \\ \varepsilon_{RER_t} \\ \varepsilon_{M_t} \\ \varepsilon_{F_t} \end{bmatrix} \qquad (11)$$

Table 3 summarizes all the causality results based on the MWALD test for each augmented VAR defined in equation (11) for Argentina, Brazil, Chile and Mexico. It is easy to see that the ELG hypothesis is supported for Brazil and Chile. Moreover, in both countries exports not only have caused economic growht but also imports. In addition, Chile has shown that exports have caused the real exchange rate. These results are indicating how the openness and liberalization development strategy in both countries have impulse the role of exports in the path of economic growth and other external important variables such as imports or the real exchange rate. In the same line, Argentina´s results support the ELG hypothesis but capital flows are at the centre of the economic growth causing all others variables except exports. Finally, Mexico presents a different pattern showing neither ELG nor GLE causality but an import-led export causality hypothesis is observed.

Table 3. Causality Test. MWALD Statistics Augmented VAR model

	Source of causation				
ARGENTINA (1976-2008)					
χ_1^2	$\ln GDP$	$\ln X$	$\ln RER$	$\ln M$	F
$\ln GDP$	*n.a.*	4.889[0.027]	2.521[0.112]	0.122[0.726]	13.472[0.000]
$\ln X$	0.069[0.792]	*n.a.*	0.002[0.995]	0.620[0.430]	0.142[0.705]
$\ln RER$	4.413[0.035]	4.076[0.043]	*n.a.*	0.002[0.957]	10.382[0.001]
$\ln M$	0.571[0.449]	2.703[0.101]	0.584[0.444]	*n.a.*	11.662[0.000]
F	0.018[0.891]	0.236[0.626]	0.016[0.890]	0.012[0.911]	*n.a.*
BRAZIL (1980-2008)					
χ_1^2	$\ln GDP$	$\ln X$	$\ln RER$	$\ln M$	F
$\ln GDP$	*n.a.*	3.777[0.051]	0.068[0.793]	0.198[0.656]	0.061[0.804]
$\ln X$	0.0481[0.826]	*n.a.*	0.0157[0.900]	0.624[0.429]	0.397[0.528]
$\ln RER$	0.010[0.918]	2.464[0.116]	*n.a.*	0.0849[0.770]	0.007[0.928]
$\ln M$	0.099[0.752]	10.347[0.001]	0.084[0.770]	*n.a*	1.121[0.289]
F	0.209[0.647]	1.291[0.255]	0.189[0.663]	0.188[0.664]	*n.a.*
CHILE (1975-2008)					
χ_1^2	$\ln GDP$	$\ln X$	$\ln RER$	$\ln M$	F
$\ln GDP$	*n.a.*	12.953[0.001]	0.844[0.655]	0.929[0.628]	1.907[0.385]
$\ln X$	0.465[0.792]	*n.a.*	0.201[0.904]	1.980[0.371]	1.237[0.538]
$\ln RER$	1.724[0.422]	6.431[0.040]	*n.a.*	1.820[0.402]	0.894[0.639]
$\ln M$	1.378[0.501]	10.293[0.005]	1.267[0.530]	*n.a.*	1.068[0.586]
F	1.816[0.403]	0.837[0.657]	2.560[0.278]	0.619[0.733]	*n.a.*
MEXICO (1979-2007)					
χ_1^2	$\ln GDP$	$\ln X$	$\ln RER$	$\ln M$	F
$\ln GDP$	*n.a.*	1.252[0.263]	0.382[0.536]	0.001[0.980]	0.591[0.441]
$\ln X$	0.206[0.649]	*n.a.*	0.023[0.877]	3.919[0.047]	0.001[0.998]
$\ln RER$	0.307[0.579]	1.133[0.287]	*n.a.*	0.776[0.378]	0.634[0.425]
$\ln M$	1.538[0.214]	0.973[0.511]	1.356[0.244]	*n.a.*	0.574[0.448]
F	0.475[0.490]	0.005[0.939]	0.631[0.426]	0.320[0.571]	*n.a.*

Notes : The $\lfloor k + d(\max) \rfloor$ th order level VAR has been estimated with $d(\max) = 1$. Lag length selection follows Table 2 results. Values in parentheses are p-values.

3.3. Results and discussion

This section briefly discusses the empirical estimations we have obtained for each single country in the estimations of our model.

First, our results coincide with those we previously mentioned for Chile by Amin Gutiérrez de Piñeres and Ferrantino, (1997), Agosin (1999) Herzer et al. (2006) and Siliverstovs and Herzer (2006) showing consistent and robust linkages running from exports to economic growth rather independently from different methodologies, periods, empirical models specifications and general approaches. As long as, openness economic reforms in Chile begun just in the mid seventies, covering the entire span in this study our estimations are supporting the idea that the outward orientated policies in Chile have modified the economy increasing the importance of the external sector to lead the economic growth path.

Meanwhile, Brazil implemented pro market reforms only since early nineties and the import substitution strategy was deeper and longer. At the same time, the Tratado de Asunción was signed in 1991 and Argentina, Brazil, Paraguay and Uruguay begun to built a common market among them (MERCOSUR)[5]. Unless opening economic reforms were implemented later and were less intense than the other Latin American countries, our results evidently show the importance of exports in promoting output growth and imports. Contrary to Cuadros et al. (2004) we verify an ELG instead of a GLE hypothesis in Brazil. The inclusion in the model of imports, the real exchange rate and the total net capital flows modifies the direction of the causality. Hence, in Brazilian analysis much more research must be carried out to clarify external linkages in the output path since very different conclusions are achieved.

Mexico is an appealing case in this paper. Results confirm neither ELG nor GLE hypothesis but suggests that imports cause and promote exports. This causality, labelled as the import-led-exports hypothesis (ILE), is explained by the North American Free Trade Association (NAFTA) launched among Canada, Mexico and United States in 1994. In few years the process produced in Mexico an important arrival of North American FDI to take advantage of the lower labour costs. This FDI has principally been linked to the so called *maquila* industry, which is based on ensambling processes in the last phases of production. This industry requires imports of intermediate goods principally coming from the United States to be ensemble and re-exported again to United States in the form final product. Precisely, this specialization pattern is explaining the ILE causality that we have found for Mexican economy. Other BPC approaches to the Mexican economy also find that the recent increase in income elasticity for imports is restricting economic growth (Matesanz et al. (2007); Pacheco-López and Thirlwall (2006); Moreno-Brid (1999). By contrast our ILE hypothesis is far away from the ELG causality addressed by Cuadros et al. (2004) and Thornton (1996). As we previously mentioned, while their study includes FDI and foreign income, ours is including global capital flows and imports as balance of payments approach requires. Therefore, these differences in the model specification completely change the results

[5] By this time, the South Common Market (MERCOSUR) is an incomplete Custom Union.

basically because of the inclusion of the imports (and the exclusion of foreign income) which is fundamental in the understanding of Mexican external recent specialization. Anyway, as Cuadros et al. (2004) remember us, results rely powerfully on the variables included.

Finally, the analysis for Argentina shows more causality linkages than in the previous countries. The first question that arises from the results is that the ELG hypothesis is supported: exports promote growth expansion. At the same time, Argentina is the unique country in this study that shows capital flows causing output expansion. Both exports and capital flows were determining the output growth related the BPC and signalling, comparing with Brazil, Chile and Mexico, a greater economic growth vulnerability to capital inflows and outflows and therefore dependency from the international financial markets conditions. Unless different model specifications, Cuadros et al. (2004) obtained similar results supporting an ELG hypothesis for Argentina and finding causality running from foreign direct investment to output. In this fashion, our results coincide with Cuadros et al. (2004) showing evidence of economic growth dependence of the foreign exchange available in the country. Contrary to Awokuse (2008) partial results, the evidence in this work do not support the bi-directional causality between imports and output he finds but coincides with his short run results where ELG hypothesis is validated. Once more, results differ depending on the variables included and the period sample and frequency. In addition, capital flows and imports seem to be important since its inclusion modify previous results in most cases.

4. Concluding remarks

Development strategies are increasingly vinculated to the external sector of the countries. Commercial and financial connections among them have become even more important since globalization process has been accelerated in the last decades. In this scenario, the balance of payments position is strongly related to the long run economic growth path of all countries in the world. This paper has digged into these linkages by running MWALD tests on augmented VAR models involving variables that are integrated and possibly cointegrated for the most important Latin American countries during the last thirty years. In this long period, Argentina, Brazil, Chile and Mexico modified their external development strategy implementing outward oriented policies in the frame of the so called Washington Consensus.

In this fashion, we have tested the well known Export led growth hypothesis for our four countries. The underlying model behind our empirical validations is based on the balance of payments constrained growth model introduced by Thirlwall (1979) and Thirlwall and Hussain (1982). This demand side approximation is a novelty in the empirical literature which has shown interesting results that can be summarized in two main contributions of the paper:

Firstly, the BCP approach we have introduced into the export growth nexus yields interesting and different results from those arising of the traditional neoclassical function contributions. Especially relevant to understand the openness and growth connections for Latin American countries is the inclusion of imports and capital flows in the specification of the causality models.

Secondly, our results suggest that, probably, a combination of the demand and supply side causality analysis for testing the ELG hypothesis (that is, the BCP and neoclassical productions functions approaches) will permit us to obtained more accurate and robust understanding in the exports growth nexus. For instance, our results are addredssing the ELG hypothesis for Chile that is confirmed as well for other supply side specifications such as Siliverstovs and Herzer (2006). Contrary, in Argentina, Brazil and Mexico different results are achieved indicating that much more research must be done and that a combination of approaches could improve the provided results.

References

AMIN GUTIÉRREZ DE PIÑERES, S. AND CANTAVELLA-JORDÁ, M. (2007): "Export-led-Growth : Are the results robust across methodologies and/or data sets? A case study of Latin America", *Applied Economics*, 39(12), 1475-1500.

AMIN GUTIÉRREZ DE PIÑERES, S. AND FERRANTINO, M. (1997): "Export diversification and structural dynamics in the growth process: The case of Chile", *Journal of Development Economics*, 52, 375-391.

AGOSIN, M. R. (1999): "Comercio y crecimiento en Chile", *Revista de la CEPAL*, 68, 79-100.

AWOKUSE, T.O. AND CHRISTOPOULOS, D. K. (2009): "Nonlinear dynamics and the exports-output nexus", *Economic Modelling*, 26, 184-190.

AWOKUSE, T. O. (2008): "Trade openness and economic growth: is growth export-led or import-led?", *Applied Economics*, 40, 161-173.

AWOKUSE, T.O. (2007): "Causality between exports, imports and economic growth. Evidence from transition economies", *Economics Letters*, 94, 389-395.

Bahmani-Oskooee, M. Economidou, M. C., AND GOBINDA GOSWAMI, G. (2005): "Export led growth revisited: A panel cointegration approach", *Scientific Journal of Administrative Development*, 3, 40-55.

CHAREMZA W.W., AND DEADMAN, F.D. (1992): *New Directions in Econometric Practice*, Brookfiels VT_ Edward Elgar.

COE, T. D., AND HELPMAN, E. (1995): "International R&D spillovers", *European Economic Review*, 39, 859-887.

CUADROS, A., ORTS, V. AND ALGUACIL, M. (2004): "Openness and Growth: Re-Examining Foreign Direct Investment, Trade and Output Linkages in Latin America". *The Journal of Development Studies*, Vol. 40 (4), 167-192.

DOLADO. J.J., AND LUTEKEPOHL. H. (1996) Making Wald test work for cointegrated VAR systems, *Econometrics Reviews*, 15, 369-386.

DOSI, G., AND SOETE, L. (1988) "Technical change and international trade." in: G. Dosi, et. al., (eds) *Technical Change and the Economic Theory*, London: Pinter Publishers, 401-431.

EDWARDS, S. (1993): "Openness, trade liberalization, and growth in developing countries", *Journal of Economic Literature*, 31, 1358-1393.

FUGAROLAS, G., AND MATESANZ, D. (2008): "Long- and short-run balance of payments adjustment: Argentine economic growth constrained", *Applied Economics Letters*, 15, 815-820.

GILES, J.A., AND WILLIAMS C.L. (2000): "Export-led Growth: a Survey of the Empirical Literature and some Non-Causality Results, Part 1", *Journal of International Trade and Economic* Development, 9, 261–337.

GRANGER, C. W. J. (1969): "Investigating causal relations by econometric models and cross-spectral methods", *Econometrica*, 37, 424-438.

GROSSMAN, G. M. AND HELPMAN, E. (1991): *Innovation and Growth in the Global Economy*, Cambridge: MIT Press.

HELPMAN, E. AND KRUGMAN, P. R. (1985): *Market structure and Foreign trade*, Cambridge (Mass.): MIT Press.

HOLLAND, M., F.V. VIEIRA AND CANUTO, O. (2002): *Economic growth and the balance of payments constraint in Latin America*, VII Encontro Nacional de Economia Política, 28-31 de mayo de 2002, en http://www.sep.org.br/eventos.asp?evento=s_sete

HERZER, D., NOWAK-LEHMANN, F. D., AND SILIVERSTOVS, B. (2006): "Export-led growth in chile: assessing the role of export composition in productivity growth", *The Developing Economies*, September, 44 (3), 306–28.

KRUGMAN, P.R. (1996): *Rethinking International Trade*, Cambridge: MIT Press.

KRUGMAN, P. R. (1987): "Is free trade passé?", *Economic Perspectives*, 1, 131-144.

LÓPEZ, J., AND CRUZ, A. (2000): "Thirwalls Law and beyond: the Latin American Experience", *Journal of Post Keynesian Economics*, spring, 22 (3), 477-495.

MACKINNON, J. (1996): "Numerical Distribution Functions for the Unit Root and Cointegration Tests", *Journal of Applied Econometrics*, 11, 601-618.

MANESCHIÖLD, P. (2008): "A note on the Export-led growth hypothesis: A time series approach", *Cuadernos de Economía*, 45, noviembre, 293-302.

MATESANZ, D. FUGAROLAS, G. AND CANDAUDAP, E. (2007): "Balanza de pagos y crecimiento económico restringido. Una comparación entre la economía Argentina y la Mexicana", *Revista de Economía Mundial*, 17, 25-49.

MCCOMBIE, J. S. L., AND THIRWALL, A. P. (1994): *Economic Growth and the Balance-of-Payments Constraint*, London: MacMillan Press.

MORENO-BRID, J.C. (2001): *Essays on Economic Growth and the Balance of Payments Constraint with Special Reference to the Case of Mexico*, Trinity College, Cambridge, PhD Thesis.

MORENO-BRID, J.C. (1999): "Mexico Economic Growth and the balance of Payments Constraint: a cointegration analysis", *International Review of Applied Economics*, 13(2), 149-159.

PACHECO LÓPEZ, P., AND THIRLWALL, A. P. (2006): "Trade liberalization, the income elasticity of demand for imports, and growth in Latin America", *Journal of Post Keynesian Economics*, Fall, 29 (1), 41-61.

PACHECO-LÓPEZ, P. AND THIRLWALL, A.P. (2004): "Trade Liberalisation in Mexico: Rhetoric and Reality", *Banca Nazionale del Lavoro Quarterly Review*, 229, June, 141-167.

SILIVERSTOVS, B., AND HERZER, D. (2006): "Export-led growth hypothesis: evidence for Chile", *Applied Economics Letters*, 13, 319-324.

THIRLWALL, A.P. (1979): "The Balance of Payments Constraint as an Explanation of International Growth Rate Differences", *Banca Nazionale del Lavoro Quarterly Review*, January, 128, 45-53.

THIRLWALL, A.P., AND HUSSAIN M. N. (1982): "The balance of payments constraint, capital flows and growth rates differences between developing countries", *Oxford Economics Papers*, 10, 498-509.

THORNTON, J. (1996): "Cointegration, causality and export-led growth in Mexico", 1895-1992, *Economics Letters*, 50, 413-416.

TODA H. Y. AND PHILLIPS, P.C.B. (1993): "Vector autorregressions and causality", *Econometrica* 61,1367-1393.

TODA. H. Y. AND YAMAMOTO. T. (1995): "Statistical inference in vector autoregression with possibly integrated processes", *Journal of Econometrics*, 66, 225-250.