EXPORT-LED-GROWTH HYPOTHESIS REVISITED. 
A BALANCE OF PAYMENTS APPROACH FOR 
ARGENTINA, BRAZIL, CHILE AND MEXICO

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De conformidad con la base quinta de la convocatoria del Programa de Estímulo a la Investigación, este trabajo ha sido sometido a evaluación externa anónima de especialistas cualificados a fin de contrastar su nivel técnico.

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Las opiniones son responsabilidad de los autores.
Abstract:
This study re-examines the export-led growth hypothesis for four Latin American countries in the spirit of the balance of payments constraint approach and, in particular, dealing with the Thirlwall and Hussain model. 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.

Jel Codes: C22, C32, C52, F31, F43

Keywords: Export Led growth hypothesis, Latin America, Balance of payments constrained approach, Granger causality.
Connections between openness and growth have been an issue of interest since the nineteenth 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.

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
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.

The choice of these four countries is motivated for two main reasons. The first one is clear enough: Argentina, Brazil, Chile and Mexico are the economically most important countries in Latin American representing around three quarters of the Latin American GDP and exports of goods and services in 2007. The second reason is that analyzing the role of exports in promoting growth is a good way for testing the external performance in the outward oriented policy implemented during the last two or three decades.

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 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.
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, Agosín (1999) find evidence for causality running from export and investment to output growth in Chile during the period 1960-1995 by using cointegration methods.

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) analyses 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 functions 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.

II. MODELLING SPECIFICATIONS AND ECONOMETRIC TECHNIQUES

II. 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. Table 1 shows the annual rates of growth of the involved variables in our model. It is easy to see that Chile has the highest output, exports, imports and net capital rates of growth. Meanwhile, Argentina has the worst rate of output growth and is the only country where the imports have grown faster than exports. In addition, the real exchange rates have shown a pretty neutral behaviour in the long run with very little rates of growth suggesting the idea of purchase parity power. Anyway, volatility of all variables, specially the real exchange rate and the net capital flows has been important in this long period.

\begin{table}[h]
\centering
\caption{GDP, EXPORTS, IMPORTS AND REAL EXCHANGE RATE, ANNUAL RATES OF GROWTH}
\end{table}

\(^3\) Period span is: Argentina (1976-2008: 32 observations), Brazil (1980-2008: 28 observations), Chile (1975-2007: 32 observations) and Mexico (1979-2007: 28 observations)
<table>
<thead>
<tr>
<th>Country</th>
<th>Year</th>
<th>y (1)</th>
<th>x (1)</th>
<th>m(1)</th>
<th>RER (1)</th>
<th>F(1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Argentina</td>
<td>1976-2008</td>
<td>2.30</td>
<td>9.66</td>
<td>9.86</td>
<td>0.69</td>
<td>10.43</td>
</tr>
<tr>
<td>Brazil</td>
<td>1980-2008</td>
<td>2.70</td>
<td>8.76</td>
<td>7.48</td>
<td>-0.27</td>
<td>4.35</td>
</tr>
<tr>
<td>Chile</td>
<td>1975-2007</td>
<td>4.97</td>
<td>12.76</td>
<td>11.64</td>
<td>1.09</td>
<td>16.50</td>
</tr>
<tr>
<td>Mexico</td>
<td>1979-2007</td>
<td>2.83</td>
<td>10.91</td>
<td>9.96</td>
<td>-0.09</td>
<td>5.19</td>
</tr>
</tbody>
</table>

(1) denotes average rate of growth of real GDP, exports, imports and real exchange rate, respectively.
Source: IMF based on own calculations.

II. 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 maximum 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

\[ P \cdot X + E \cdot F = P^* \cdot E \cdot M \]  \hspace{1cm} (1)
\[ x = \eta(p - p^* - e) + \varepsilon y^* \text{ with } \eta < 0, \pi > 0 \]  \hspace{1cm} (2)
\[ m = \gamma(p^* + e - p) + \pi y \text{ with } \gamma < 0, \varepsilon > 0 \]  \hspace{1cm} (3)
\[ \theta = \frac{P \cdot X}{P \cdot X + E \cdot F} \]  \hspace{1cm} (4)
\[ \theta(p + x) + (1 - \theta)(f + e) = p^* + e + m \]  \hspace{1cm} (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, \( \varepsilon \) and \( \eta \) represent the income and price elasticities for exports and \( \pi \) and \( \gamma \) the same elasticities for imports.

Equation (4) defines \( \theta \) 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} e y^* + \frac{(1 - \theta)}{\pi}(f + e - p) + \frac{\theta \cdot \eta + \gamma + 1}{\pi}((p - p^* - e) \)  \hspace{1cm} (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) \) \hspace{1cm} (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).

II.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

$$\ln Y_t = h[l\ln X_t, \ln RER_t, \ln M_t, F_t] \quad (8)$$

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:
\[ y_t = y + A_t y_{t-1} + \epsilon_t + A_p y_{t-p} + \epsilon_t \quad (9) \]

being \( y_t \) the integrated and possible cointegrated variables, \( \nu \) the vector of intercepts, \( A_t \) the vector parameter for lag \( i (i = 1, K, p) \) and \( \epsilon_t \) 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

\[ y_t = y + A_t y_{t-1} + K + A_p y_{t-p} + K + A_{p+d} y_{t-p-d} + \epsilon_t \quad (10) \]

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:

\[ H_0: \text{the row} \ j, \text{column} \ k \text{ element in} \ A_t \text{ equals zero for} \ i = 1, K, p \]

Hence, the TYDL procedure consists on over-fit a levels VAR specification with a total of \( p = (k + d_{\text{max}}) \) lags being \( k \) the lag-length chosen by using some information criteria and \( d_{\text{max}} \) 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 \( d_{\text{max}} \) 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 \( A_t \) are not restricted at all under the null hypothesis (for instance, the non causality restriction which involves in a VAR modelling elements from all \( A_t \), \( i = 1, K, k \)) 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 $\chi^2$ distribution. The test has to be performed on the $A_i$, $i = 1, K, k$ 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.

### III. ECONOMETRIC ESTIMATES AND EMPIRICAL RESULTS

#### III.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 2 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 2. AUGMENTED DICKEY-FULLER UNIT ROOT TEST (ADF).

\[ H_0 : \delta = 0 \]

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

\[ H_1 : \delta < 0 \]

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

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

<table>
<thead>
<tr>
<th>ARGENTINA (1976-2008)</th>
<th>MODEL (I)</th>
<th>MODEL (II)</th>
<th>MODEL (III)</th>
</tr>
</thead>
<tbody>
<tr>
<td>variable</td>
<td>Lag</td>
<td>( \tau_{\delta} )</td>
<td>( t_{\alpha} )</td>
</tr>
<tr>
<td>ln GDP</td>
<td>0</td>
<td>0.559</td>
<td>-2.145</td>
</tr>
<tr>
<td>( \Delta \ln GDP )</td>
<td>n.a.</td>
<td>n.a.</td>
<td>n.a.</td>
</tr>
<tr>
<td>ln X</td>
<td>1</td>
<td>-0.837</td>
<td>-3.121</td>
</tr>
<tr>
<td>( \Delta \ln X )</td>
<td>n.a.</td>
<td>n.a.</td>
<td>n.a.</td>
</tr>
<tr>
<td>ln RER</td>
<td>0</td>
<td>0.710</td>
<td>-2.249</td>
</tr>
<tr>
<td>( \Delta \ln RER )</td>
<td>n.a.</td>
<td>n.a.</td>
<td>n.a.</td>
</tr>
<tr>
<td>ln M</td>
<td>1</td>
<td>2.706</td>
<td>-2.963</td>
</tr>
<tr>
<td>( \Delta \ln M )</td>
<td>n.a.</td>
<td>n.a.</td>
<td>n.a.</td>
</tr>
<tr>
<td>( F )</td>
<td>1</td>
<td>-1.138</td>
<td>-3.460</td>
</tr>
<tr>
<td>( \Delta F )</td>
<td>n.a.</td>
<td>n.a.</td>
<td>n.a.</td>
</tr>
</tbody>
</table>

Notes: \( k \) is 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. \( \tau_{\delta} \), \( \tau_{\alpha} \) 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.

TABLE 2. (continuation) . AUGMENTED DICKEY-FULLER UNIT ROOT TEST (ADF).

<table>
<thead>
<tr>
<th>BRAZIL (1980-2008)</th>
<th>MODEL (I)</th>
<th>MODEL (II)</th>
<th>MODEL (III)</th>
</tr>
</thead>
<tbody>
<tr>
<td>variable</td>
<td>Lag</td>
<td>( \tau_{\delta} )</td>
<td>( t_{\alpha} )</td>
</tr>
<tr>
<td>ln GDP</td>
<td>2</td>
<td>2.438</td>
<td>0.049</td>
</tr>
<tr>
<td>( \Delta \ln GDP )</td>
<td>n.a.</td>
<td>n.a.</td>
<td>n.a.</td>
</tr>
<tr>
<td>ln M</td>
<td>1</td>
<td>2.797</td>
<td>0.7329</td>
</tr>
</tbody>
</table>

13
Notes: $k$ is the lag structure order chosen to guarantee white noise residuals; subscripts $tc$, $c$ and $nc$ indicate if trend and intercept or none is included in test model (i), (ii) and (iii) respectively. $\tau_{\beta_d}$, $\tau_{\alpha_m}$ 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.

### III.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 $\text{VAR}(k)$ models with orders $k = 0, K, j_{\max}$ 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-likelihood function adjusted by a penalty function. Table 3 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 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 3. VAR model. Lag selection and residuals

<table>
<thead>
<tr>
<th>Country</th>
<th>Lag</th>
<th>$L$</th>
<th>$AIC$</th>
<th>$SC$</th>
<th>$HQ$</th>
<th>$Q_{pior}$</th>
<th>$LM$</th>
<th>$JB_{chol}$</th>
<th>$JB_{burz}$</th>
<th>$White$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Argentina</td>
<td>1</td>
<td>-181.00</td>
<td>0.55*</td>
<td>14.96*</td>
<td>14.033*</td>
<td>225.69</td>
<td>25.47</td>
<td>11.03</td>
<td>136.77</td>
<td>177.68</td>
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</table>

4 In the Mexican case the lag selection is based in both SC and HQ criteria as long as better gaussian residuals are obtained.
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<th></th>
<th>1</th>
<th>129.03</th>
<th>11.78*</th>
<th>13.21*</th>
<th>12.20*</th>
<th>179.84</th>
<th>10.58</th>
<th>16.32</th>
<th>59.61</th>
<th>153.60</th>
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<td>BRAZIL</td>
<td>129.03</td>
<td>11.78*</td>
<td>13.21*</td>
<td>12.20*</td>
<td>179.84</td>
<td>10.58</td>
<td>16.32</td>
<td>59.61</td>
<td>153.60</td>
<td></td>
</tr>
<tr>
<td>CHILE</td>
<td>-52.66</td>
<td>6.94*</td>
<td>9.49</td>
<td>7.77*</td>
<td>205.45</td>
<td>12.66</td>
<td>20.59</td>
<td>68.57</td>
<td>321.08</td>
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<tr>
<td>MEXICO</td>
<td>-105.15</td>
<td>10.01</td>
<td>11.45*</td>
<td>10.43*</td>
<td>181.46</td>
<td>9.44</td>
<td>14.85</td>
<td>127.95</td>
<td>166.04</td>
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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.

To conclude, and overfitting the true VAR order, we estimate a levels VAR with a total of \( p=(k+d_{max}) \) 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 \((k+d_{max})\) order VAR modelling linking economic growth, exports, real exchange rate, imports and financial account for each country.

\[
\begin{bmatrix}
\ln GDP_{t-i} \\
\ln X_{t-i} \\
\ln RER_{t-i} \\
\ln M_{t-i} \\
F_{t-i}
\end{bmatrix} = \begin{bmatrix}
\alpha_{10} \\
\alpha_{20} \\
\alpha_{30} \\
\alpha_{40} \\
\alpha_{50}
\end{bmatrix} + \sum_{l=1}^{k} \begin{bmatrix}
\alpha_{11,l} \\
\alpha_{12,l} \\
\alpha_{13,l} \\
\alpha_{14,l} \\
\alpha_{15,l}
\end{bmatrix} \begin{bmatrix}
\ln GDP_{t-i} \\
\ln X_{t-i} \\
\ln RER_{t-i} \\
\ln M_{t-i} \\
F_{t-i}
\end{bmatrix} + \sum_{j=k+1}^{k+d_{\text{max}}} \begin{bmatrix}
\alpha_{21,j} \\
\alpha_{22,j} \\
\alpha_{23,j} \\
\alpha_{24,j} \\
\alpha_{25,j}
\end{bmatrix} \begin{bmatrix}
\alpha_{31,j} \\
\alpha_{32,j} \\
\alpha_{33,j} \\
\alpha_{34,j} \\
\alpha_{35,j}
\end{bmatrix} \begin{bmatrix}
\alpha_{41,j} \\
\alpha_{42,j} \\
\alpha_{43,j} \\
\alpha_{44,j} \\
\alpha_{45,j}
\end{bmatrix} \begin{bmatrix}
\alpha_{51,j} \\
\alpha_{52,j} \\
\alpha_{53,j} \\
\alpha_{54,j} \\
\alpha_{55,j}
\end{bmatrix} + \begin{bmatrix}
\varepsilon_{\text{GDP}} \\
\varepsilon_{\text{X}} \\
\varepsilon_{\text{RER}} \\
\varepsilon_{\text{M}} \\
\varepsilon_{\text{F}}
\end{bmatrix}
\]

\[(11)\]
Table 4 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 growth 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>
<thead>
<tr>
<th>Source of causation</th>
<th>ARGENTINA (1976-2008)</th>
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</table>

**TABLE 4. CAUSALITY TEST. MWALD Statistics Augmented VAR model**
### Brazil (1980-2008)

<table>
<thead>
<tr>
<th>$\chi^2$</th>
<th>ln GDP</th>
<th>ln X</th>
<th>ln RER</th>
<th>ln M</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>ln GDP</td>
<td>n.a.</td>
<td>3.777[0.051]</td>
<td>0.068[0.793]</td>
<td>0.198[0.656]</td>
<td>0.061[0.804]</td>
</tr>
<tr>
<td>ln X</td>
<td>0.048[0.826]</td>
<td>n.a.</td>
<td>0.0157[0.900]</td>
<td>0.624[0.429]</td>
<td>0.397[0.528]</td>
</tr>
<tr>
<td>ln RER</td>
<td>0.010[0.418]</td>
<td>2.464[0.0116]</td>
<td>n.a.</td>
<td>0.0849[0.70]</td>
<td>0.007[0.928]</td>
</tr>
<tr>
<td>ln M</td>
<td>0.099[0.752]</td>
<td>10.347[0.001]</td>
<td>0.084[0.770]</td>
<td>n.a.</td>
<td>1.121[0.289]</td>
</tr>
<tr>
<td>F</td>
<td>0.209[0.647]</td>
<td>1.291[0.255]</td>
<td>0.189[0.663]</td>
<td>0.188[0.664]</td>
<td>n.a.</td>
</tr>
</tbody>
</table>

### Chile (1975-2008)

<table>
<thead>
<tr>
<th>$\chi^2$</th>
<th>ln GDP</th>
<th>ln X</th>
<th>ln RER</th>
<th>ln M</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>ln GDP</td>
<td>n.a.</td>
<td>12.953[0.001]</td>
<td>0.844[0.655]</td>
<td>0.929[0.628]</td>
<td>1.907[0.385]</td>
</tr>
<tr>
<td>ln X</td>
<td>0.465[0.792]</td>
<td>n.a.</td>
<td>0.201[0.904]</td>
<td>1.980[0.371]</td>
<td>1.237[0.538]</td>
</tr>
<tr>
<td>ln RER</td>
<td>1.724[0.422]</td>
<td>6.431[0.040]</td>
<td>n.a.</td>
<td>1.820[0.402]</td>
<td>0.894[0.639]</td>
</tr>
<tr>
<td>ln M</td>
<td>1.378[0.501]</td>
<td>10.293[0.005]</td>
<td>1.267[0.530]</td>
<td>n.a.</td>
<td>1.068[0.586]</td>
</tr>
<tr>
<td>F</td>
<td>1.816[0.403]</td>
<td>0.837[0.657]</td>
<td>2.560[0.278]</td>
<td>0.619[0.733]</td>
<td>n.a.</td>
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</tbody>
</table>

### Mexico (1979-2007)

<table>
<thead>
<tr>
<th>$\chi^2$</th>
<th>ln GDP</th>
<th>ln X</th>
<th>ln RER</th>
<th>ln M</th>
<th>F</th>
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</thead>
<tbody>
<tr>
<td>ln GDP</td>
<td>n.a.</td>
<td>1.252[0.263]</td>
<td>0.382[0.536]</td>
<td>0.001[0.980]</td>
<td>0.591[0.441]</td>
</tr>
<tr>
<td>ln X</td>
<td>0.206[0.649]</td>
<td>n.a.</td>
<td>0.023[0.877]</td>
<td>3.919[0.047]</td>
<td>0.001[0.998]</td>
</tr>
<tr>
<td>ln RER</td>
<td>0.307[0.579]</td>
<td>1.133[0.287]</td>
<td>n.a.</td>
<td>0.776[0.378]</td>
<td>0.634[0.425]</td>
</tr>
<tr>
<td>ln M</td>
<td>1.538[0.214]</td>
<td>0.973[0.511]</td>
<td>1.356[0.244]</td>
<td>n.a.</td>
<td>0.574[0.448]</td>
</tr>
<tr>
<td>F</td>
<td>0.475[0.490]</td>
<td>0.005[0.939]</td>
<td>0.631[0.426]</td>
<td>0.320[0.571]</td>
<td>n.a.</td>
</tr>
</tbody>
</table>

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

### III.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). 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

---

5 By this time, the South Common Market (MERCOSUR) is an incomplete Custom Union.
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 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. Besides 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 does not support that bi-directional causality between imports and output he is finding 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.

IV. 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 dug 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 addressing 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.

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Elena Olmedo, Juan M. Valderas, Ricardo Gimeno and Lorenzo Escot
<table>
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<tr>
<td>205</td>
<td>Precio de la tierra con presión urbana: un modelo para España</td>
<td>Esther Decimavilla, Carlos San Juan y Stefan Sperlich</td>
</tr>
<tr>
<td>206</td>
<td>Interregional migration in Spain: a semiparametric analysis</td>
<td>Adolfo Maza y José Villaverde</td>
</tr>
<tr>
<td>207</td>
<td>Productivity growth in European banking</td>
<td>Carmen Murillo-Melchor, José Manuel Pastor y Emili Tortosa-Ausina</td>
</tr>
<tr>
<td>208</td>
<td>Explaining Bank Cost Efficiency in Europe: Environmental and Productivity Influences.</td>
<td>Santiago Carbó Valverde, David B. Humphrey y Rafael López del Paso</td>
</tr>
<tr>
<td>209</td>
<td>La elasticidad de sustitución intertemporal con preferencias no separables intratemporalmente: los casos de Alemania, España y Francia.</td>
<td>Elena Márquez de la Cruz, Ana R. Martínez Cañete y Inés Pérez-Soba Aguilar</td>
</tr>
<tr>
<td>210</td>
<td>Contribución de los efectos tamaño, book-to-market y momentum a la valoración de activos: el caso español.</td>
<td>Begoña Font-Belaire y Alfredo Juan Grau-Grau</td>
</tr>
<tr>
<td>211</td>
<td>Permanent income, convergence and inequality among countries</td>
<td>José M. Pastor and Lorenzo Serrano</td>
</tr>
<tr>
<td>212</td>
<td>The Latin Model of Welfare: Do 'Insertion Contracts' Reduce Long-Term Dependence?</td>
<td>Luis Ayala and Magdalena Rodríguez</td>
</tr>
<tr>
<td>213</td>
<td>The effect of geographic expansion on the productivity of Spanish savings banks</td>
<td>Manuel Illueca, José M. Pastor and Emili Tortosa-Ausina</td>
</tr>
<tr>
<td>214</td>
<td>Dynamic network interconnection under consumer switching costs</td>
<td>Ángel Luis López Rodríguez</td>
</tr>
<tr>
<td>215</td>
<td>La influencia del entorno socioeconómico en la realización de estudios universitarios: una aproximación al caso español en la década de los noventa</td>
<td>Marta Rahona López</td>
</tr>
<tr>
<td>216</td>
<td>The valuation of spanish ipos: efficiency analysis</td>
<td>Susana Álvarez Otero</td>
</tr>
<tr>
<td>217</td>
<td>On the generation of a regular multi-input multi-output technology using parametric output distance functions</td>
<td>Sergio Perelman and Daniel Santín</td>
</tr>
<tr>
<td>218</td>
<td>La gobernanza de los procesos parlamentarios: la organización industrial del congreso de los diputados en España</td>
<td>Gonzalo Caballero Miguez</td>
</tr>
<tr>
<td>219</td>
<td>Determinants of bank market structure: Efficiency and political economy variables</td>
<td>Francisco González</td>
</tr>
<tr>
<td>220</td>
<td>Agresividad de las órdenes introducidas en el mercado español: estrategias, determinantes y medidas de performance</td>
<td>David Abad Diaz</td>
</tr>
</tbody>
</table>
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Werner Kleinhanß, Carmen Murillo, Carlos San Juan y Stefan Sperlich
<table>
<thead>
<tr>
<th>Year</th>
<th>Title</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>272/2006</td>
<td>Riesgo asimétrico y estrategias de momentum en el mercado de valores español</td>
<td>Luis Muga y Rafael Santamaria</td>
</tr>
<tr>
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<td>Valoración de capital-riesgo en proyectos de base tecnológica e innovadora a través de la teoría de opciones reales</td>
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</tr>
<tr>
<td>274/2006</td>
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</tr>
<tr>
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<td>Study of the influence of the voters’ political culture on vote decision through the simulation of a political competition problem in Spain</td>
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</tr>
<tr>
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</tr>
<tr>
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</tr>
<tr>
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<td>El consumo y la valoración de activos</td>
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</tr>
<tr>
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</tr>
<tr>
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</tr>
<tr>
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</tr>
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</tr>
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</tr>
<tr>
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</tr>
<tr>
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</tr>
<tr>
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<td>Xavier Labandeira and Miguel Rodríguez</td>
</tr>
</tbody>
</table>
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Marcelino Martínez Cabrera

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Félix Domínguez Barrero

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Javier Blanco González y Ignacio del Rosal Fernández

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Cesar Augusto Bustos Reyes y Óscar González Benito

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Luis Miguel Zapico Aldeano

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Alberte Martínez López

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Isabel Lillo, Mª Dolores López y Javier Rodrigo

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Mª Concepción López Fernández, Ana Mª Serrano Bedía and Gema García Piqueres
<table>
<thead>
<tr>
<th>Issue</th>
<th>Title</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>323/2007</td>
<td>Wood and industrialization. evidence and hypotheses from the case of Spain, 1860-1935.</td>
<td>Iñaki Iriarte-Goñi and María Isabel Ayuda Bosque</td>
</tr>
<tr>
<td>325/2007</td>
<td>Monetary policy and structural changes in the volatility of us interest rates.</td>
<td>Juncal Cuñado, Javier Gomez Biscarri and Fernando Perez de Gracia</td>
</tr>
<tr>
<td>326/2007</td>
<td>The productivity effects of intrafirm diffusion.</td>
<td>Lucio Fuentelsaz, Jaime Gómez and Sergio Palomas</td>
</tr>
<tr>
<td>328/2007</td>
<td>El grado de cobertura del gasto público en España respecto a la UE-15</td>
<td>Nuria Rueda, Begoña Barruso, Carmen Calderón y Mª del Mar Herrador</td>
</tr>
<tr>
<td>329/2007</td>
<td>The Impact of Direct Subsidies in Spain before and after the CAP'92 Reform</td>
<td>Carmen Murillo, Carlos San Juan and Stefan Sperlich</td>
</tr>
<tr>
<td>330/2007</td>
<td>Determinants of post-privatisation performance of Spanish divested firms</td>
<td>Laura Cabeza García and Silvia Gómez Ansón</td>
</tr>
<tr>
<td>331/2007</td>
<td>¿Por qué deciden diversificar las empresas españolas? Razones oportunistas versus razones económicas</td>
<td>Almudena Martínez Campillo</td>
</tr>
<tr>
<td>332/2007</td>
<td>Dynamical Hierarchical Tree in Currency Markets</td>
<td>Juan Gabriel Brida, David Matesanz Gómez and Wiston Adrián Risso</td>
</tr>
<tr>
<td>333/2007</td>
<td>Los determinantes sociodemográficos del gasto sanitario. Análisis con microdatos individuales</td>
<td>Ana María Angulo, Ramón Barberán, Pilar Egea y Jesús Mur</td>
</tr>
<tr>
<td>334/2007</td>
<td>Why do companies go private? The Spanish case</td>
<td>Inés Pérez-Soba Aguilar</td>
</tr>
<tr>
<td>335/2007</td>
<td>The use of gis to study transport for disabled people</td>
<td>Verónica Cañal Fernández</td>
</tr>
<tr>
<td>336/2007</td>
<td>The long run consequences of M&amp;A: An empirical application</td>
<td>Cristina Bernad, Lucio Fuentelsaz and Jaime Gómez</td>
</tr>
<tr>
<td>337/2007</td>
<td>Las clasificaciones de materias en economía: principios para el desarrollo de una nueva clasificación</td>
<td>Valentín Edo Hernández</td>
</tr>
<tr>
<td>339/2007</td>
<td>Impacts of an iron and steel plant on residential property values</td>
<td>Celia Bilbao-Terol</td>
</tr>
<tr>
<td>340/2007</td>
<td>Firm size and capital structure: Evidence using dynamic panel data</td>
<td>Víctor M. González and Francisco González</td>
</tr>
<tr>
<td>Número</td>
<td>Título</td>
<td>Autor(es)</td>
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</tr>
<tr>
<td>341/2007</td>
<td>¿Cómo organizar una cadena hotelera? La elección de la forma de gobierno</td>
<td>Marta Fernández Barcala y Manuel González Díaz</td>
</tr>
<tr>
<td>342/2007</td>
<td>Análisis de los efectos de la decisión de diversificar: un contraste del marco teórico “Agencia-Stewardship”</td>
<td>Almudena Martínez Campillo y Roberto Fernández Gago</td>
</tr>
<tr>
<td>343/2007</td>
<td>Selecting portfolios given multiple eurostoxx-based uncertainty scenarios: a stochastic goal programming approach from fuzzy betas</td>
<td>Enrique Ballestero, Blanca Pérez-Gladish, Mar Arenas-Parra and Amelia Bilbao-Terol</td>
</tr>
<tr>
<td>344/2007</td>
<td>“El bienestar de los inmigrantes y los factores implicados en la decisión de emigrar”</td>
<td>Anastasia Hernández Alemán y Carmelo J. León</td>
</tr>
<tr>
<td>346/2007</td>
<td>Diferencias salariales entre empresas públicas y privadas. El caso español</td>
<td>Begoña Cueto y Nuria Sánchez-Sánchez</td>
</tr>
<tr>
<td>347/2007</td>
<td>Effects of Fiscal Treatments of Second Home Ownership on Renting Supply</td>
<td>Celia Bilbao Terol and Juan Prieto Rodríguez</td>
</tr>
<tr>
<td>348/2007</td>
<td>Auditors’ ethical dilemmas in the going concern evaluation</td>
<td>Andres Guiral, Waymond Rodgers, Emiliano Ruiz and Jose A. Gonzalo</td>
</tr>
<tr>
<td>351/2007</td>
<td>Persistencia del resultado contable y sus componentes: implicaciones de la medida de ajustes por devengo</td>
<td>Raúl Iñiguez Sánchez y Francisco Poveda Fuentes</td>
</tr>
<tr>
<td>352/2007</td>
<td>Wage Inequality and Globalisation: What can we Learn from the Past? A General Equilibrium Approach</td>
<td>Concha Betrán, Javier Ferri and Maria A. Pons</td>
</tr>
<tr>
<td>353/2007</td>
<td>Eficacia de los incentivos fiscales a la inversión en I+D en España en los años noventa</td>
<td>Desiderio Romero Jordán y José Félix Sanz Sanz</td>
</tr>
<tr>
<td>354/2007</td>
<td>Convergencia regional en renta y bienestar en España</td>
<td>Robert Meneu Gaya</td>
</tr>
<tr>
<td>355/2007</td>
<td>Tributación ambiental: Estado de la Cuestión y Experiencia en España</td>
<td>Ana Carrera Poncela</td>
</tr>
<tr>
<td>356/2007</td>
<td>Salient features of dependence in daily us stock market indices</td>
<td>Luis A. Gil-Alana, Juncal Cuñado and Fernando Pérez de Gracia</td>
</tr>
<tr>
<td>357/2007</td>
<td>La educación superior: ¿un gasto o una inversión rentable para el sector público?</td>
<td>Inés P. Murillo y Francisco Pedraja</td>
</tr>
</tbody>
</table>
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Carlos Pestana Barros and Juan Prieto-Rodriguez

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Ciro Eduardo Bazán Navarro

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Mariano Matilla-García and Manuel Ruiz Marín

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Uwe Hassler, Paulo M.M. Rodrigues and Antonio Rubia

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Esther B. Del Brio, Trino-Manuel Ñíguez and Javier Perote

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Santiago Carbó Valverde, David B. Humphrey, José Manuel Liñares Zegarra and Francisco Rodríguez Fernandez

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M. L. López-Avello, M. V. Rodriguez-Uría, B. Pérez-Gladish, A. Bilbao-Terol, M. Arenas-Parra

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Gracia Rubio Martín y Prosper Lamothe Fernández

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Mª Leticia Santos Vijande, Mª José Sanzo Pérez, Nuria García Rodríguez y Juan A. Trespalacios Gutiérrez

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David Abad y Belén Nieto

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Jesús López-Rodríguez y J. Andrés Faiña

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Jaime Gómez, Juan Pablo Maícas

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Ana R. Martínez-Cañete y Inés Pérez-Soba Aguilar
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Mariano Matilla García, Pedro Pérez Pascual y Basilio Sanz Carnero

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Alfonso Echazarra de Gregorio

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Borja Montaño Sanz

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Laura Cabeza García and Silvia Gomez Anson

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