Energy and non-energy imports, exports and growth. Evidence for Spain (1900-2008)

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Abstract

This paper attempts to empirically examine the multivariate causal relationship between energy and non-energy imports, exports, and economic growth for Spain from an historical perspective. Results provided from Johansen's (1988) and Toda and Yamamoto (1995) methodologies are widely consistent. For the first half of the 20th century, sub-period characterized by low level of industrialization and inward oriented trade policy, they support that economic growth is rather independent to the external trade. In contrast, outcome obtained from the sub-period after implementation at 1959 of the liberalization plan and outward oriented trade policy indicates that there is a network of causal relationships among variables of interest. Concretely, results suggest that economic development led exports and, in turn, exports permit the rise of non-energy imports. Moreover, they support feedback between energy imports, exports and economic growth through the existence of a closed causal loop.

Keywords: Energy imports, non-energy imports, exports, economic growth, causality.

JEL Codes: F43, N1, N7, O11, Q43

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1. Introduction

One of the most consolidated theoretical ideas in the economics field is the capacity of international trade as generator of economic growth (Irwin, 1996). It is an essential reason why in the last two decades an increasing interest in to empirically study the potential causality has emerged from advance in econometric techniques particularly suitable for non-stationary time series analysis (e.g. Johansen, 1988, 1991; Johansen and Juselius, 1990; Toda and Yamamoto, 1995). Currently there is an important empirical literature body on issue, but much of the analysis performed is rather incomplete from the standpoint that it does not consider the role of imports. In the cases where it is considered, works are focused in offering evidence on relative recent periods. So, except the recent paper of Pistoresi and Rinaldi (2012), which yields empirical results concerning Italy,[1] from our knowledge there is no other study that provides evidence about how had changed the relationship between imports, exports and GDP under different historical stages of a country.

The aim of this paper is to contribute the literature by empirically analysing possible causality between foreign trade and real GDP for Spain from an historical perspective. We will exploit statistical information for a long period to explore the stability of relationship among variables in presence of the policy reforms carried out following the *Stabilisation and Liberalisation Plan* (SLP) of 1959. This policy measures constitute a suitable case study for our purpose since it marked the end of an era characterized by shortage of productive resources with high energy restrictions derived from the situation of autarky, and led the way toward a new period of liberalization and foreign trade openness. Moreover, we will recognize the traditional shortage of own energy resources and consequently the fact that imports of energy products may have had a particularly

[1] The paper is particularly interesting from the standpoint that explores, from an historical approach, how the causal relationship changes under different stages of trade development. Authors found imports led growth and, in turn, growth led exports for the sub-period before the First World War (1863-1913). Only weak evidence in favor of the export led growth and the growth led import hypotheses are obtained for the post Second World War sub-period (1951-2004). Variation of the nexus between external trade and real GDP in last sub-period is attributed to increases of intra-industry trade experienced by the country.

important role in the process of outward industrialization and economic growth. Then, we will try to disentangle the relevance properly attributed to energy imports.[2]

Thus, together with interest in to explore the specific role of energy imports, our approach will differ from the previously adopted for Spain in at least two further basic aspects. On the one hand, unlike the papers of Kónya (2006) and Laurin (2012),[3] we will implement the analysis from an historical perspective since we are rather concerned to know whether the policy reforms carried at 1959 has significantly affected the possible relationship between foreign trade and GDP. On the other hand, our analysis can be conceived as a required extension of the papers of Balaguer and Cantavella-Jordá (2001, 2004) which, in spite that they adopted a historical perspective, disregard the evolution of imports in the econometric specification in the tradition of an early generation of research in this area.

The consideration of imports together with exports will allows us a better evaluation about whole potentiality of foreign trade on GDP. Indeed, imports may also generate economic growth through various channels. They provide the much necessary inputs for production, may permit the access to foreign R&D knowledge, foreign technology and innovations, and may increases efficiency in domestic markets through of more competitive pressure (e.g. Grossman and Helpman, 1994; Kim et al, 2009). Moreover, the use of both variables prevents potential estimation bias derived from a positive correlation between them. In fact, exports provide foreign exchange that allows to fuel imports. In turn, country's production and export capacity may be highly depending on imports of capital, energy, and other intermediate inputs which are not domestically accessible or, otherwise, can be obtained but at higher cost than from international markets.

The paper is organized as follows. Section 2 provides the analysis of data series, as well as the description of causality methodology and empirical results. After analysing the stationarity properties of time series, we estimate a multivariate vector autoregressive

[2] Balaguer and Ripollés (2013) have shown that the global use of energy in Spain has been a precondition for GDP development in the last five decades. However, from our knowledge, there is no evidence about whether imports of energy products cause exports and economic growth (or conversely).

[3] Kónya (2006), by using data from 1960 to 1997, is rather interested in a cross-sectional comparison of the relationship between exports and GDP for several OECD countries. Laurin (2012) attempts a short modern period (1988-2004) with the aim to know the role of both aggregate exports and aggregate imports on regional GDP.

(VAR) by attempting two alternative approaches with the aim to know the robustness of our results to different methodologies. We will start our empirical analysis by applying the procedure of Johansen (1988), and Johansen and Juselius (1990). Latter, the methodology developed by Toda and Yamamoto (1995) will be also considered. Finally, the concluding remarks are presented in Section 3.

2. Empirical results

2.1. Data and stationarity properties of time series

We will use annual data on GDP, exports, energy imports and non-energy imports for Spain corresponding to the period of 1900-2008. The GDP variable up to 2000 is drawn from Prados de la Escosura (2003), while more recent data is collected from the *Bank of Spain's Statistical Bulletin* (December, 2011). The total volume of both exports and imports are obtained from Prados de la Escosura (1986, 1988) up 1913, Tena (1992) from 1914 to 1939, Martínez (2001) from 1940 until 1958, and the Spanish *Ministry of Economics and Competitiveness* for the most recent data. Disaggregation of imports for energy and non-energy products have been made according to information provided by the compendium of statistic sources for energy imports held in Carreras and Tafunell (2005) for the period 1900-2000, whereas the more recent data is available in the *Bank of Spain's Statistics Bulletin* (December, 2011).[4]

All variables are expressed at constant prices of 2005 (in million Euros) according to their corresponding deflators. On the one hand, the GDP variable has been deflated by using the evolution of the GDP deflator obtained from Prados de la Escosura (2003) and the Spanish *Statistics Institute*. On the other hand, imports and exports have been expressed in real terms by using the Fisher price index for trade flows from Prados de la Escosura (1988) and Paasche price index offered in the Spanish *Statistics Institute*. Figure 1 shows time series in which we are interested. For a detailed overview of considered period of time and a discussion of policy changes linked with the SLP, see Prados de la Escosura (2003, 2010) and Fernández-Navarrete (2005).

[Please insert Figure 1]

[4] Energy imports include imports of coal and coke, gasoline, petroleum for energetic use, natural gas, electricity and crude oil.

To avoid spurious causality we will ensure that, for both anterior and posterior sub-periods to 1959, all times series involved in multivariate analysis are stationary. So, we attempt to test unit roots of energy imports, non-energy imports, exports and GDP expressed in logs (henceforth as *em*, *nem*, *x* and *gdp*, respectively). In order to contemplate the possibility of a univariate break at an unknown point in intercept, the slope, or in both, we apply the Zivot and Andrews (1992) unit root procedure which tests the null hypothesis of a unit root against an alternative stationarity process. The results are presented in Table 1. Regardless the examined sub-period results indicate that the four time series are integrated of order one I(1) in their levels, but are stationary after taking first differences.

[Please insert Table 1]

A linear combination of nonstationary series with the same order of integration may be stationary (Engle and Granger, 1987). In this case the series are considered to be cointegrated, which can be interpreted as the existence of a long-run equilibrium relationship between variables. To determinate the number of cointegrating vectors we use the multivariate maximum likelihood procedure proposed by Johansen (1988, 1991) and Johansen and Juselius (1990). The authors recommend attempting two alternative likelihood statistics. On the one hand, the maximum eigenvalue statistic (λMAX) that tests the null hypothesis that there are at most *r* cointegrating vectors against the alternative of *r+1*. On the other hand, the trace-statistic that evaluates the null hypothesis of r cointegrating vectors against *r* or more. Results for each one of the sub-periods in which we are interested are presented in Table 2. As we can see, the results from the maximal eigenvalue and trace tests consistently suggest that time series are not cointegrated for the first sub-period, while there is a common long-run relationship for the second sub-period.

[Please insert Table 2]

2.2. Causality based on Johansen's cointegration

We apply the Johansen's cointegration procedure to explore the causal relationship between trade variables and economic growth. Let us to consider the following vector error correction model (VECM):

$$\Delta y_t = \alpha + \beta\, t + \sum_{i=1}^{m} \theta_i\ \Delta y_{t-i} + \gamma\ ECT_{t-1} + \varepsilon_t \qquad (1)$$

where Δ refers to first-difference operator, $y_t = (em_t, nem_t, x_t, gdp_t)'$ is the vector of endogenous variables, $\alpha_t = (\alpha_{em}, \alpha_{nem}, \alpha_x, \alpha_{gdp})'$ is the intercept vector, and $\beta_t = (\beta_{em}, \beta_{nem}, \beta_x, \beta_{gdp})'$ refers to the trend vector, y_{t-i} is the vector of endogenous variables in lag terms, and m denotes the optimal number of lagged variables. Additionally, the coefficient γ associated with the error-correction term ECT_{t-1} (which is only incorporated in equation if variables are cointegrated) is derived from long-run cointegrating relationship. Finally, ε_t represents the vector of error terms, which are assumed to be *iid*.

Empirical strategy for causality analysis depends whether cointegration is or is not guaranteed. If variables are not cointegrated, there is no error correction term (ECT_{t-1}), and we can only check for short-run causality by testing the significance of the coefficients of explanatory variables (θ_i). Otherwise, long-run causality can be tested by looking at the joint significance of the coefficients associated with explanatory variables (θ_i) and the error-correction term (γ).

Results of Granger causality tests are reported in Table 3, where the optimal lag length (m) has been selected by using the Bayesian Information Criterion (BIC).[5] For the first sub-period (1900-1958), we only detect unidirectional causality in the short-run running from non-energy imports to energy imports ($nem \rightarrow em$). For the second sub-period (1959-2008), where there is cointegration, long-run causality is tested. The results corresponding to this last sub-period indicate the presence of numerous patterns of causality between variables under study. Figure 2 illustrates a summary of detected causalities according to the rejection of null hypotheses (at 5% significance level). That is, first, we found unidirectional causation running from energy imports to exports ($em \rightarrow x$). Second, results support two-way causality between non-energy imports and exports ($nem \leftrightarrow x$). Third, we detect bidirectional causation between exports and economic growth ($x \leftrightarrow gdp$). Finally, results indicate that economic growth causes energy imports ($gdp \rightarrow em$), but energy imports do not have an explanatory power on economic growth.

[Please insert Table 3]

[5] An impulse dummy for the years of Civil War (1936-1939) has been added to regressions.

[Please insert Figure 2]

2.3. Causality based on Toda and Yamamoto

We now proceed in checking the robustness of the above causality results for our set of variables applying the causality test proposed by Toda and Yamamoto (1995). This procedure involves the estimation of an augmented VAR in levels) and guarantees the asymptotic distribution of a modified Wald statistic (even if the processes may be integrated or cointegrated of an arbitrary order). We consider the following multivariate VAR specification:

$$y_t = \lambda + \phi\, t + \sum_{i=1}^{k+d_{\max}} \pi_i \; y_{t-i} + u_t \qquad (2)$$

where $y_t = (em_t, nem_t, x_t, gdp_t)'$ is the vector of endogenous variables in which we are interested, $\lambda_t = (\lambda_{em}, \lambda_{nem}, \lambda_x, \lambda_{gdp})'$ is the intercept vector, $\phi_t = (\phi_{em}, \phi_{nem}, \phi_x, \phi_{gdp})'$ refers to the trend vector, π_i is the (nxn) matrix of autoregressive coefficients of vector y_{t-i}, which in turn, is the vector of lagged endogenous variables. The maximum number of lags considered, ($k+d_{max}$), are based on artificial augmentation of the correct lag order (m) by the maximum order of integration (d_{max}) corresponding the variables. Should be noted that the Granger non-causality test will be applied on the first k coefficient matrices, ignoring the last d_{max} lagged vectors. Lastly, u_t represents the vector of error terms, which are assumed to be *iid*.

The empirical results are provided in Table 4, where the optimal lag length (p) is selected according to the BIC while the maximum order of integration (d_{max}) is obtained from the above employed unit root tests.[6] In general, the new outcomes are consistent with those obtained from the VECM framework. That is, for the first analysed sub-period (1900-1958), we only obtain unidirectional causality which runs from imports of non-energy to energy ($nem \rightarrow em$). For the second sub-period (1959-2008), results are once more in favour of presence of a network of causal relationships. Figure 3 summarizes the interesting results supported by rejection of null hypotheses (at 5% significance level). The only specific difference regarding the main results from VECM of above section is that causation from non-energy imports to exports is now not well

[6] As in the above causality analysis based on VECM, an impulse dummy for Civil War (1936-1939) has been added to regressions.

supported by the analysis. Then, we should be careful to conclude with respect to this specific causality. Indeed seems more prudent to opt for not reject the corresponding null hypothesis, especially considering that the methodology developed in Toda and Yamamoto avoids possible problems derived from the low power to test for cointegration among variables in standard sample sizes (e.g., Zapata and Rambaldi, 1997).

[Please insert Table 4]

3. Conclusions

The objective of this work has been to provide robust results to better understanding of how the whole external trade has been contributing to the Spanish economic development. We have investigated causality between foreign trade and real GDP by adopting an historical perspective (1900-2008). Given the decided liberalization and trade policy reforms carried out from the Spanish *Stabilisation and Liberalisation Plan* (SLP) at 1959, we separately analysed two sub-periods. In general, the first sub-period can be characterized by a situation of relative economic isolation, industrial backwardness, and limited external trade that was even exacerbated during the years after the Civil War by the principles of nationalism and autarky policy. The policy reforms rose at 1959 led the way toward a new sub-period characterized by more liberalization and outward orientated industrialization.

To take into account the entire trade effects and to prevent potential estimation bias from omission of relevant variable we have studied, in addition to real exports, the evolution of real imports. Moreover, since the country has a shortage of energy resources and these must be obtained largely from abroad, we have considered interesting to disentangle the specific role of energy imports. These considerations added a new dimension to the evidence reported by those empirical papers on issue that already adopted a long historical viewpoint for Spain. Moreover, with the aim to check robustness of our main results, we have tested causality inspired in the methodology of Johansen (1988), and Johansen and Juselius (1990) as well the developed by Toda and Yamamoto (1995).

Our findings are, in general, robust to both alternative methodologies applied. They suggest that evolution of foreign trade and economic growth seemed to move

independently in long run through the inward oriented growth sub-period (1900-1958). These results sharply contrast with those obtained from sub-period after the implementation of liberalization and measures to promote foreign trade (1959-2008). In certain sense our results for long run come to confirm the basic conclusions previously obtained by Balaguer and Cantavella-Jordá (2001, 2004), which showed that exports became essential to explain evolution of real GDP only after the implementation SLP. However, according this paper, the long run relationship between trade and economic growth is somewhat more complex and the exports are not enough to explain economic development in the last sub-period.

Evidence from the sub-period after the implementation of SLP suggests presence of a causal network among variables used in the analysis. Results support a feedback between economic growth and exports and, in turn, the importance of exports to fuel non-energy imports. Moreover, we obtained the existence of a closed causal loop between energy imports, exports and economic growth. That is, economic growth has been supported through of increase in exports but indirectly by imports of energy products. Thus, any policy measures oriented at limiting external trade by through exports or energy imports could break the causal circle and, therefore, it would trigger undesirable effects on economic growth in the long run.

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Table 1. Zivot and Andrews unit root test

	First sub-period (1900-1958)						Second sub-period (1959-2008)					
	Levels			First differences			Levels			First differences		
	Statistic		Year Break	Statistic		Year Break	Statistic		Year Break	Statistic		Year Break
em	-4.836	(0)	1936	-7.412***	(0)	1936	-4.119	(0)	1967	-7.764***	(0)	1969
nem	-4.338	(0)	1936	-7.412***	(0)	1936	-4.515	(2)	1987	-7.716***	(1)	1986
x	-4.525	(0)	1936	-8.813***	(0)	1943	-5.570	(0)	1970	-8.999***	(0)	1964
gdp	-2.238	(0)	1950	-6.848***	(0)	1937	-4.793	(1)	1972	-5.745***	(0)	1964

The optimal lag length (in parenthesis) is selected by using the Schwarz information criteria. We use ***, and ** to indicate significance at 1% and 5% respectively, according to critical values taken from Zivot and Andrews (1992).

Table 2. Maximum likelihood cointegration tests

Null hypothesis	Alternative hypothesis	λMAX	Trace
First sub-period (1900-1958)			
$r = 0$	$r \geq 1$	23.157	43.940
$r = 1$	$r \geq 2$	11.661	20.783
$r = 2$	$r \geq 3$	8.609	9.122
Second sub-period (1959-2008)			
$r = 0$	$r \geq 1$	108.127***	135.325***
$r = 1$	$r \geq 2$	14.309	27.198
$r = 2$	$r \geq 3$	6.819	12.889

Number of cointegrating vectors is noted by (r). λMAX and Trace are the likelihood statistics for the number of cointegrating vectors. We denote *** and ** to indicate the coefficients significance at the 1% and 5% levels, respectively, according to critical values taken from Johansen and Juselius (1990).

Table 3. Granger causality tests based on the Johansen's cointegration framework

Null hypothesis	First sub-period (1900-1958) VAR in first differences		Second sub-period (1959-2008) Error Correction Model	
	F-statistic	P-value	F-statistic	P-value
em does not cause nem	0.407	[0.523]	1.00	[0.608]
em does not cause x	0.011	[0.917]	67.64***	[0.000]
em does not cause gdp	0.173	[0.678]	2.51	[0.285]
nem does not cause em	8.684***	[0.003]	1.12	[0.571]
nem does not cause x	0.069	[0.792]	72.20***	[0.000]
nem does not cause gdp	0.040	[0.841]	2.15	[0.341]
x does not cause em	1.721	[0.190]	1.80	[0.407]
x does not cause nem	0.168	[0.681]	6.85**	[0.033]
x does not cause gdp	0.201	[0.654]	14.56***	[0.001]
gdp does not cause em	0.590	[0.442]	7.25**	[0.027]
gdp does not cause nem	0.323	[0.570]	1.93	[0.382]
gdp does not cause x	0.020	[0.888]	84.89***	[0.000]

The optimal lag length (which is 1 for both sub-periods) is selected by using the Schwarz information criteria. An impulse dummy for Civil War (1936-1939) has been added to regressions. We denote *** and ** to indicate the coefficients significance at the 1% and 5% levels, respectively.

Table 4. Granger causality tests based on the Toda-Yamamoto framework

Null hypothesis	First sub-period (1900-1958) VAR in first differences		Second sub-period (1959-2008) Error Correction Model	
	F-statistic	P-value	F-statistic	P-value
em does not cause nem	0.61	[0.435]	0.52	[0.472]
em does not cause x	0.24	[0.623]	3.90**	[0.048]
em does not cause gdp	0.06	[0.808]	0.72	[0.396]
nem does not cause em	6.18**	[0.013]	0.09	[0.761]
nem does not cause x	0.07	[0.794]	0.00	[0.980]
nem does not cause gdp	0.79	[0.375]	0.77	[0.379]
x does not cause em	0.78	[0.377]	2.60	[0.107]
x does not cause nem	2.10	[0.147]	6.11**	[0.013]
x does not cause gdp	0.56	[0.454]	5.63**	[0.018]
gdp does not cause em	0.52	[0.470]	5.95**	[0.015]
gdp does not cause nem	0.02	[0.879]	2.16	[0.142]
gdp does not cause x	0.07	[0.790]	5.99**	[0.014]

The optimal lag length (which is 1+1 for both sub-periods) is selected by using the Schwarz information criteria. An impulse dummy for Civil War (1936-1939) has been added to regressions. We denote *** and ** to indicate the coefficients significance at the 1% and 5% levels, respectively.

Figure 1.Time series expressed in millions of euros at 2005 prices

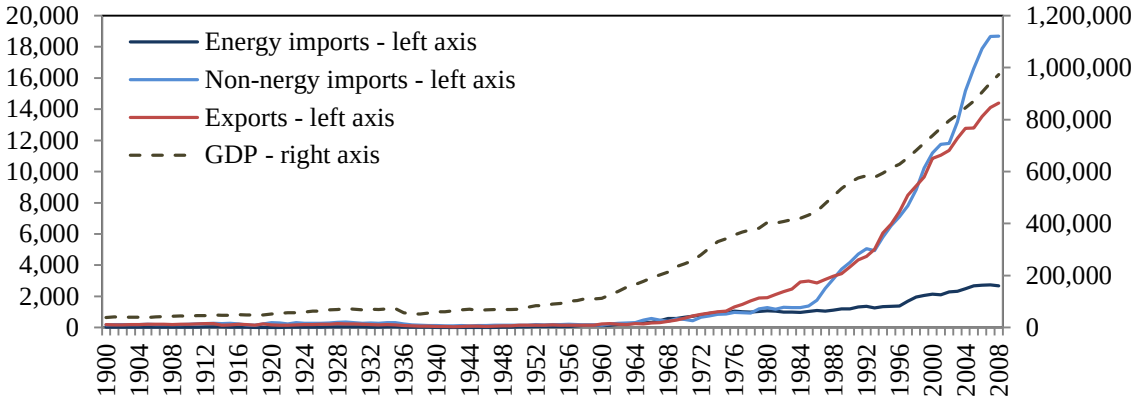

Figure 2. Causality results: second sub-period (1959-2008)