DOCUMENTOS DE TRABAJO

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N° 810 Noviembre 2017

BANCO CENTRAL DE CHILE

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How do manufacturing exports react to RER and foreign demand? The Chilean case[*]

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Abstract

How do manufacturing exports react to the real exchange rate and to foreign demand? We investigate this question using Chilean panel data spanning from 2003.Q1 to 2016.Q4. We find that the recent fall in manufacturing exports growth is consistent with a persistent slowdown in foreign demand, which has been partially offset by an average depreciation of the bilateral real exchange rate (with respect to destination countries of these exports). Specifically, the short-run elasticities of manufacturing exports differ in size: (i) the elasticity of foreign demand —approximated by trading partners' activity aggregates— ranges between 1.4 and 2; and (ii) the elasticity with respect to the bilateral real exchange rate is comprehended in the interval [0.4 - 0.6]. Core estimated elasticities pass usual robustness checks.

Resumen

¿Cómo reaccionan las exportaciones manufactureras al tipo de cambio real y a la demanda externa? Investigamos esta pregunta utilizando un panel para Chile que comprende el periodo 2003.T1 a 2016.T4. Encontramos que la reciente caída en el crecimiento de las exportaciones manufactureras es consistente con una desaceleración persistente en la demanda externa, que ha sido parcialmente compensada por una depreciación promedio del tipo de cambio real bilateral (con respecto a los países de destino de estas exportaciones). Específicamente, las elasticidades a corto plazo de las exportaciones manufactureras difieren en tamaño: (i) la elasticidad de la demanda extranjera —medida por varios agregados de actividad de socios comerciales— se encuentra en un rango entre 1.4 y 2; y (ii) la elasticidad con respecto al tipo de cambio real bilateral está comprendida en el intervalo [0.4 - 0.6]. Las elasticidades estimadas principales pasan controles usuales de robustez.

I. Introduction

From 2013Q1 to 2017Q1 the Chilean peso has depreciated against the US dollar at a two-digit rate, around 33%, while the real depreciation has been lower: (i) bilaterally with respect to the U.S. it approximated 9%; and (ii) in multilateral terms it has been even smaller, close to 5%. A priori, a depreciation of the Chilean peso would result in greater competitiveness of Chilean exports and, therefore, a higher growth of its volumes. However, between 2013 and 2016, the volume of total exports accumulated a slightly negative variation, combining a drop of -1.5% in mining shipments and -2% in manufacturing exports, and an increase close to 15% in agricultural exports. Similarly, goods' exports have shown a limited dynamism in the years 2014-16 in comparison with a pre-Crisis 2008 period growth average. These recent developments are framed within a context where world trade growth has also shown poor dynamism.

Graph 1 illustrates that manufacturing exports volume towards the end of 2016 reached the same level as in 2013, in a context where the multilateral real exchange rate (RER) was 5% higher.

Graph 1: RER and Manufacturing exports. Bilateral RER
(Index 2013.Q1=100)

Volume Manufacturing exports

Multilateral Real Exchange Rate (RER)
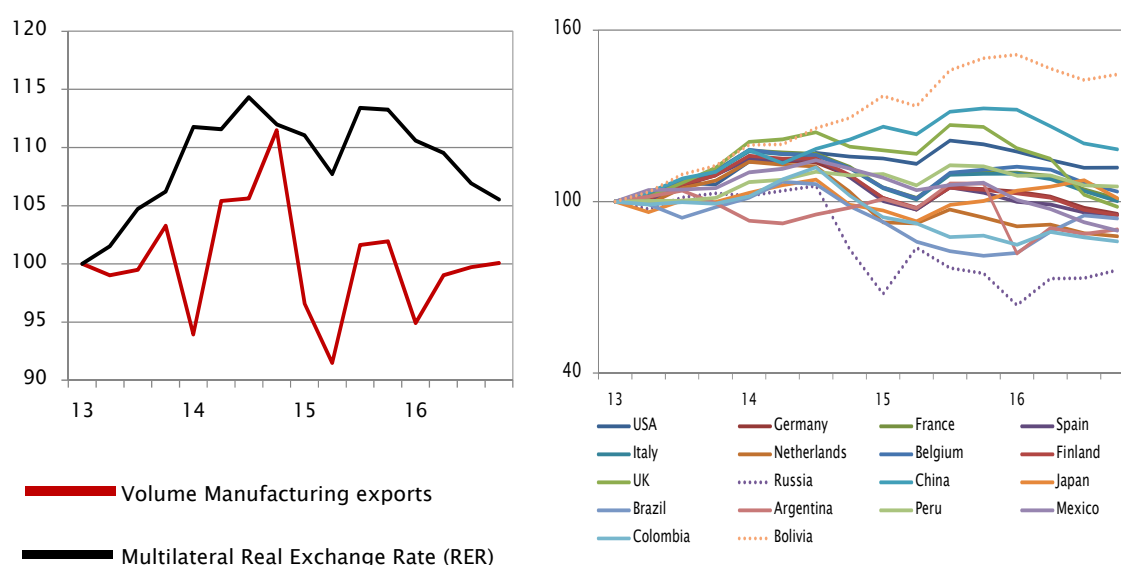
Source: Central Bank of Chile.

However, a standardized analysis of bilateral RER (BRER) reveals an interesting heterogeneity (Graph 1, right panel).[1] For example, the BRER with respect to Russia

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[1] We normalize to 100 the index in 2013.Q1 in view of the fact after May 2013 emerging countries' currencies depreciated due to the tapering talk. The calculation follows a standard methodology: the bilateral nominal exchange rate multiplies the producer price index (PPI) of each partner country and is divided by the local consumer price index.

declined between 2013.Q1 and 2016.Q4, from 100 to 76. Not surprisingly, such a BRER adjustment with respect to Russia reflects the fall in its terms of trade of 2014 and the consequent depreciation of the Ruble.[2] At the other extreme, we find that the BRER with respect to Bolivia is the one that has depreciated the most, around 34%, and this is due to the fact that Bolivia has maintained fixed nominal parity with respect to the dollar. Besides, the Chilean peso has depreciated in bilateral terms with respect to China. In summary, the evolution of the BRERs exhibit heterogeneity suggesting that it is unreasonable for Chile to systematically depreciate with respect to all trading partner countries.

Graph 2: GDP of Trade Partners (TP) and foreign demand measures

(Annual growth rate, percentage)
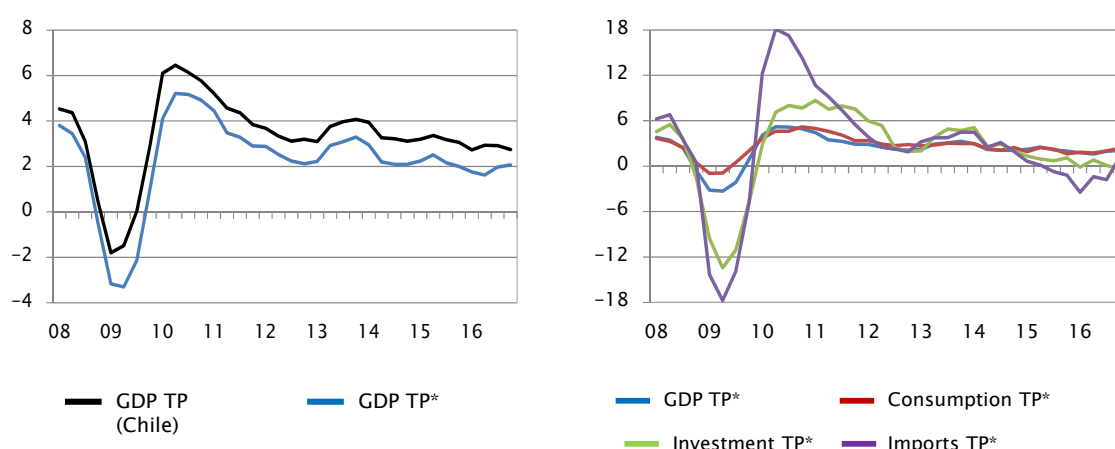
Note: Trading partners' GDP data is public (Chile's main trading partners GDP weighted by their share of total exports in two mobile years. The countries considered are the destination of 94% of exports). GDP TPs* data is our construction, which weights *manufacturing* sector exports (Table 2 lists the countries considered). Applying the same logic, we did the same calculation using consumption, investment and imports of Chile's trading partners.
Source: Bloomberg.

The Graph 2 illustrates the foreign demand growth relevant for Chilean manufacturing exports. As can be seen in the left panel, the GDP growth of trade partners (TP) relevant to manufacturing sector exports (blue line) is lower than growth of total exports (black line). This is because, on the one hand, high-growth economies, e.g., China, have a greater weight in total exports than in manufacturing ones.[3] In addition, Latin America has a higher weight for Chile's manufacturing exports than for total exports, which also explains why the GDP of the manufacturing sector TPs has grown less than GDP TP (Chile). Besides, the right panel of Graph 2 illustrates that the dynamism of demand for Chilean exports may vary depending on the macroeconomic aggregates of the TPs countries considered.

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[2] In fact, to purchase a Ruble, $ 15.5 was needed in 2013Q1, while in 2016.T4 $ 10.6 was needed, equivalent to a loss of 38% of the Ruble in terms of the CLP. The deterioration of the nominal value of the Russian currency internationally coincided with the abrupt drop in the oil price by the end of 2014.

[3] China is destination of a large share of Chilean copper exports.

Considering all these elements, the objective of this paper is to estimate how manufacturing exports react to BRER and foreign demand. The results are summarized in three conclusions. First, the short-run elasticities of manufacturing exports differ in size: (i) the elasticity of foreign demand —measured by aggregates most directly associated with TPs— is between [1.4; 2]; and (ii) the elasticity with respect to the BRER is comprehended in the range [0.4; 0.6].[4] These results are in line with previous work summarized in Table 1.

Second, the weak dynamism of manufacturing exports growth in the last years was explained by a persistent slowdown in foreign demand, which has been partially offset by an average depreciation of the BRER with respect to the group of destination countries. Our evidence on growth contributions is in line with results presented by IMF (2017). Finally, since 2012 the share of manufacturing exports which is not explained by fundamentals is, on average, negative. Inquiring about the fundamental origin of this residual is difficult without a structural model. However, its sign is consistent with the poor observed dynamism of world trade in relation with world activity (IMF, 2016).

Third, when analyzing two sub-aggregates of manufacturing sector exports —consumer goods and investment / intermediate goods— we find BRER elasticities of comparable size to those reported for the aggregate. However, for the case of foreign demand, there is greater heterogeneity in the value of the elasticity.

The notion that world trade growth keeps a stable relationship with world GDP growth is not new (Kuznets, 1964, p. 8). However, since 2012 world trade growth has slowed down more than predicted by the historical relationship with world GDP growth. Such decoupling has attracted the attention of analysts, researchers, international organizations and central banks. For example, chapter 2 of WEO, IMF (2016), argues that lower growth in trade volumes is explained by a significant adjustment in the demand for capital goods (investment). Besides, IMF (2015) presents an analysis focused on the effect of a depreciation of the RER on the trade balance (Krugman, 1986).

Alexander *et al.* (2017) presents dynamic models to forecast Canadian non-traditional exports. In sample forecasting evaluations, the model significantly improves the accuracy when controlling on manufacturing supply conditions. The authors conclude that the loss of dynamism in Canadian manufacturing exports is primarily due to productive structural weaknesses of manufacturing sectors, and secondarily by lower foreign demand. Additional examples of research papers that conduct similar estimation exercises are Ahmed *et al.* (2015), that uses a panel, and Raissi and Tulin (2015), which analyze the case of India's exports.

Our analysis relates to other studies for Chile. Our estimation methodology is similar to Carrasco *et al.* (2015) and Cabezas *et al.* (2004). Instead of using an annual sample as in Carrasco *et al.*, we handle data in quarterly frequency. Our results confirm their findings. We specify a similar export demand equation as in Cabezas *et al.* (2004), but we focus on both long and short-run elasticities, emphasizing the latter. Aravena (2005) focus on

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[4] Specifically, GDP and consumption of Chile's trading partners.

aggregated exports and imports and use a VEC methodology. Finally, other studies that provide export demand elasticities are Agosin (1999) and De Gregorio (1984), though they use a slightly different measure of RER than this study (for details see note to the Table 1).

Table 1: Summary of elasticities reported in the literature (Chile)

Authors	Variable	Export elasticities				Methodology			
		Demand	RER	Demand	RER		Fixed effects	Time effects	Cluster
		Short run		Long run					
Carrasco et al. (2015)	Manufacturing exports	3.0-3.3	0.4-0.5	2	0.4	LS Panel	Yes	Yes	No
Aravena (2005)	Exports			0.4	0.1	VEC Model			
Cabezas et al. (2004)	Exports			1.2-4.2	0.2-0.8	OLS			
Agosin (1999) (a)	Manufacturing exports		0.4		0.9	OLS			
Moguillanski & Titelman (1993)	Non copper exports		0.32		1.26	OLS			
De Gregorio (1984) (b)	Non copper exports	0.3	0.32-0.44	1.64-2.14	1.75-2.9	OLS_IV			
	Exports	0.2	0.2-0.3	0.9-1.1	1-1.6	OLS_IV			

Notes: (a) Agosin (1999) defines the relative price as: (Nominal Exchange rate)*(Manufacturing export unit value index/manufacturing wages) and (b) De Gregorio weights manufacturing activity of trading partners.

The structure of the paper is as follows. Section II describes the data used. The third section presents the econometric methodology and discuss its economic foundation. The fourth section reports the results and the fifth section analyzes its robustness. Finally, the sixth section concludes.

II. Data

Manufacturing exports have represented a significant percentage of total Chilean goods exports in recent years. Between 2003 and 2016, its average participation was close to 40% in nominal terms and 35% in real terms.

Graph 3 summarizes the seven different manufacturing subsector exports considered. The largest is the food manufacturing sector with an average participation of almost 30%. It includes products such as salmon, fish and fruit derivatives —sectors prone to supply shocks. The second most representative is the chemical manufacturing sector with a share of 22%, highlighting within it fertilizers and the oxide of molybdenum. The rest of manufacturing sectors have had a less significant participation, between 5 and 10%.

If we analyze the recent evolution of these subsectors' exports volume, we observe that only two of the seven subsectors closed in 2016 with levels higher than the beginning of 2013: Beverages and Tobacco and Forestry and Wood. The remaining five; however, closed at most at similar levels.

These heterogeneous dynamics can be explained by multiple causes. One of them is the diversification structure of target markets in each subsector. For example, most of the food exports have shipped to USA and Japan in the last 13 years, whereas chemical exports have

sold in great share to South America and Europe. If shocks alter the demand in these locations, exports will adjust accordingly.

Graph 3: Structure of the manufacturing export sector

Structure of manufacturing exports	Volume manufacturing exports by sector (CdR13)
(Average 2003-2016*)	(Index 2013.Q1=100+)
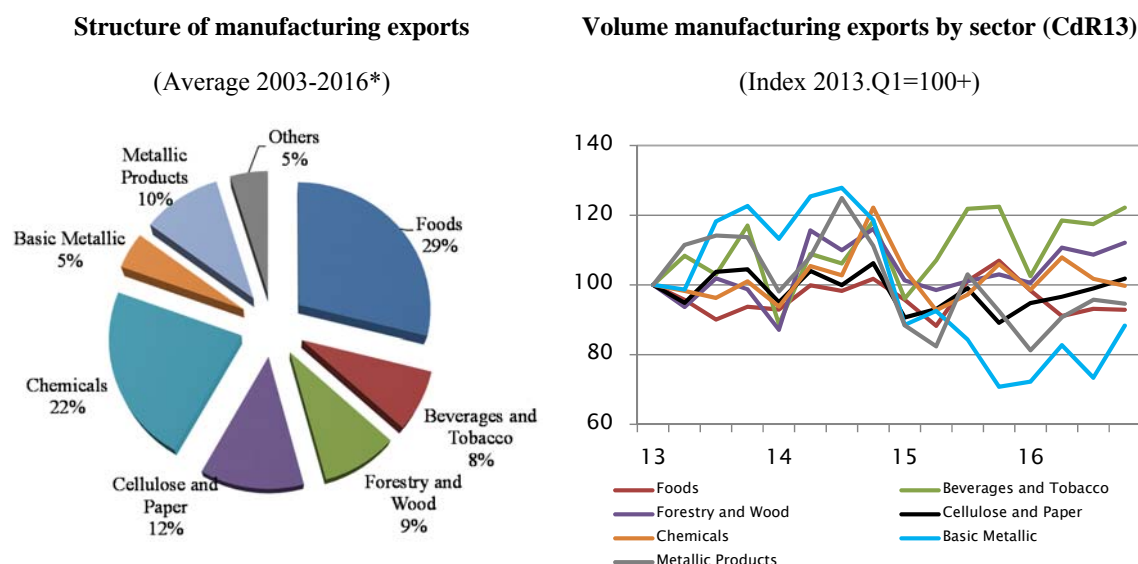
Note: */ Calculations from values in current dollars. Source: Central Bank of Chile

In order to take advantage of this heterogeneity of the manufacturing sub-sectors and their main markets of destination, a data panel is constructed from 2003 to 2016, with quarterly frequency. Table 2 reports destination countries considered in the sample, which responds to the public availability of information from the Central Bank of Chile.[5]

Table 2: Chile's trading partners relevant for manufacturing export sector

USA	15.2	Belgium	1.7	China	6.9	Argentina	3.2	Rest of	27.0
UK	1.9	Finland	0.2	Japan	10.0	Bolivia	5.3	the world	
		France	1.2	Russia	1.2	Brazil	6.0		
		Germany	1.6			Colombia	2.4		
		Italy	1.7			Mexico	4.5		
		Netherlands	4.1			Peru	5.9		

Note: Numbers, in percentages, denote the share of manufacturing exports with destination in each trading partner (sample 2003-2016). Source: Central Bank of Chile.

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[5] We do not consider the Rest of the World (27%) due to the lack of available disaggregated data.

Exports of subsectors to each TP are expressed in nominal values and then deflated by the unit export value indices (UXVI) corresponding to each sector. In this way, the exports' volume (real terms), X, are calculated as:

$$X_{i,j} = \frac{X_{i,j}^{Nominal}}{UXVI_i}$$

Where index i denotes the ith exporting manufacturing sector and j index the jth target market. The approximation of export volume time series were seasonally adjusted by standard methods (ARIMA-X12).

Regarding foreign demand, it is approximated by trading partners' foreign aggregates: GDP, consumption, investment and imports (all seasonally adjusted). We also collect the TPs' producer price indices (PPI). The source of these series is Bloomberg.

The BRER is defined for the destination j:

$$BRER_j = \frac{e_j P_j^*}{P}$$

where, P_j^* is PPI expressed in TP's currency j, e_j is the nominal exchange rate expressed in Chilean pesos per monetary unit of the destination country j and P is the consumer price index (CPI) of Chile.[6]

III. Empirical methodology.

The econometric specification for the export demand used is standard in the literature (Ahmed *et al.*, 2015, Sertić *et al.* 2015, Raissi and Tulin, 2015, among others). In particular, the relationship is typically log-linear, where the volume exported depends on foreign demand and on the real exchange rate (RER). Changes in foreign demand determine both exports volume variation (the size of the market in the long term) and fluctuations in prices. The RER has a positive effect on the volume exported by two mechanisms: a real depreciation increases the country's competitiveness with respect to the foreign competing products, and in addition, allows Chilean producers to reduce the prices they charge in the market of destiny.

The imbalance or residual of the long-term relationship obtained is interpreted as a gap that must be closed, thereby an additional regressor of the short-term specification. We estimate the latter specification as in Ahmed *et al.* (2015):

$$\Delta X_{i,j,t} = constant + \beta \Delta BRER_{j,t-1} + \theta \Delta Y_{j,t}^* + \varphi \Delta Y_{i,t-1} + \Phi D_t + \alpha EC_{i,j,t-1} + \lambda \Delta X_{i,j,t-1} + \varepsilon_{i,j,t}$$

$$\varepsilon_{i,j,t} = \delta_{i,j} + u_{i,j,t} \tag{1}$$

where the operator "Δ" denotes the first difference meaning the inter-quarterly growth of the variable since the variables are expressed in logarithms. Thus, $\Delta X_{i,j,t}$ denotes the inter-

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[6] Nominal exchange rate of Chile with respect to TPs' currencies are taken from Central Bank of Chile.

quarterly growth of the export volume of sector i to destination j. To simplify, we omit the operator in the description of the remaining independent variables. So, $BRER_{j,t-1}$ is the bilateral real exchange rate with the TP j (lagged), $Y_{j,t}^*$ denotes the measure of foreign demand, $EC_{i,j,t-1}$ is the error correction term, a residual coming from the relationship in levels which the volume exported is in function of foreign demand and BRER. Finally, $X_{i,j,t-1}$ denotes the dependent variable lagged.

We tried various additional controls. Following Alexander *et al.* (2017), Raissi and Tulin (2015) and Ahmed *et al.* (2015), we considered the variable $Y_{i,t-1}$ which denotes the value-added of the manufacturing sector i (lagged). The motivation of adding this variable is to control for idiosyncratic shocks in the manufacturing sector and/or to reflect a relevant capacity constraint (see, e.g., Ahmed *et al.*, 2015). In an application to India, Raissi and Tulin (2015) include the energy generation deficit in order to control for this particular capacity constraint.[7] Besides, D is a dummy variable that identifies the Subprime Crisis (it equals to 1 for 2008.Q4, 2009.Q1 and 2009.Q2, and 0 otherwise).

Additionally, the error $\varepsilon_{i,j,t}$ includes: (i) $\delta_{i,j}$ unobservable fixed effects of manufacturing sectors and each export destination; and (ii) a Gaussian iid error term, orthogonal to the fixed effect.[8]

Our interest focuses on estimating β and θ. The former represents the effect of BRER depreciation on the manufacturing exports growth. The latter captures the reaction of exports to foreign demand. The theory predicts that $\beta \geq 0$ and $\theta \geq 0$.

Some observations on the right hand side variables of equation (1). First, to include the BRER as regressor potentially has two econometric challenges. There is to some extent collinearity between the BRER and foreign demand when correlating contemporaneously.[9] For example, if the TP temporarily faces a fall in demand, this would slow down its purchases from abroad, causing Chile to appreciate its BRER with respect to this TP. One simple way to mitigate this is to predetermine the BRER. Other source of collinearity is between the BRER and exports supply. For example, if a negative supply shock occurs in the manufacturing sector, this could affect local marginal costs and with some lag prices, thereby affecting BRER fluctuations. Second, we assume that the value added is lagged, because of at least two reasons: it makes economic sense to think that it is first necessary to produce the product and then export it and by predetermining the supply, it mitigates the problem of latent reverse causality between exports and production. Third, the dependent variable lagged as an additional regressor, produces two sources of persistence in the

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[7] The idea is simple, exporters cannot meet their production plans due to the fact that they cannot turn on their machines. The authors refer to it as a bottleneck for producers.

[8] The fixed effect identifies the influence of the specific invariant characteristic that affects the exporting sector to each destination economy (e.g. market size, sector preference to export to a particular TP, etc.).

[9] Mathematically, collinearity turns estimated coefficients unstable. We examine the evidence on this issue conducting recursive estimation of equation (1). See below.

equation, which ultimately introduces a source of endogeneity widely studied by the dynamic panel literature (Baltagi, 2008, c. 8).[10]

The estimation strategy is designed to mitigate these problems. First, we calculate the Within Group (WG) estimator panel because it solves the identification problem (that is, it suppresses the inconsistency caused by the dependence of the fixed effect with the lag of the dependent variable). However, the mitigation is partial and this is explained because the WG transformation does not cancel out the still existing correlation between the autoregressive variable and the error term. This inconsistency only disappears when the time dimension T is large (Hamilton, c. 8). The second strategy consists in estimating the panel by choosing instruments to cope with those endogenous regressors using "System GMM" (Arellano and Bover, 1995 and Blundell and Bond, 1998). While directly dealing with the problem of endogeneity, it does not necessarily solve it. In addition, the cross-section dimension is required to be large.[11]

The following section reports the results with both strategies because in our application $T =$ 56 and $N = 126$ (7 sectors and 18 countries). *A priori*, with this information, it is not possible to categorically prefer one methodology over another. Later, we evaluate the magnitude of such bias.

IV. Results

This section reports the results. A first question is whether manufacturing exports co-integrate with foreign demand measures and BRER. We find that the long-run equilibrium relationship has empirical support, according to standard tests.[12] Therefore, the short-term analysis that equation (1) implies is valid.[13]

In addition, while not shown in detail, we comment on estimated elasticities obtained from long run manufacturing export demand equations, as sketched at the beginning of section III. In general, the size of estimates are in line with the literature, as summarized in Table 1. First, one-percent increase in foreign demand could increase the manufacturing export volume growth by about 1 percent to 1.7 percent, depending on the demand measure. The results are robust to various changes, including lagging the demand measures, etc. Regarding the elasticity of manufacturing exports to the BRER, it ranges from zero to 0.5. Though estimates show the right signs, they are slightly above conventional statistical levels. If we consider the post Subprime Crisis sample, after the copper price boom, the

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[10] On the one hand, they combine the autoregressive effect and, on the other hand, the individual effect characterized by the unobservable heterogeneity of the individuals. Including the lagged dependent variable as regressor introduces endogeneity with respect to this variable since it depends on the fixed effect. Then, pooled OLS estimators are biased and inconsistent.

[11] This method ideally uses a set of instruments that are not correlated with the error term. Therefore, unbiased and consistent estimators are obtained.

[12] For purposes of brevity, the Pedroni test (1999) is presented in Table A.1 of the annex. The evidence allows us to reject the null hypothesis of non-existence of co-integration between the variables in levels.

[13] Estimates are made in STATA, XTABOND2 package, see Roodman (2006).

elasticities become statistically significant. Similar estimates both in sign and size are also reported by Carrasco *et al.* (2012) and Cabezas *et al.* (2004). These studies show that the BRER elasticity estimates are not always statistically significant.

Table 3 shows the short run results. There are two models, the first assumes that foreign demand is approximated by TPs' GDP, while the second considers TPs' consumption. Notice that we provide results from applying two estimation methods, namely GMM and WG, to confirm or rule out the concern on biased estimates (see Table A.2 in the Annex for additional estimations).

Table 3: Determinants of manufacturing exports
[Different measures of foreign demand and estimation methods]
(Standard errors in parenthesis)

	M(1): GDP*		M(2): C*	
	GMM	WG	GMM	WG
Δ BRER (−1)	0.49**	0.53*	0.56***	0.59*
	(0.20)	(0.25)	(0.19)	(0.24)
Δ Ext. Demand	1.35**	1.4**	1.77***	1.99**
	(0.61)	(0.56)	(0.54)	(0.61)
Dummy	−0.047	−0.064	−0.047	−0.064
	(0.04)	(0.05)	(0.04)	(0.06)
Δ Supply (−1)	0.81***	0.98*	0.81***	0.97*
	(0.20)	(0.40)	(0.20)	(0.40)
EC (−1)	−0.66***	−0.36***	−0.66***	−0.36***
	(0.08)	(0.05)	(0.08)	(0.04)
Δ X(−1)	−0.23**	−0.27**	−0.23**	−0.27***
	(0.09)	(0.07)	(0.10)	(0.07)
AR(2)	0.209	−−	0.216	−−
Hansen Test	0.3	−−	0.32	−−
N. Instruments	109	−−	109	−−
N groups	126	126	126	126
N obs.	6547	6547	6547	6547
R2−adj.	−−	0.29	−−	0.29

Note: Panel data estimation. Regressors: BRER, foreign demand, dummy crisis, supply, error correction (EC) and persistence. M(1) and M(2) assume that the foreign demand is GDP and Consumption of Trading Partners, respectively. The GMM system is estimated in two stages and the table reports estimates of the second. The dependent variable is lagged twice and the first lag of all independent endogenous variables were used as instrumental variables. EC is the residual of the fitted relationship in levels, where manufacturing exports are function of BRER and foreign demand. * p <10%, ** p <5%, *** p <1%. AR (2) presents the p-value corresponding to the serial autocorrelation test in first differences (H0: absence of serial correlation in the residuals). The Hansen test presents the p-values (H0: the over-identification constraints are valid). The OLS Within Group (WG) column corresponds to estimates made assuming fixed effects by sector and destination of export. The p-values were robustly estimated (standard errors clustered across cross-section, White cross-section covariance method).
Source: authors' calculations.

A first result is that the estimated coefficients of the BRER and foreign demand are not very different between methods, but they do change slightly for the estimated coefficients of supply. In the next section of robustness we will show that, as one would expect, the estimates from GMM are more stable in smaller samples.

Continuing with the analysis of the estimates we emphasize that the coefficients have the expected sign, have similar sizes as reported in the literature and are statistically significant for both foreign demand and the BRER. We conclude that both play an important role in explaining the dynamics of the manufacturing exports growth.

Considering the results of Table A.2 of the annex, complementary to Table 3, the estimated elasticity to the BRER is in the range [0.4; 0.6]. This means that a bilateral real depreciation of 1% raises manufacturing exports in 0.5% q-o-q in the following period. Second, the elasticities —marginal effect in manufacturing exports out of foreign demand variations— ranges between 1.4 and 2.[14] For these calculations we considered models M(1) and M(2).[15]

From the above it does not necessarily follow that the performance of Chilean manufacturing exports reacts more to the TPs' economic cycle than to the boost of competitiveness provided by higher BRER. To solve this empirical question, we examine the contribution of drivers to the evolution of manufacturing exports in Graph 4. The analysis reveals that the lower growth of manufacturing exports has been more associated with a persistent deceleration of TPs in the last years (the blue bar of the Graph shows the impact of the elasticity of foreign demand measured in terms of TPs' GDP) by the q/q growth of the same variable. While in the sample, BRER has acted with a lower relative persistence, as a shock absorber, in the opposite direction, smoothing the fall of manufacturing exports (IMF, 2017, p. 55).

If we look specifically at the last three years (2014-2016), we conclude that the average contribution of exchange rate depreciation to manufacturing exports is approximately 1.2%.[16] Foreign demand, on the other hand, has had an average contribution of almost three percentage points. In addition, since 2012 the residual on average is negative. Inquiring about the fundamental source of this residual is difficult without a structural model; however, the sign of the residual is in line with the slower dynamism observed in world trade growth, in comparison with world activity growth, see IMF (2016).

Finally, we run equation (1) separating manufacturing exports between: (i) consumer goods and (ii) intermediate goods and / or investment. The elasticities with respect to the BRER estimated in these exercises are reported in Table 4. Confirming previous findings (Table 3), the reaction of consumer goods and investment / intermediate shipments are within the estimated ranges of BRER elasticities reported. However, for the case of foreign demand, there is greater heterogeneity. The latter could be explained by the market structures of each sector, its technology to export and its business models. To inquire about these causes is the subject of future work. In the next section we expand on this heterogeneity analyzing a few additional statistical exercises.

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[14] For GMM estimates standard statistics are provided. The Hansen statistic gives support to the validity of the instruments and that the residuals are iid. (AR (2) test does not reveal second-order autocorrelation).

[15] As expected, the elasticities of foreign demand are sensitive to the different aggregates. For example, if one concentrates on the investment of the TPs. The size of the estimate is naturally reduced to reflect its lower covariance with exports (see Table A.2).

[16] The size of the contribution relates to the evidence reported in IMF (2017, p. 66) for the case of Chile.

Graph 4: Contributions of manufacturing exports growth
(Quarter on quarter growth cumulated sum 4 quarters, percentage)

| ■ GDP TP | ■ RER | ■ GDP Industrial | ■ Persistence | ■ Residuals | ○ Industrial Exports |
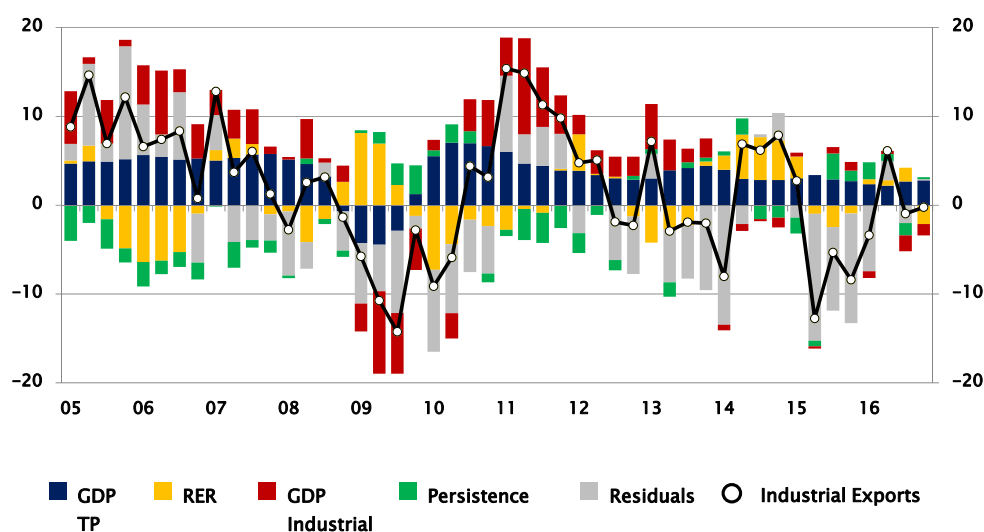
Source: Central Bank of Chile and authors' calculations.

Table 4: Determinants of manufacturing exports by group
[Different measures of foreign demand and estimation methods]
(Standard errors in parenthesis)

Consumer Goods						
	M(1): GDP*		M(2): C*		M(4): M*	
	GMM	WG	GMM	WG	GMM	WG
Δ BRER (−1)	0.42**	0.45***	0.58***	0.58***	0.40**	0.46***
	(0.19)	(0.15)	(0.16)	(0.14)	(0.18)	(0.14)
Δ Ext. Demand	1.08*	0.54	1.13	0.73	0.57**	0.45*
	(0.56)	(0.92)	(0.82)	(1.27)	(0.21)	(0.22)

Intermediate and / or Investment Goods						
	M(1): GDP*		M(3): I*		M(4): M*	
	GMM	WG	GMM	WG	GMM	WG
Δ BRER (−1)	0.55*	0.53	0.61**	0.55*	0.50*	0.52
	(0.29)	(0.31)	(0.28)	(0.30)	(0.29)	(0.31)
Δ Ext. Demand	1.48	1.77	0.98**	0.91*	0.55**	0.59**
	(1.04)	(1.09)	(0.37)	(0.44)	(0.28)	(0.26)

Note: Dependent variable in the top panel of the table is exports of consumer goods (Food and Beverages and Tobacco) and in the lower panel exports of intermediate and / or investment goods (Forest and Wood, Pulp and Paper, Chemicals, Basic Metallics and Metallic Products, Machinery and Equipment). M (1), M (2), M (3) and M (4) assume that the foreign demand is TPs' GDP, Consumption, investment and imports, respectively. Other controls are omitted for brevity. Refer to note of Table 3 above for additional details.
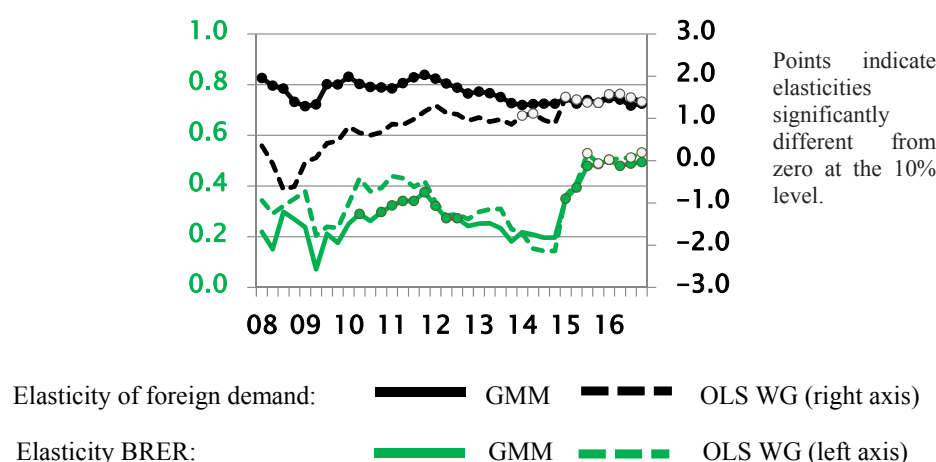Source: authors' calculations.

V. Robustness

This section examines the robustness of the estimates presented above. A first question is whether the estimates reported in previous years are stable over time. To answer this question, we design a recursive estimation exercise with incremental sample windows. The first subsample used for estimation includes 2003.Q1-2008.Q1 (excluding the Subprime Crisis). The second subsample comprises the period 2003.Q1-2008.Q2, and so on.

The results are presented in Graph 5 using the TP's GDP as a proxy for the foreign demand and for brevity we present remaining measures of foreign demand in the Annex (see Graph A.1). Dots on each line indicate that the elasticity is statistically significant and different from zero at 10% level. Note that the point estimators WG are biased when the sample is small, but converge to the GMM estimators when the sample is enlarged (at least for the parameters of interest). Disregarding the two methods, results are similar when the sample size is reasonably large.
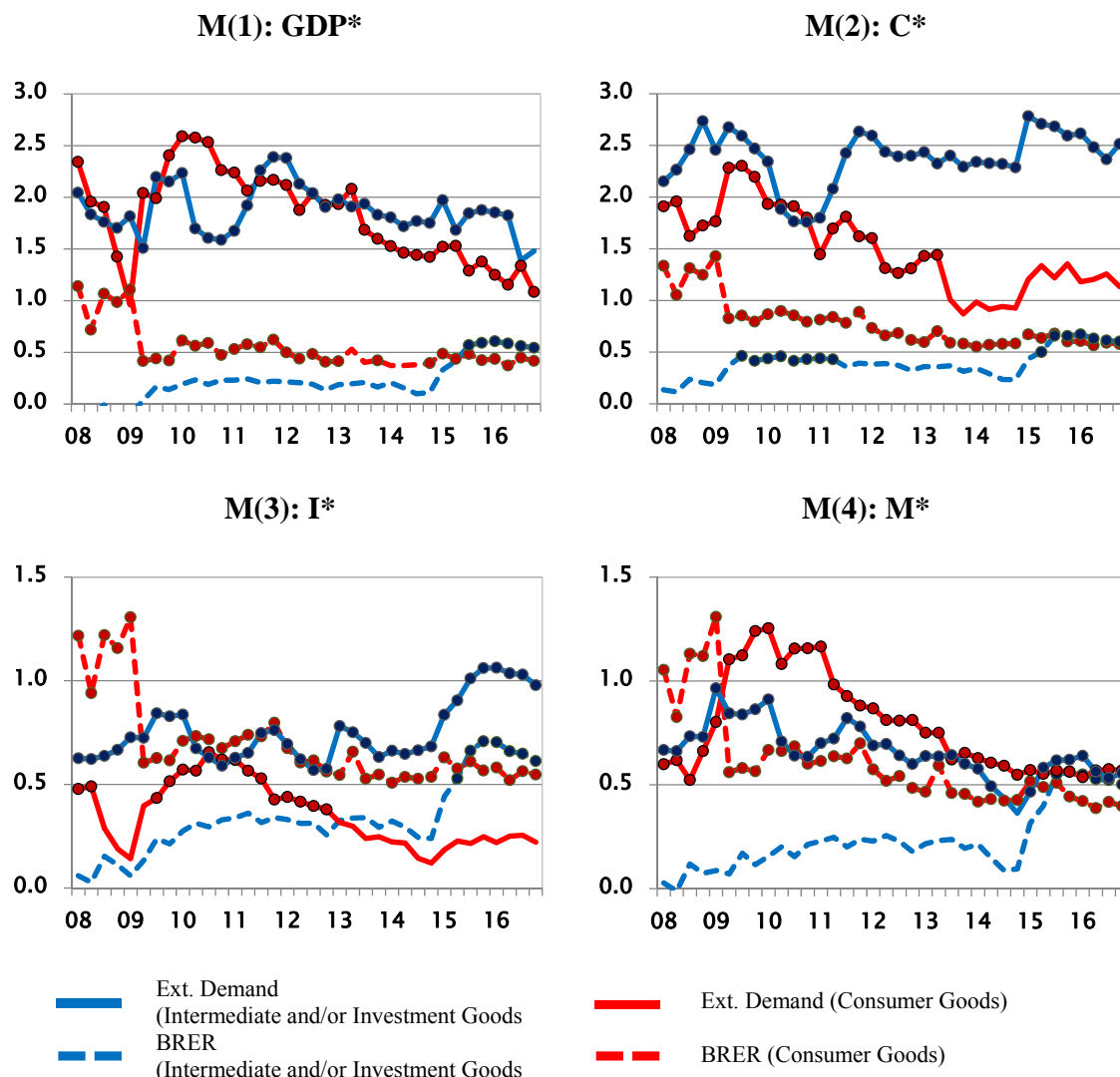
Graph 5: Robustness analysis: BRER elasticity and foreign demand
(Recursive windows, OLS and GMM)

Points indicate elasticities significantly different from zero at the 10% level.

| Elasticity of foreign demand: | GMM | OLS WG (right axis) |
| Elasticity BRER: | GMM | OLS WG (left axis) |

Source: authors' calculations.

This first exercise reveals that the elasticity to foreign demand is always estimated higher than the elasticity to the BRER. In addition, the former has been stable over time, with a slight downward trend since 2013. In the case of TPs' GDP, its elasticity was 2 before 2013 and fell to around 1.5 with the entire sample. With the GMM method that elasticity has been almost always significant, whereas the WG method it has not always been the case. Regarding, the BRER it is observed that this elasticity has grown from values close to 0.2 to stabilize around values 0.5-0.6, without great differences between GMM and WG. The BRER elasticity has also been sometimes or sporadically statistically significant and different from zero. In the years 2015-2016 the BRER elasticities were always significant.

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Graph 6. Manufacturing exports by groups. Robustness BRER and foreign demand

(Recursive windows, GMM)

M(1): GDP*

M(2): C*

M(3): I*

M(4): M*

Ext. Demand
(Intermediate and/or Investment Goods

BRER
(Intermediate and/or Investment Goods

Ext. Demand (Consumer Goods)

BRER (Consumer Goods)

Note: Consumer Goods: Food and Beverages and Tobacco. Intermediate and / or Investment Goods: Forestry and Wood, Pulp and Paper, Chemicals, Basic Metallics and Metallic Products. Recursive window estimates: the first estimation period corresponds to 2003.I-2008.I, the second 2003.I-2008.II, and so on. For each step, both the long and short run models are estimated, we plot elasticities of the short run model. M (1), M (2), M (3) and M (4) assume that foreign demand is Chile's trading partners GDP, Consumption, Investment and Imports, respectively. Dots on each line indicate that the elasticity is statistically significant and different from zero at 10% level. Source: authors' calculations.

Finally, an analogous robustness analysis of elasticity stability is presented for the groups of exports of manufactured consumer goods and manufactured intermediate goods and / or investment. Graph 6 illustrates the results, highlighting several aspects. First, by focusing on the discontinuous line representing the BRER elasticity, we observed: (i) using the whole sample, and in particular in the windows covering the years 2015-2016, we noticed

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that the elasticity to the BRER was very similar for both groups of manufacturing exports. But, they have not always been that stable. The evidence for the sub-samples to 2013 deliver the manufacturing consumer goods exports have been more elastic to the BRER than the exports of manufacturing investment goods / intermediates. The causes of these differences could be explained by the remoteness of target markets facing each group and the intensity of competition with other suppliers, among other hypotheses.[17]

Second, referring to the elasticity to foreign demand, we appreciate a greater heterogeneity of elasticity (full lines in the graph). In addition, the separation between groups of manufacturing exports is interesting because it suggests a downward trend in the elasticities estimated for exports of manufacturing consumer goods, but there is no trend in the elasticities of manufacturing investment / intermediate goods exports.

VI. Conclusions

This paper focuses on analyzing how manufacturing exports react to bilateral RER and foreign demand in the short term. Briefly, the behavior of manufacturing exports responds relatively more to the evolution of foreign demand than to exchange rate movements.

The main result is that the weak growth performance of manufacturing exports in the last three years was explained by a persistent deceleration of foreign demand, which has been partially offset by a depreciation of the BRER with respect to the group of countries that are destination for domestic manufacturing exports. This evidence is related to results presented by IMF (2017). In fact, we find that the contribution of the RER in manufacturing exports growth between the year 2014 and 2016 is approximately + 1.2%, comparable in size to the calculation reported in that study. Finally, since 2012 the residual is on average negative. The sign of this residual is consistent with the lower observed dynamism of world trade.

In the second order of importance, we conclude that the short-run elasticities of manufacturing exports are different in size, on the one hand the elasticity of foreign demand −measured by aggregates more directly associated with the income of TPs− is between [1.4; 2] and with respect to the BRER [0.4; 0.6]. These results are in line with previous work.

The approximate foreign demand elasticities by GDP and consumption of TPs are stable over time, although in the first case, there is a slight downward trend after 2013. As for the BRER elasticities, they remain relatively unchanged when controlled by different measures of foreign demand. This finding is robust to several exercises. However, over time it has shown more instability: smaller around 0.2 in the pre-Crisis subsamples and somewhat higher between 0.4 and 0.6 when using the entire sample.

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[17] In fact, in the case of exports of consumer goods, most of its exports are destined to markets farther away, such as the US and Europe, while shipments of investment goods and intermediate goods are destined in large percentage to our neighboring countries.

Third, when analyzing two sub aggregates of manufacturing exports: consumer goods and investment / intermediate goods, we find elasticities to the BRER of size similar to those reported for the aggregate. In other words, the reaction to the BRER of consumer goods and investment / intermediate shipments is comparable. However, in the case of foreign demand, we observe greater heterogeneity.

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Annex

Table A.1: Pedroni (1999) cointegration panel test

	M(1)	M(2)	M(3)	M(4)
p–value	0.001	0.000	0.003	0.001

Note: The null hypothesis assumes the absence of cointegration between the level of manufacturing exports, the BRER and foreign demand. M (1), M (2), M (3) and M (4) assume that foreign demand is the GDP, Consumption, Investment and Imports of trading partners, respectively.
Source: authors' calculations.

Table A.2: (Extended Table 3) Determinants of manufacturing exports
[Different measures of foreign demand and estimation methods]
(Standard errors in parenthesis)

	M(1): GDP*		M(2): C*		M(3): I*		M(4): M*	
	GMM	WG	GMM	WG	GMM	WG	GMM	WG
Δ BRER (−1)	0.494**	0.532*	0.563***	0.589*	0.596***	0.572*	0.442**	0.533*
	(0.20)	(0.25)	(0.19)	(0.24)	(0.20)	(0.24)	(0.20)	(0.25)
Δ Ext. Demand	1.350**	1.396**	1.770***	1.994**	0.674***	0.634*	0.549***	0.555***
	(0.61)	(0.56)	(0.54)	(0.61)	(0.26)	(0.26)	(0.19)	(0.15)
Dummy	−0.047	−0.064	−0.047	−0.064	−0.046	−0.064	−0.042	−0.057
	(0.04)	(0.05)	(0.04)	(0.06)	(0.04)	(0.06)	(0.04)	(0.05)
Δ Supply (−1)	0.813***	0.979*	0.806***	0.969*	0.796***	0.954*	0.781***	0.957*
	(0.20)	(0.40)	(0.20)	(0.40)	(0.20)	(0.40)	(0.21)	(0.41)
EC (−1)	−0.658***	−0.357***	−0.661***	−0.356***	−0.659***	−0.358***	−0.653***	−0.353***
	(0.08)	(0.05)	(0.08)	(0.04)	(0.08)	(0.04)	(0.08)	(0.04)
Δ X(−1)	−0.227**	−0.265**	−0.226**	−0.266***	−0.228**	−0.265***	−0.231**	−0.267***
	(0.09)	(0.07)	(0.10)	(0.07)	(0.10)	(0.07)	(0.10)	(0.07)
AR(2)	0.209	––	0.216	––	0.204	––	0.202	––
Hansen Test	0.301	––	0.318	––	0.324	––	0.272	––
N. Instruments	109	––	109	––	109	––	109	––
N groups	126	126	126	126	126	126	126	126
N obs.	6547	6547	6547	6547	6547	6547	6547	6547
R2–adj.	––	0.290	––	0.289	––	0.290	––	0.288

Note: Panel data estimation. Regressors: BRER, foreign demand, dummy crisis, supply, error correction (EC) and persistence. M (1), M (2), M (3) and M (4) assume that the foreign demand is GDP, Consumption, investment and imports of trading partners respectively. The GMM system is estimated in two stages and the table reports estimates of the second. The dependent variable is lagged twice and the first lag of all independent endogenous variables were used as instrumental variables. EC is the residue of a relation in levels where manufacturing exports are function of BRER and the foreign demand. * P <10%, ** p <5%, *** p <1%. AR (2) presents the p-value corresponding to the serial self-correlation test in first differences (H0: absence of serial correlation in the residuals). The Hansen test presents the p-value (H0: the over-identification constraints are valid). The MCO Within Group (WG) column corresponds to estimates made assuming fixed effects by sector and destination of export. The p-values were robustly estimated (to correct the errors by heteroscedasticity and Autocorrelation was used "standard errors clustered across cross-section, White cross-section covariance method").
Source: authors' calculations.

Graph A.1. Robustness: BRER elasticity and foreign demand
(Recursive window, OLS and GMM)

M (1):GDP*

M (2): C*

M(3): I*

M (4):M*

Elasticity of foreign demand:	——— GMM	– – – OLS WG (right axis)
Elasticity BRER:	——— GMM	– – – OLS WG (left axis)
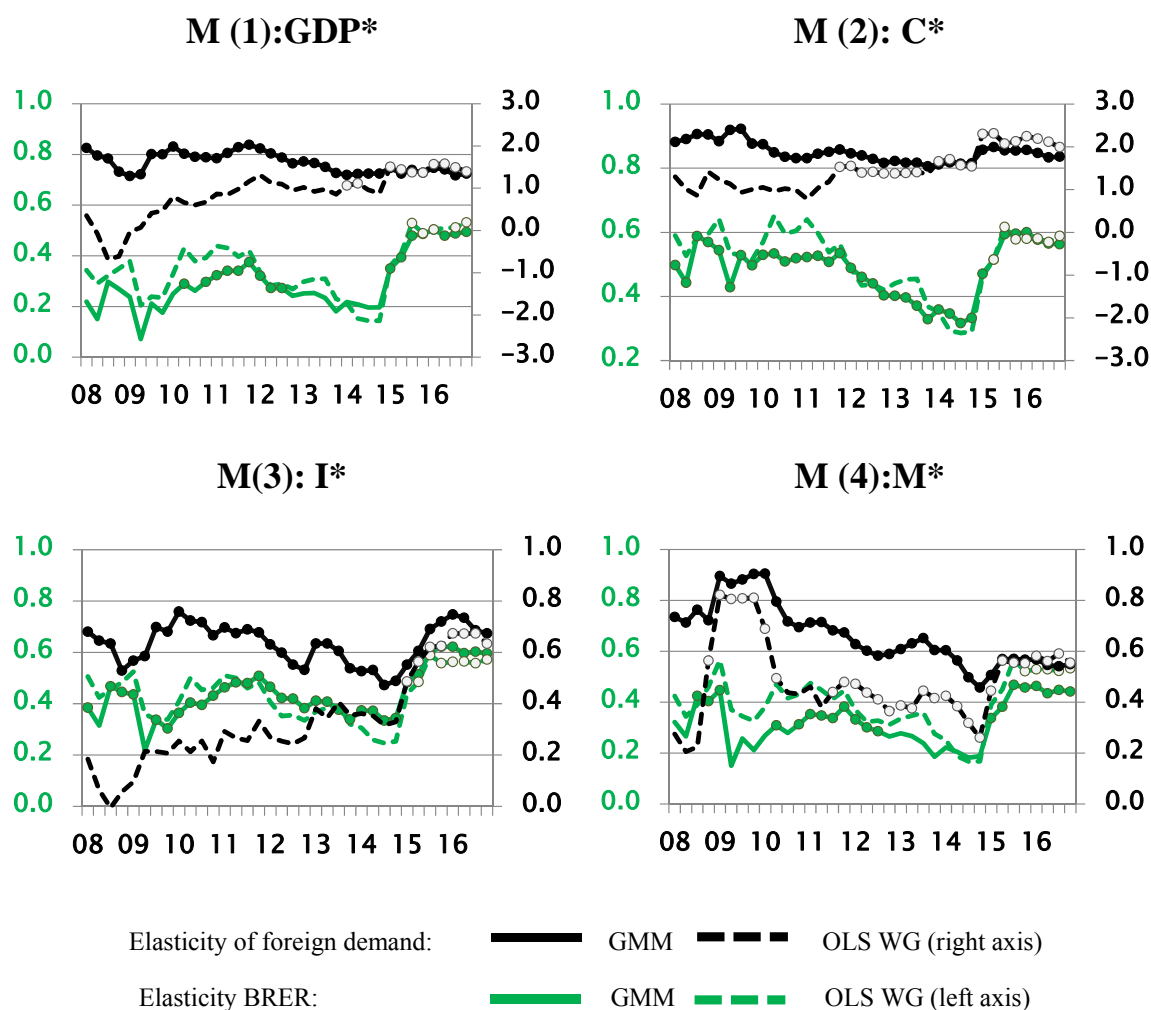
Note: Panel estimates recursive windows. The first estimation window covers 2003.Q2-2008.Q1. Circles indicate that such elasticity equals zero is rejected at 10% of statistical significance. M (1), M (2), M (3) and M (4) assume that foreign demand is the GDP, Consumption, Investment and Imports of trading partners respectively.
Source: authors' calculations.

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