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Does domestic demand matter for firms' exports?

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Abstract
The existence of a link between exports and domestic demand challenges the standard theoretical assumption in international trade models and carries out important policy implications. Being a small open economy and one of the hardest hit economies during the latest economic and financial crisis, Portugal is a natural case study for assessing the role of this channel, in particular given the large export market share gains that mitigated the negative effects on economic activity. A key difference of our empirical approach vis-à-vis previous literature is that the estimated relationship between exports and domestic sales results directly from a monopolistic model of a firm selling to both domestic and external markets. Drawing on an appropriate estimation strategy, it is found a noteworthy negative relationship between domestic demand and firms' exports covering the manufacturing sector over the period 2009–2016. This result holds for almost all industries although with a heterogeneous magnitude. Additionally, there is also evidence that this effect is stronger for larger firms.

JEL: C33, C36, D21, D22, F14, F41

Keywords: international trade, firms, exports, domestic demand, foreign demand, panel data.

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1. Introduction

The empirical literature on the link between exports and domestic sales has been gaining momentum over the last years. Such a development represents a departure from standard international trade models where it is assumed a constant marginal cost as in the seminal work by Krugman (1979, 1980) and Melitz (2003). Such an assumption implies that foreign and domestic markets can be treated independently.

However, based on several alternative approaches, there is by now some evidence suggesting that the firm decisions are affected by both markets.[1] Vannoorenberghe (2012) finds a negative relationship between exports and domestic sales for French firms, while, also for France, Berman *et al.* (2015) conclude that domestic sales are positively influenced by exports. Altomonte *et al.* (2013) consider four European countries namely France, Germany, Italy and the UK and find that domestic demand conditions are important in driving export market participation with firms more likely to export during a downturn of the domestic market. Blum and Horstmann (2013) document a negative relationship between exports and domestic sales for Chilean firms while Ahn and McQuoid (2017) find a negative correlation between domestic sales and exports for Indonesia. Drawing on data for Italian firms, Bugamelli *et al.* (2015) report a significant relationship between exports and domestic sales with the sign depending on the business cycle phase.

The link between exports and domestic demand has also been fueling the recent policy debate. In particular, the presence of a negative relationship may constitute an additional economic adjustment channel, in particular in the Euro area countries, where a common currency in a low inflation environment leads to the rigidity of real exchange rates. From an economic policy stance, this issue is key for the discussion about the effectiveness of the economic adjustment programs applied to countries under stress during the sovereign debt crisis. Herein, we focus on Portugal, one of the hardest hit economies during the latest economic and financial turbulence episode. The potential relevance of this channel has been highlighted in Pisani-Ferry *et al.* (2013) and Blanchard and Portugal (2017).[2]

After Greece in May 2010 and Ireland in November 2010, in May 2011, Portugal became the third Euro area country to receive economic and financial assistance, accepting to implement an economic program designed by the so-called troika namely, the European Commission (EC), the European Central

1. At the macro level, Esteves and Rua (2015) present strong evidence of a negative relationship between exports and domestic demand for Portugal while Bobeica *et al.* (2016) extend the supporting evidence to a panel of eleven Euro area countries.

2. In this respect, Esteves and Prades (2018) argue that the exporting behavior may differ across countries, depending negatively on product concentration and thus explaining the less successful adjustment of the Greek economy.

Bank (ECB) and the International Monetary Fund (IMF). This economic and financial assistance program clearly reinforced the effects of the 2008–2009 recession on economic activity in a way never recorded in Portugal. Considering 2007 as the reference year, real GDP declined almost eight per cent until 2013, while domestic demand decreased around fifteen per cent, starting to recover gradually thereafter. At the same time, exports grew well above foreign demand which resulted in huge exports market share gains which cannot be explained by the evolution of the real exchange rate.

This paper outlines a theoretical model relaxing the assumption of constant marginal costs allowing for the interplay between foreign and domestic markets. Solving such a firm optimization problem yields a model specification for firms' exports to be estimated. When compared with previous literature, the empirical and testable relationship between exports and domestic sales is directly obtained from a monopolistic model of a firm selling to both domestic and external markets. This implies a non-linear relationship between exports and domestic demand that is not typically taken on board appropriately in the estimation. Additionally, the traditional empirical approach in international trade of estimating a log-linear model may suffer from the heteroskedasticity problem raised by Silva and Tenreyro (2006). Therefore, we resort to a pseudo-maximum-likelihood estimator using a fixed effects Poisson procedure. In our empirical analysis we use firm-level data that covers the Portuguese manufacturing exporters for the period 2009–2016. As noted earlier, such a time window encompasses a very challenging period for the Portuguese firms which makes it a natural case study.

We find that external demand has a positive impact on firms' exports while there is a negative and statistically significant relationship between exports and domestic sales. However, one should highlight that the elasticities of exports to domestic demand and to external demand are not constant. This is a new but intuitive result. In fact, both elasticities depend on the relative importance between domestic and foreign sales. Concerning the elasticity of exports to domestic demand, it is zero when firms do not sell to the domestic market as in this case the firm cannot by definition shift sales from the domestic to the foreign market. Naturally, the elasticity becomes more negative as the domestic sales are relatively more important on firms' sales. Regarding the elasticity of exports to foreign demand, the positive reaction to external demand shocks is higher if there is scope for the firm to shift sales from the domestic to foreign market. These results are supported both by the theoretical model as well as by the empirical results, which hold for different estimation methods and samples. We also find that the results are robust across manufacturing industries, as this negative relationship holds for almost all industries being statistically significant in 13 out of the 18 industries considered. Nevertheless, the magnitude of the effect depends clearly of the industry considered. There is also evidence that this effect is less strong for smaller firms. Hence, larger firms, which are known to be more prone to export, seem to be more able to shift sales from the domestic to the foreign market.

The paper is organized as follows. In Section 2, a theoretical model underlying the link between exports and domestic demand is presented. The dataset is described in Section 3 and the estimation strategy is discussed in Section 4. In Section 5, the main empirical results are reported while Section 6 explores the heterogeneity both across industries and firms size. Finally, Section 7 concludes.

2. Theoretical framework

We consider two markets, a foreign (F) and a domestic (D) market, which are assumed to be segmented so that different prices can be charged by the firm in each market. By assuming monopolistic competition, each firm i at time t faces a downward sloping demand curve in the foreign market, q_{it}^F, given as

$$q_{it}^F = \Phi_t^F z_{it}^F \left(p_{it}^F\right)^{-\eta} \tag{1}$$

where Φ_t^F represents the aggregate export market size, z_{it}^F is a firm-specific export demand shifter, p_{it}^F is the firm's export price and $\eta > 1$ is the price elasticity of demand (as in, for example, Aw *et al.* 2011 and Vannoorenberghe 2012). Hence, the corresponding inverse demand function is given by

$$p_{it}^F = \left(\Phi_t^F z_{it}^F\right)^{\frac{1}{\eta}} \left(q_{it}^F\right)^{-\frac{1}{\eta}} \tag{2}$$

In the domestic market, q_{it}^D, firms face similar demand conditions, *i.e.*,

$$q_{it}^D = \Phi_t^D z_{it}^D \left(p_{it}^D\right)^{-\eta} \tag{3}$$

and

$$p_{it}^D = \left(\Phi_t^D z_{it}^D\right)^{\frac{1}{\eta}} \left(q_{it}^D\right)^{-\frac{1}{\eta}} \tag{4}$$

where Φ_t^D represents the common aggregate domestic demand, z_{it}^F is a firm-specific domestic demand shifter and p_{it}^D is the firm's domestic price.[3]

Using (1) – (4), revenues on the foreign and domestic markets can be expressed, r_{it}^F and r_{it}^D, respectively, as

$$r_{it}^F = \left(\Phi_t^F z_{it}^F\right)^{\frac{1}{\eta}} \left(q_{it}^F\right)^{\frac{\eta-1}{\eta}} \tag{5}$$

and

$$r_{it}^D = \left(\Phi_t^D z_{it}^D\right)^{\frac{1}{\eta}} \left(q_{it}^D\right)^{\frac{\eta-1}{\eta}} \tag{6}$$

Typically, in international trade structural models it is assumed that marginal costs do not depend upon the quantity of the good supplied by the firm (see Clerides *et al.* 1998, Melitz 2003, Das *et al.* 2007, Aw *et al.* 2011, among many others). This implies that demand shocks in one market do not affect the decision in the other market and the optimization problem for each market can be considered separately. Herein, we relax that assumption which makes the decisions by firm i in both markets interrelated. In particular, likewise Vannoorenberghe (2012), we consider a total cost function for each firm, c_{it}, given by

$$c_{it} = \theta_i \left(q_{it}^F + q_{it}^D\right)^{\alpha} + f_i + f_x \tag{7}$$

where θ_i is a firm-specific cost parameter, f_i is a firm-specific fixed cost of producing and f_x is a fixed cost of exporting. The parameter α defines the type of marginal cost, that is, constant marginal cost when $\alpha = 1$, decreasing marginal cost when $\alpha < 1$ and increasing marginal cost when $\alpha > 1$.

Hence, the optimization problem to be solved by each firm is given by

$$\max_{q_{it}^F, q_{it}^D} \left(\Phi_t^D z_{it}^D\right)^{\frac{1}{\eta}} \left(q_{it}^D\right)^{\frac{\eta-1}{\eta}} - \theta_i \left(q_{it}^F + q_{it}^D\right)^{\alpha} - f_i - f_x$$

3. The demand curves faced by firm i in the foreign and domestic markets can be generated by the Dixit-Stiglitz utility function over varieties.

Solving this problem involves equating the marginal revenue in each market (derived from (5) and (6)) to the marginal cost (resulting from (7)). This leads to the following optimal quantities

$$q_{it}^{F}=\left(\frac{\eta\alpha}{\eta-1}\theta_{i}\right)^{-\frac{\eta}{1+\eta(\alpha-1)}}\left(\Phi_{t}^{F}z_{it}^{F}\right)^{\frac{1}{1+\eta(\alpha-1)}}\left(1+\frac{\Phi_{t}^{D}z_{it}^{D}}{\Phi_{t}^{F}z_{it}^{F}}\right)^{-\frac{\eta(\alpha-1)}{1+\eta(\alpha-1)}} \tag{8}$$

and

$$q_{it}^{D}=\left(\frac{\eta\alpha}{\eta-1}\theta_{i}\right)^{-\frac{\eta}{1+\eta(\alpha-1)}}\left(\Phi_{t}^{D}z_{it}^{D}\right)^{\frac{1}{1+\eta(\alpha-1)}}\left(1+\frac{\Phi_{t}^{F}z_{it}^{F}}{\Phi_{t}^{D}z_{it}^{D}}\right)^{-\frac{\eta(\alpha-1)}{1+\eta(\alpha-1)}} \tag{9}$$

The corresponding export sales are obtained by substituting (8) into (5) and can be expressed as

$$r_{it}^{F}=\left(\frac{\eta\alpha}{\eta-1}\theta_{i}\right)^{\frac{1-\eta}{1+\eta(\alpha-1)}}\left(\Phi_{t}^{F}z_{it}^{F}\right)^{\frac{\alpha}{1+\eta(\alpha-1)}}\left(1+\frac{\Phi_{t}^{D}z_{it}^{D}}{\Phi_{t}^{F}z_{it}^{F}}\right)^{\frac{(1-\eta)(\alpha-1)}{1+\eta(\alpha-1)}} \tag{10}$$

whereas the domestic sales result from using (9) into (6)

$$r_{it}^{D}=\left(\frac{\eta\alpha}{\eta-1}\theta_{i}\right)^{\frac{1-\eta}{1+\eta(\alpha-1)}}\left(\Phi_{t}^{D}z_{it}^{D}\right)^{\frac{\alpha}{1+\eta(\alpha-1)}}\left(1+\frac{\Phi_{t}^{F}z_{it}^{F}}{\Phi_{t}^{D}z_{it}^{D}}\right)^{\frac{(1-\eta)(\alpha-1)}{1+\eta(\alpha-1)}} \tag{11}$$

Focusing on the exports equation (10), one can see that exports are positively influenced by foreign demand, $\Phi_{t}^{F}z_{it}^{F}$. On the other hand, for $\alpha>1$, that is, in the presence of increasing marginal costs, one obtains $\frac{(1-\eta)(\alpha-1)}{1+\eta(\alpha-1)}<0$. This means that the relative importance of the domestic to the foreign market, $\frac{\Phi_{t}^{D}z_{it}^{D}}{\Phi_{t}^{F}z_{it}^{F}}$, has a negative effect on exports. In other words, as one can show that $\frac{r_{it}^{D}}{r_{it}^{F}}=\frac{\Phi_{t}^{D}z_{it}^{D}}{\Phi_{t}^{F}z_{it}^{F}}$ using (10) and (11), the larger is the domestic to export sales ratio, the larger will be the negative impact on exports. Note that, in the case of constant marginal costs, $\alpha=1$, $\frac{(1-\eta)(\alpha-1)}{1+\eta(\alpha-1)}=0$ and exports are not influenced by domestic sales as it is commonly assumed in the literature.

3. Data

3.1. Definitions and sources

Exports. Data for exports at the firm level are from the external trade database of Statistics Portugal (INE), the Portuguese national statistical office, classified according to the 2010 Combined Nomenclature (NC) (INE, Statistics Portugal 2018a). This database includes nominal values of internationally traded goods between Portugal and other Member States of the European Union (intra–EU trade) and between Portugal and non-EU countries (extra-EU trade). Data on extra-EU trade are collected from customs declarations, while data on intra–EU trade are collected through the Intrastat system. Each transaction record includes, among other information, the firm's identifier, product code (8 digits), the destination country, the value of the transaction in Euro.

Domestic sales. Data regarding domestic sales for each firm comes from the Integrated Business System (SCIE) (INE, Statistics Portugal 2018b). This database results from a process of statistical data integration that covers enterprises and is based on administrative data, with an emphasis on Simplified Business Information (IES). The set of information available encompasses many other variables, including the sector of activity. INE compiles and validates a concise version of the database releasing it for the period 2006–2016. As each firm has an unique identifier, the two sources of information could be matched.

Foreign demand. The evolution of foreign demand is naturally crucial for exports behavior. At the macro level, such a variable is usually computed as a weighted average of the imports of the main trade partners where the weights reflect the relative importance of those trade partners for the country exports (see, for example, Hubrich and Karlsson 2010, for its use at the Eurosystem). In the same spirit, a foreign demand, in moment t, can be computed at the firm level, $FD_{i,t}$. In particular, one has to take into account both the product and the geographical export specialization of each firm yielding

$$FD_{i,t} = \sum_{p=1}^{P} \sum_{j=1}^{J} \omega_{i,p,j} M_{j,p,t} \tag{12}$$

where $\omega_{i,p,j}$ is the average share of the exports of product p ($p = 1, ..., P$) to country j ($j = 1, ..., J$) in firm's i total exports, while $M_{j,p,t}$ measures the imports of country j of each product p and at time t (see also Berman *et al.* 2015).

The firm level weights, $\omega_{i,p,j}$, are constant over time and are computed using the above mentioned database for the Portuguese external trade. The imports data for the trade partners are obtained from BACI (CEPII 2018), which is a world trade database developed by the CEPII with a high level of product disaggregation based on original data provided by the United Nations Statistical Division (COMTRADE database). We consider the most disaggregated version available for all the period, *i.e.*, the Harmonized System at 6 digit level following the 1996 classification (HS6–1996). As such data is released in US Dollar, it has been converted to Euro using the annual average exchange rate. The data is then merged with the Portuguese external trade database using only the 6 initial digits. The resulting dataset covers 213 trade countries/territorial units partners and a total of 4,875 products. In this way, we obtain the foreign demand faced by each firm taking into account its product and destination orientation.

3.2. Descriptive statistics

Several descriptive statistics are reported in Table 1. In particular, we provide a set of standard statistics for the following variables: exports, domestic sales, the ratio between domestic sales and exports, and foreign demand. We report statistics for the year 2009,[4] the last year available for this type of data which is 2016 and for the whole period.

In Panel A, we consider all manufacturing firms leading to a sample of 21,749 observations and 3,996 firms. Looking at the figures for the ratio between domestic and exports sales, it is clear that this variable is being influenced by firms reporting a very small value for exports relatively to domestic sales. Therefore, in order to avoid the contamination of the results due to such extreme observations, another sample is considered. Firstly, all the firms reporting total sales less than one thousand Euro are excluded to avoid very small firms which are more prone to reporting errors. Secondly, firms are considered if exports represent at least one per cent of domestic sales or if domestic sales represent at least one per cent of exports. The idea is to narrow the analysis to firms that are effectively present in both markets. This sample has 19,381 observations and 3,655 firms (Panel B). Finally, a third sample is analyzed (Panel C). As the theoretical model considered does not deal explicitly with the entry and exit of firms, the sample was further restricted to firms that are present in both markets in all periods as robustness analysis. This sample has 8,784 observations and 1,098 firms.

4. The year 2009 is the first year considered for estimation purposes due to the use of an instrumental variables procedure that makes use of lagged values of specific variables.

TABLE 1. Descriptive statistics

Variables	$Mean$	$s.d.$	P_{10}	P_{50}	P_{90}
Panel A: full sample					
Year 2009 $N = 2,014$					
Exports $(X_{i,t})$	5,547	21,776	29	1,178	11,137
Domestic Sales $(DS_{i,t})$	6,876	26,555	89	1,256	13,457
Ratio $DS_{i,t}/X_{i,t}$	316	8,267	0	1	59
Foreign Demand $(FD_{i,t})$	304,963	680,887	1,006	68,789	840,613
Year 2016 $N = 3,064$					
Exports $(X_{i,t})$	8,121	39,542	31	1,328	14,052
Domestic Sales $(DS_{i,t})$	6,474	27,135	88	1,167	12,172
Ratio $DS_{i,t}/X_{i,t}$	2,895	153,184	0	1	36
Foreign Demand $(FD_{i,t})$	461,944	1,066,017	2,650	111,290	1,188,191
All years $N = 21,749$ $firms = 3,996$					
Exports $(X_{i,t})$	7,286	37,639	38	1,298	13,107
Domestic Sales $(DS_{i,t})$	6,530	26,676	84	1,157	12,121
Ratio $DS_{i,t}/X_{i,t}$	677	58,577	0	1	34
Foreign Demand $(FD_{i,t})$	448,014	1,057,308	3,111	100,624	1,157,586
Panel B: drop observations if ratio < 0.01 or > 100					
Year 2009 $N = 1,726$					
Exports $(X_{i,t})$	6,033	23,354	76	1,353	12,084
Domestic Sales $(DS_{i,t})$	7,044	28,111	136	1,278	13,473
Ratio $DS_{i,t}/X_{i,t}$	7	15	0	1	19
Foreign Demand $(FD_{i,t})$	308,245	685,833	2,508	76,417	813,648
Year 2016 $N = 2,704$					
Exports $(X_{i,t})$	8,082	39,967	78	1,426	13,831
Domestic Sales $(DS_{i,t})$	6,621	27,115	134	1,257	12,362
Ratio $DS_{i,t}/X_{i,t}$	6	13	0	1	16
Foreign Demand $(FD_{i,t})$	472,918	1,083,265	5,124	116,852	1,206,248
All years $N = 19,381$ $firms = 3,655$					
Exports $(X_{i,t})$	7,364	38,806	83	1,362	12,885
Domestic Sales $(DS_{i,t})$	6,620	26,545	127	1,225	12,283
Ratio $DS_{i,t}/X_{i,t}$	6	14	0	1	16
Foreign Demand $(FD_{i,t})$	457,465	1,076,704	5,383	105,835	1,173,118
Panel C: drop observations if ratio < 0.01 or > 100 & firms in all periods					
Year 2009 $N = 1098$					
Exports $(X_{i,t})$	7,398	23,805	174	1,724	16,452
Domestic Sales $(DS_{i,t})$	9,121	34,195	227	1,859	16,650
Ratio $DS_{i,t}/X_{i,t}$	5	12	0	1	15
Foreign Demand $(FD_{i,t})$	331,861	775,894	5,148	78,588	835,320
Year 2016 $N = 1098$					
Exports $(X_{i,t})$	12,518	42,578	401	3,193	27,073
Domestic Sales $(DS_{i,t})$	9,224	33,265	249	1,985	18,252
Ratio $DS_{i,t}/X_{i,t}$	3	8	0	1	7
Foreign Demand $(FD_{i,t})$	424,925	909,002	10,165	109,854	1,158,784
All years $N = 8,784$ $firms = 1,098$					
Exports $(X_{i,t})$	10,534	36,636	371	2,534	22,371
Domestic Sales $(DS_{i,t})$	9,187	33,475	237	1,919	17,432
Ratio $DS_{i,t}/X_{i,t}$	3	8	0	1	8
Foreign Demand $(FD_{i,t})$	422,984	944,244	9,562	106,645	1,107,321

Notes. The information used in the regressions spans over the period 2009 – 2016 (the data is available since 2006, but we loose three periods once we build the two instruments defined in Section 4). Labels: *s.d.*, standard deviation; N, number of observations; $firms$, number of firms; P_{10}, P_{50}, and P_{90}, percentiles 10, 50 and 90. Monetary units are in Euro $\times 1000$. *Source*: Own computations.

4. Estimation strategy

The model to be estimated corresponds to equation (10), or put simply as

$$X_{it} = \beta_{i0}\ FD_{it}^{\beta_1}\ (1 + \frac{DD_{i,t}}{FD_{i,t}})^{\beta_2} \tag{13}$$

where X_{it} is exports by firm i in period t, β_1 is expected to be positive and β_2 negative as discussed earlier. An important feature of this specification is that exports depend on the relative importance between both markets. As it is clear, the elasticity of exports to domestic demand is not constant, depending on the relative dimension between the two markets which can differ across firms and over time. More formally, one can show that using equation (13), the exports elasticities to foreign demand, $\varepsilon_{x,fd}$, and domestic demand, $\varepsilon_{x,dd}$, are given, respectively, by

$$\varepsilon_{x,fd} = \beta_1 - \beta_2 \frac{R}{1+R} \tag{14}$$

and

$$\varepsilon_{x,dd} = \beta_2 \frac{R}{1+R} \tag{15}$$

where R stands for the ratio between domestic (DD_{it}) and foreign (FD_{it}) demands. Figure 1 depicts the relation between the model coefficients β_1 and β_2 and the above elasticities considering that $\beta_1 > 0$ and $\beta_2 < 0$. As the domestic market becomes more important, in relative terms, the elasticities of exports to foreign demand and domestic demand asymptotically converge towards $\beta_1 - \beta_2$ and to β_2, respectively.

Intuitively, in the case of $\varepsilon_{x,dd}$, a percentage decrease in domestic sales that ends up being reoriented to the export market, will translate into a large (small) elasticity, in absolute terms, if domestic sales are large (small) in relative terms. Naturally, if there are no domestic sales, then no reorientation is possible and the elasticity is zero. In the case of $\varepsilon_{x,fd}$, if there are no domestic sales, the elasticity is given by β_1. As the domestic market gets more important, there is scope for reorientation, and the elasticity is higher.

Concerning the estimation of the model, two important issues should be highlighted. The first is related with the use of a log linearized version of equation (10). In this respect, one should mention that in the right hand side one cannot separate out domestic demand from foreign demand as the relevant variable becomes $ln\left(1 + \frac{DD_{i,t}}{FD_{i,t}}\right)$. In fact, one should avoid approximating $ln\left(1 + \frac{DD_{i,t}}{FD_{i,t}}\right)$ by $ln\left(\frac{DD_{i,t}}{FD_{i,t}}\right)$ as such approximation only works if the ratio

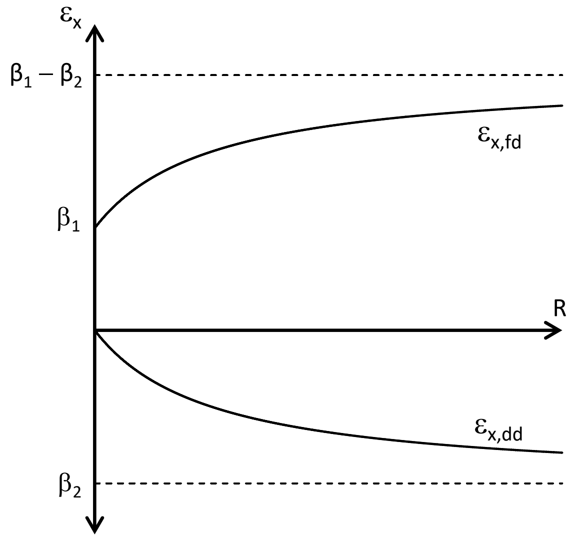

FIGURE 1: Exports elasticities

$\frac{DD_{i,t}}{FD_{i,t}}$ is large. However, as the focus is on exporters, for many firms the foreign market is much larger than the domestic one. Furthermore, the estimation of the 'traditional' log-linear model by fixed effects may lead to biased estimates. As discussed in Silva and Tenreyro (2006), if one faces heteroskedasticity, the fixed effect estimator applied to the log-linear model will produce biased estimates. The proposed solution is based on pseudo-maximum-likelihood, specifically a Poisson model on the levels of the dependent variable, as described in equation (13). In our current setup we have longitudinal data, so we use a fixed effects Poisson procedure.[5]

Secondly, given the lack of information concerning domestic sales by product for each firm and total domestic demand for each product at a high disaggregation level, it is not possible to compute the domestic demand faced by each firm as it is done for foreign demand. However, as one can show that in equilibrium the ratio between domestic and foreign demands is the same as the ratio between domestic sales and exports for each firm, then we will consider the latter in the estimation of the model. Naturally, the use of such a variable raises further issues of endogeneity that are not solved by the typical fixed effects procedure. To handle such remaining endogeneity, we consider the above mentioned ratio in the previous period, that is, we use $\frac{DS_{i,t-1}}{X_{i,t-1}}$ to replace $\frac{DD_{i,t}}{FD_{i,t}}$

5. For a detailed discussion on the estimation of this type of models using panel data see Egger *et al.* (2015).

in the estimation of (13). Intuitively, it seems natural to use the ratio between domestic sales and exports in the previous period as it represents the degree of relative exposure to both markets in the period before the reaction takes place. As a robustness analysis, we also consider an instrumental variables estimator, by using lags of this ratio as its own instrument following the discussion in Arellano and Bond (1991).

5. Empirical results

The estimations are reported in Table 2. The design of the different specifications and estimators is the following. First, we estimate the 'traditional' log-linear model by fixed effects, column '$ln\,(X_{it})$ (FE)'. The dependent variable is the natural log of firms' exports. We assume the fixed effects procedure is able to tackle all endogeneity issues associated with this specification. Second, following the discussion in Silva and Tenreyro (2006) and in Egger *et al.* (2015), we account for heteroskedasticity and implement a (pseudo-maximum-likelihood) fixed effects Poisson estimator. The dependent variable is now firms' exports (in levels), as described in equation (13). The results are shown under column 'X_{it} (FE Poisson)'. Finally, one may argue that such specification does not solve entirely the endogeneity associated with '$ln\left(1+\frac{DS_{i,t-1}}{X_{i,t-1}}\right)$'. As such, we will assess the robustness of this specification by using a fixed effects instrumental variables procedure (column 'X_{it} (FE Poisson–IV)').

We first discuss a set of specification tests in order to evaluate the validity of the different estimates. We start by testing for heteroskedasticity in the first specification. We implement the test discussed in Greene (2017). The underlying χ^2 test leads us to reject the null hypothesis of homoskedasticity. This implies that estimates under column '$ln\,(X_{it})$ (FE)' in Table 2 are inconsistent. As such, we adopt the solution discussed in Silva and Tenreyro (2006) and estimate the model in levels, *i.e.*, using firm's exports as the dependent variable in a Poisson regression with fixed effects (column 'X_{it} (FE Poisson)').

If the fixed effects estimator does not solve entirely the endogeneity within equation (13), one possible solution to handle such remaining endogeneity would be the use of an instrumental variables estimator. This is the approach we follow in the estimation reported in column 'X_{it} (FE Poisson–IV)'. Within our framework and data one natural path to follow is to adopt the instrument strategy discussed in Arellano and Bond (1991), *i.e.*, define lags of the endogenous variable as instruments. The argument being that lag values are correlated with current values, and would not be correlated with present error term. At the same time such strategy provides instruments that change over time, which allows the use of fixed effects procedures.

TABLE 2. Determinants of firms' exports: FE, Poisson & Instrumental Variables

	$ln\,(X_{it})$ (FE)	X_{it} (FE Poisson)	X_{it} (FE Poisson–IV)
Panel A: full sample			
$ln(FD_{it})$	0.477***	0.386***	0.385***
	(0.011)	(0.043)	(0.042)
$ln\left(1+\frac{DS_{i,t-1}}{X_{i,t-1}}\right)$	-0.137***	-0.237***	-0.255***
	(0.024)	(0.045)	(0.054)
$R^2, within$	0.50		
$Log-likelihood$		-5436254	
$Hansen$ test			1.26
$(p-value)$			(0.26)
Panel B: drop observations if ratio < 0.01 or > 100			
$ln(FD_{it})$	0.406***	0.349***	0.344***
	(0.013)	(0.040)	(0.039)
$ln\left(1+\frac{DS_{i,t-1}}{X_{i,t-1}}\right)$	-0.125***	-0.183***	-0.204***
	(0.013)	(0.040)	(0.066)
$R^2, within$	0.37		
$Log-likelihood$		-4544774	
$Hansen$ test			2.01
$(p-value)$			(0.16)
Panel C: drop observations if ratio < 0.01 or > 100 & firms in all periods			
$ln(FD_{it})$	0.416***	0.304***	0.304***
	(0.020)	(0.044)	(0.044)
$ln\left(1+\frac{DS_{i,t-1}}{X_{i,t-1}}\right)$	-0.256***	-0.277***	-0.332***
	(0.027)	(0.057)	(0.090)
$R^2, within$	0.48		
$Log-likelihood$		-2455400	
$Hansen$ test			0.14
$(p-value)$			(0.71)

Notes. The dependent variable $ln\,(X_{it})$ denotes the log of exports for firm i in period t and X_{it} corresponds to exports (in levels) for firm i in period t. $ln(FD_{it})$ stands for the natural log of Foreign Demand for firm i in period t (DS stands for Domestic Sales). Model (FE) is estimated by linear fixed effects, model (FE Poisson) by fixed effects Poisson and model(FE Poisson–IV) by fixed effects instrumental variables Poisson pseudo-maximum-likelihood. The fixed effects are at the firm level. Robust standard-errors in parenthesis (clustered by firm). Significance levels: 1%, ***; 5%, **; 10%, *. All models include time dummies (jointly statistically significant in all models). The first sample has 21,749 observations, corresponding to 3,996 firms. The second sample uses 19,381 observations and 3,655 firms, while the third sample has 8,784 observations and 1,098 firms. See Section 3 for a description of the data and Section 4 for a discussion on the estimation strategy. *Source*: Own computations.

Along this line of reasoning, the instruments used in the estimation of model 'X_{it} (FE Poisson–IV)', the fixed effects instrumental variables Poisson estimator, are $ln\left(1+\frac{DS_{i,t-2}}{X_{i,t-2}}\right)$ and $ln\left(1+\frac{DS_{i,t-3}}{X_{i,t-3}}\right)$. The specification has been estimated using the two-step GMM estimator. The Hansen J statistic that evaluates the overidentifying restrictions is 1.26, with a corresponding *p-value* of 0.26, which does not reject the validity of our instrument set in Panel A (likewise in Panel B and C).

The results reported in Table 2 are in accordance with the model outlined in Section 2 concerning the sign and significance of the parameters associated with $ln(FD_{it})$ and $ln\left(1+\frac{DS_{i,t-1}}{X_{i,t-1}}\right)$.[6]

We find that, regardless the estimation method and the sample considered (panels A, B and C), all the coefficients are statistically significant at the 1% significance level with the foreign demand presenting a positive sign whereas the variable related with the ratio between domestic sales and exports records a negative sign.[7] In terms of magnitude, the 'traditional' log-linear approach delivers the highest coefficients for the former and the lowest (in absolute terms) for the latter. It follows from the discussion above that such estimates may be affected by the estimation bias. We also find that the fixed effects Poisson procedure delivers similar results to those obtained with its counterpart with instrumental variables.

To summarize the results we show in Figure 2 the estimated exports elasticities, which compares with Figure 1. We provide both, the point estimates, as well as the 95% confidence intervals for the estimates of the elasticities defined by equations (14) and (15). These elasticities were computed using the estimates for model 'X_{it} (FE Poisson)' and Panel B provided in Table 2. For instance, if one takes a representative value of 6 for R, our estimates indicate that the elasticity of exports with respect to domestic demand is -0.16 while the elasticity of exports to foreign demand is 0.51.

6. For the three models a joint significance test rejects the null of absence of significance of the time dummies included in the regression.

7. Note that, given the usual degree of business cycle synchronization across countries, the inclusion of foreign demand as explanatory variable may be crucial in order to avoid a misspecification problem that can lead to a spurious positive correlation between exports and domestic demand.

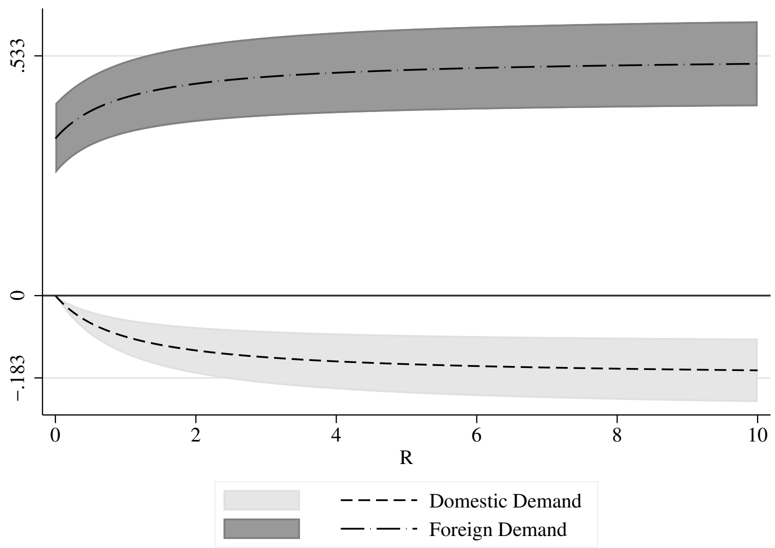

FIGURE 2: Estimated exports elasticities

6. Heterogeneity across industries and firm size

There are reasons to believe that the link between domestic demand and exports could be different across firms. Is fact, as illustrated by equation (10), the relation between exports and domestic demand depend of some factors as the elasticity of demand and the costs structure. Therefore, in this section we investigate empirically how the negative relationship between exports and domestic demand depends on some firm characteristics. Firstly, we focus on the sectoral dimension. Intuitively, the characteristics of the good should play a role, namely their ability to be reallocated between markets, i.e. its degree of 'tradableness'. Secondly, the importance of the firm size is analyzed within each sector. One could argue that a larger firm within a specific sector is more capable to absorb shocks and shift sales from the domestic to external market.

In Table 3 we report the results for eighteen industries within the manufacturing sector, using the sample defined in Panel B of Table 1 and the fixed effects Poisson pseudo-maximum-likelihood estimator. Firstly, one should also mention that the foreign demand indicator has a positive and statistical significant coefficient for all industries. We also find that the negative relationship between exports and domestic demand holds for almost all sectors (17 out of 18 industries). At the one per cent statistical significance level, the estimated coefficient is negative for 10 industries (13 industries when considering the ten per cent statistical significance level). Nevertheless, among those industries where the effect is statistically significant, the magnitude of the coefficient varies quite substantially, ranging from -0.094 for the furniture industry to -0.711 and -0.765 in paper and motor vehicles industries, respectively. The smallest and non-significant coefficient is recorded for the pharmaceutical industry, a sector that is most probably oriented to export and thus do not depend much on domestic demand. Such heterogeneity reinforces the importance of looking at sectorial disaggregation when trying to understand the overall evolution of exports.

Given the heterogeneity across sectors, we now assess the importance of the firm size within each sector. In particular, we classify the firms in each sector in terciles (small, medium and large) based on the average number of employees working in the firm throughout the sample period. In Table 4, we present the results for each sector and firm size. We find that the foreign demand indicator is positive for all pairs of industry and firm size (and statistically significant for 46 out of 54 cases at a one per cent significance level). Regarding the relationship between exports and domestic demand the results suggest that firm size matters. In particular, for small firms there are four industries where the coefficient is statistically significant (at the one per cent significance level) whereas this figure goes up to nine and eight for medium and large firms, respectively. Regarding the magnitude of the coefficient, and focusing on the cases where it is statistically significant, we find that there is only one industry where the highest coefficient (in absolute terms) is recorded for small firms, namely ‘Other manufactures’. This figure goes up to five in the case of medium firms and is even higher in the case of large firms (seven industries). Hence, the above results suggest that the effect tends to be more marked for medium and large firms which supports the view that firm size also plays a role for the ability to reallocate sales.

TABLE 3. Determinants of firms' exports by industry (Poisson FE)

Industry NACE code	10	11	13	14	15	16	17	18	19 & 20
$ln(FD_{it})$	0.412***	0.513***	0.585***	0.390***	0.157***	0.756***	0.113***	0.160***	0.510***
	(0.060)	(0.091)	(0.121)	(0.067)	(0.043)	(0.202)	(0.031)	(0.043)	(0.101)
$ln\left(1+\frac{DD_{i,t-1}}{FD_{i,t-1}}\right)$	-0.360***	-0.309***	-0.248	-0.240***	-0.362***	-0.284*	-0.711***	0.233***	-0.035
	(0.095)	(0.059)	(0.159)	(0.089)	(0.103)	(0.156)	(0.121)	(0.055)	(0.096)
Observations	1,502	825	1,389	1,891	1,610	1,079	386	267	485
Firms	268	160	250	374	290	201	63	58	87
Industry NACE code	21	22	23	24 & 25	26 & 27	28	29 & 30	31	32
$ln(FD_{it})$	0.412***	0.217**	0.599***	0.518***	0.221***	0.246***	0.452***	0.427***	0.374***
	(0.076)	(0.097)	(0.115)	(0.058)	(0.053)	(0.079)	(0.151)	(0.057)	(0.075)
$ln\left(1+\frac{DD_{i,t-1}}{FD_{i,t-1}}\right)$	-0.034	-0.253**	-0.057	-0.185***	-0.209***	-0.180***	-0.765***	-0.094*	-0.154***
	(0.034)	(0.102)	(0.059)	(0.043)	(0.048)	(0.044)	(0.197)	(0.055)	(0.058)
Observations	139	1,206	1,831	2,987	767	1,151	552	958	356
Firms	24	209	343	586	135	208	114	221	78

Notes. The sample corresponds to the one used in Panel B of Table 1. Estimates are performed by fixed effects Poisson pseudo-maximum-likelihood. The fixed effects are at the firm level. The dependent variable is Exports (in levels). $ln(FD_{it})$ stands for the natural log of Foreign Demand for firm i in period t (DD stands for Domestic Demand). Industries: 10, Food Products; 11, Beverages; 13, Textiles; 14, Wearing Apparel and Dressing; 15, Footwear, Articles of Fur; 16, Wood and Cork; 17, Paper and Paper Products; 18, Publishing, Printing and Reproduction; 19 & 20, Fuel and Chemicals; 21, Pharmaceuticals; 22, Rubber and Plastic; 23, Other Non-Metallic Mineral Products; 24 & 25, Basic Metals and Fabricated Metal Products (exc. Machinery and Equipment); 26 & 27, Computing, Communication and Electrical Machinery; 28, Machinery and Equipment; 29& 30, Motor Vehicles; 31, Furniture, 32, Other Manufactures. Robust standard-errors in parenthesis (clustered by firm). Significance levels: 1%, ***; 5%, **; 10%, *. All models include time dummies (jointly statistically significant in all models). See Section 3 for a description of the data and Section 4 for a discussion on the estimation strategy. *Source*: Own computations.

Table 4. Determinants of firms' exports by industry & size, Panel B (Poisson FE)

Industry NACE code	10	11	13	14	15	16	17	18	19 & 20
Small									
$ln(FD_{it})$	0.501***	0.309***	0.335***	0.172***	0.288***	0.254***	0.152***	0.809***	0.426***
	(0.089)	(0.069)	(0.057)	(0.064)	(0.074)	(0.083)	(0.055)	(0.184)	(0.054)
$ln\left(1+\frac{DS_{i,t-1}}{X_{i,t-1}}\right)$	-0.214**	-0.146***	-0.124	-0.225	-0.308***	-0.222***	-0.524**	-0.043	0.060
	(0.101)	(0.054)	(0.080)	(0.197)	(0.116)	(0.082)	(0.264)	(0.105)	(0.043)
Observations	417	243	368	561	442	322	104	62	138
Firms	86	54	84	126	99	68	22	17	30
Medium									
$ln(FD_{it})$	0.376***	0.211	0.183***	0.440***	0.072	0.357***	0.562***	0.228***	0.145*
	(0.075)	(0.167)	(0.051)	(0.105)	(0.051)	(0.102)	(0.168)	(0.041)	(0.086)
$ln\left(1+\frac{DS_{i,t-1}}{X_{i,t-1}}\right)$	-0.250***	-0.188**	-0.439***	-0.468***	-0.314***	-0.363***	-0.593***	0.017	-0.454***
	(0.082)	(0.096)	(0.103)	(0.121)	(0.078)	(0.124)	(0.154)	(0.102)	(0.058)
Observations	491	289	489	633	540	349	158	86	153
Firms	91	54	84	125	95	68	22	19	27
Large									
$ln(FD_{it})$	0.417***	0.549***	0.707***	0.418***	0.179***	0.848***	0.112***	0.125***	0.546***
	(0.078)	(0.097)	(0.137)	(0.097)	(0.062)	(0.215)	(0.024)	(0.031)	(0.103)
$ln\left(1+\frac{DS_{i,t-1}}{X_{i,t-1}}\right)$	-0.411***	-0.359***	-0.317	-0.163	-0.430**	-0.273	-0.669***	0.253***	0.016
	(0.134)	(0.068)	(0.258)	(0.129)	(0.213)	(0.219)	(0.140)	(0.050)	(0.091)
Observations	594	293	532	697	628	408	124	119	194
Firms	91	52	82	123	96	65	19	22	30

Note: see notes to Table 3.

Table 4. Determinants of firms' exports by industry & size, Panel B (Poisson FE) (continued)

	Small								
Industry NACE code	21	22	23	24 & 25	26 & 27	28	29 & 30	31	32
$ln(FD_{it})$	0.363**	0.289***	0.308***	0.431***	0.381***	0.347***	0.305**	0.439***	0.367***
	(0.167)	(0.111)	(0.048)	(0.052)	(0.097)	(0.081)	(0.122)	(0.067)	(0.128)
$ln\left(1+\frac{DS_{i,t-1}}{X_{i,t-1}}\right)$	0.074***	-0.188**	-0.078	-0.061	-0.130	0.095	-0.222	-0.152	-0.566***
	(0.029)	(0.091)	(0.051)	(0.064)	(0.107)	(0.078)	(0.151)	(0.101)	(0.213)
Observations	45	293	500	775	216	327	180	287	99
Firms	9	62	112	198	45	67	40	75	26
	Medium								
$ln(FD_{it})$	0.364***	0.328***	0.402***	0.404***	0.224***	0.376***	0.228*	0.404***	0.277***
	(0.053)	(0.122)	(0.050)	(0.060)	(0.050)	(0.063)	(0.133)	(0.091)	(0.059)
$ln\left(1+\frac{DS_{i,t-1}}{X_{i,t-1}}\right)$	-0.056	-0.093	-0.128**	-0.098**	-0.250***	-0.072	-0.387	-0.153**	-0.168***
	(0.036)	(0.166)	(0.050)	(0.050)	(0.052)	(0.049)	(0.250)	(0.063)	(0.057)
Observations	40	422	588	973	262	361	181	304	111
Firms	7	75	114	191	44	67	38	73	24
	Large								
$ln(FD_{it})$	0.414***	0.199*	0.668***	0.547***	0.221***	0.195	0.508***	0.422***	0.468***
	(0.140)	(0.112)	(0.153)	(0.074)	(0.064)	(0.132)	(0.185)	(0.085)	(0.078)
$ln\left(1+\frac{DS_{i,t-1}}{X_{i,t-1}}\right)$	-0.012	-0.346**	-0.028	-0.221***	-0.198***	-0.273***	-0.912***	-0.079	-0.124***
	(0.024)	(0.136)	(0.077)	(0.055)	(0.062)	(0.087)	(0.214)	(0.069)	(0.042)
Observations	54	491	743	1,239	289	463	191	367	146
Firms	8	72	117	197	46	74	36	73	28

Note: see notes to Table 3.

7. Concluding remarks

The link between exports and domestic sales has been fueling recent economic literature and the policy debate. In particular, the presence of a negative relationship may constitute an additional economic adjustment channel, in particular in the Euro area countries, where a common currency in a low inflation environment leads to the rigidity of real exchange rates.

The focus is on Portugal, one of the countries which underwent a severe crisis during the latest economic turbulence episode. The economic and financial assistance program implemented in May 2011 reinforced the effects of the 2008 – 2009 recession on economic activity in a way never seen in Portugal. However, at the same time, exports grew well above foreign demand which resulted in large exports market share gains which cannot be explained by the evolution of the real exchange rate. The Portuguese success of the adjustment process has been partly attributed to the behavior of the exporting firms.

When compared with previous literature, there are two noticeable departures. Firstly, the empirical and testable relationship between exports and domestic sales is directly obtained from a monopolistic model of a firm selling to both domestic and external markets. It implies a non-linear relationship between exports and domestic demand that is not typically considered in empirical studies. Secondly, in order to deal with the heteroskedasticity problem which may affect the traditional log-linear approach, a fixed effects Poisson procedure is used.

The empirical findings confirm the shifting behavior from a weaker domestic market to stronger external markets by Portuguese firms during the latest economic and financial crisis. In particular, drawing on firm-level data for the Portuguese exporters for the period 2009–2016, we find a negative and statistically significant relationship between exports and domestic sales. One should note that the implied elasticities between exports and domestic demand and between exports and foreign demand are not constant across firms as it depends on the relative degree of exposure to the domestic and foreign markets. Naturally, firms' exports should not react to domestic market conditions if the firm does not sell in the home country whereas the reaction is expected to be larger if the scope for shifting is larger.

Based on a sectoral analysis, we also find that such a relationship holds for almost all industries within the manufacturing sector although the magnitude differs from industry to industry. Furthermore, there is evidence that the effect is stronger for larger firms.

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