The Portuguese Export Miracle during the Great Recession: Greater Productivity or Lower Markups?

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Abstract
This paper investigates the factors behind the remarkable export performance of Portuguese firms during the 2010–2014 sovereign debt crisis. Our hypothesis is that the domestic slump, which freed up production capacity, may have pushed producers to export. This survival-driven exports strategy, which is not caused by an increase in productivity level, was perhaps only possible by lowering the profit margin. Our results support the hypothesis of substitution between internal and external markets in times of crisis. The estimates of the intensive and extensive margin using static and dynamic models show that more productive firms tend to export more, which is consistent with the self-selection hypothesis. However, they also show that during the recession, firms seem to increase their exports by lowering markups. In order to utilise the capacity freed up by the domestic recession, exporting firms appear to have lowered their profit margins to increase their competitiveness in foreign markets, the vent-for-surplus hypothesis.
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1 Introduction

Paul Krugman called Portugal "a kind of economic miracle" in an interview with newspaper *Jornal de Negócios* (Ramos et al., 2023). The Great Recession of the late 2000s shook most of the world's economies. Few countries experienced the consequences of the global downturn as intensively as the peripheric Southern EU economies. In the Portuguese case, the real GDP decreased at an annual average rate of 1.6% from 2009 to 2013, with a peak in 2012, at -4.1%, after austerity measures implemented by the 2011 IMF-ECB-EU Troika's Memorandum of Understanding. The private consumption contracted by 1.2% per year during this period, and the unemployment rate more than doubled its pre-crisis level, from 7.6% to 17.1%, with youth unemployment reaching a worrying 38.3%.

Despite this severe domestic slump, exports demonstrated a remarkable resilience. After tumbling by 8.1% during the global trade collapse of 2009, Portuguese firms' exports quickly recovered and grew, on average, by 7.5% per year between 2010 and 2013. The export-to-GDP ratio shot up by 12.9 percentage points, from 27.3% in 2009 to 40.2% in 2013, which contrasts with its GDP share in the Euro Area, that plummeted.

The aim of this paper is to examine the causes of this remarkable export performance of Portuguese firms in the period 2010–2014.[1] In particular, using Portuguese firm-level data from the tradable sector, we analyse whether higher productivity or lower profit margins explain the export boom. Our main hypothesis is that the domestic economic downturn, which freed up production capacity, may have pushed producers to sell their products on foreign markets. This survival-driven exports strategy, which is not due to an increase in productivity level as postulated by the self-selection theory, was perhaps only possible by lowering the markup.

We contribute to the literature on the relationship between domestic demand and exports. At the macroeconomic level, Esteves and Rua (2015) found evidence of a negative relationship between exports and domestic demand for Portugal. An analysis at the firm level is useful for identifying the factors underlying the relationship between domestic demand and exports, which are usually not considered at the macroeconomic level. However, to our knowledge, few studies analysed the negative relationship between

[1] Portugal would be a "case study" today when looking back at the country's sovereign debt and banking crises between 2011 and 2014, said Krugman. It was a "bit of a mystery how things went so well".

domestic slump and export sales at microeconomic level (Berman et al., 2015; Bugamelli et al., 2015; Almunia et al., 2021; Esteves et al., 2022). Moreover, only Almunia et al. (2021) and Esteves et al. (2022) explicitly analyse their explanatory factors, but none of them considered markup, a central determinant in our hypothesis.

The paper is organized as follows. Section 2 presents an overview of the literature on the relationship between domestic demand and exports. It also includes both a theoretical and empirical model. Section 3 describes the dataset and discusses the estimation strategy, while the main empirical results and their discussion are presented in Section 4. Section 5 concludes.

2 Theoretical framework

2.1 *Literature review*

At first glance, the remarkable performance of Portuguese exports does not seem to be compatible with the theoretical international trade literature. The neoclassical Heckscher-Ohlin theory, which assumes stable differences in relative factor endowments, does not predict such a change in trade patterns. Vernon's (1966) product cycle theory could explain such a change for a particular market, but it is not able to explain such a turnaround for the economy as a whole.

The link between a domestic slump and export growth is also difficult to reconcile with Krugman's (1979, 1980) models of product differentiation and economies of scale, and with Melitz's (2003) model of firm-level productivity heterogeneity. On the contrary, these "new trade theory" models support a positive relationship between the domestic market and exports. Melitz (2003), for example, points out that the existence of fixed export costs induces only the more productive firms to enter the export market and to thrive—the most efficient firms increase both market shares. A positive correlation may also be due to "learning by doing", "learning by research", and "learning to export" effects which raise firms' productivity (Wiedersheim-Paul et al., 1978; Aw et al. 2007, 2011; Schmeiser, 2012; Eaton et al., 2021) or due to a "liquidity effect" when there is a liquidity constraint and the cash flow generated by exports or the additional access to external finance is used to finance domestic operations (Silva and Carreira, 2011; Chaney, 2016).

The relationship between exports and domestic sales is ambiguous both theoretically and empirically. The above mentioned "new trade theory" models assume that firms face constant marginal costs, which in turn implies that firms' decisions about their domestic and export sales are independent of each other—that is, demand shocks that affect firms' sales in one market have no effect on sales in other markets—, which seems quite unrealistic. There is evidence of a negative relationship between domestic and foreign markets, especially in times of internal crisis (Vannoorenberghe, 2012; Berman et al., 2015; Esteves and Rua, 2015; Esteves and Prades, 2018; Lucio et al, 2019; Almunia et al., 2021; Esteves et al., 2022). Bugamelli et al. (2015) point out that the sign of the relationship between exports and domestic sales depends on the phase of the economic cycle.

There is an emerging literature that emphasises the fact that the presence of capacity constraints or increasing marginal costs may generate a negative relationship between domestic slump and export sales (Vannoorenberghe, 2012; Blum et al., 2013; Ahn and McQuoid 2017). Once capacity utilisation falls below a certain threshold, the cost of operating excess capacity may exceed the incremental cost of exports. Furthermore, some firms can only produce above a certain minimum capacity utilisation rate or otherwise have to shut down their production completely. Shifting sales to foreign markets to utilise freed up production capacity could then be seen as "survival-driven" rather than a result of an increase in competitiveness (Belke et al., 2015; Almunia et al., 2021). Adam Smith called this the "vent-for-surplus".[2]

Increasing marginal costs are caused by production factors that are difficult (or costly) to adjust in the short-term—e.g., due to lengthy hiring procedures or overtime pay for labour (Belke et al., 2015). However, in times of economic crises, governments can adopt a plethora of economic policies that affect input costs, as was the case with the Portuguese government's labour market reforms during the European sovereign debt crisis. In this case, marginal costs can be expected to go down.

All in all, the negative domestic demand shock, which freed up production capacity, may have pushed producers to sell their products on foreign markets. This survival-driven exports strategy, which is not due to an increase in competitiveness as postulated by the self-selection hypothesis, was perhaps only possible by lowering the markup. We call this rationale the "vent-for-surplus" hypothesis.

[2] Adam Smith stated in The Wealth of Nations that "when the produce of any particular branch of industry exceeds what the demand of the country requires, the surplus must be sent abroad (…). Without such exportation, a part of the productive labour of the country must cease, and the value of its annual produce diminish." (Smith, 1776: Book II, Chapter V).

2.2 *The model*

The aim of the theoretical model is to analyse the effects of the collapse in domestic demand on export decisions. Accordingly, we abstract from the decision to enter or exit production. The model shares the long-run features of the dynamic models of exporting developed by Melitz (2003) and Aw et al. (2008; 2011).

We assume that each firm produces a single output that can be sold in both domestic (*D*) and export (*X*) markets. Both markets are supposed to be monopolistically competitive and segmented from each other. When a firm export it must pay a per period fixed cost f_X. When it exports for the first time it also must pay an entry sunk costs s_X.[3] Therefore, as in Melitz (2003) and Aw et al. (2008; 2011), the more productive firms will enter the export market, while less productive firms will continue to produce exclusively for the domestic market.

The demand curves faced by firm i in each market (q_{it}^j, with $j = D, X$) are assumed to have the Dixit-Stiglitz form:

$$q_{it}^j = \frac{Y_t^j}{P_t^j} z_{it}^j \left(\frac{p_{it}^j}{P_t^j}\right)^{-\eta_j} = D_t^j z_{it}^j \left(p_{it}^j\right)^{-\eta_j}, \tag{1}$$

where P_t^j and Y_t^j are the market price index and total market size, respectively. The firm *i*'s demand depends on the constant price elasticity of demand $\eta_j > 1$ (in absolute value), the common market aggregates (with $D_t^j = Y_t^j / \left(P_t^j\right)^{1+\eta_j}$), a firm-specific demand shock z_{it}^j and its price p_{it}^j. By including this last term, we incorporate an exogenous source of firm-level variation which will allow a firm's relative demands in the domestic and export markets to vary across firms and over time. The firm is assumed to observe D_t^j and z_{it}^j when making its input and output decision.

Using Equation (1), the firm *i*'s revenue on each market (r_{it}^j) can be expressed as:

$$r_{it}^j = \left(D_t^j z_{it}^j\right)^{\frac{1}{\eta_j}} \left(q_{it}^j\right)^{\frac{\eta_j - 1}{\eta_j}}. \tag{2}$$

Differentiating (2) with respect to q_{it}, yields the corresponding firm *i*'s marginal revenue:

$$mr_{it}^j = \frac{\eta_j - 1}{\eta_j} \left(\frac{D_t^j z_{it}^j}{q_{it}^j}\right)^{\frac{1}{\eta_j}}. \tag{3}$$

[3] Baldwin and Krugman (1989) and Roberts and Tybout (1997) suggested that the sunk costs, which can include expenses for market research, building distribution networks and adapting products to foreign standards, often deter many firms from starting export activities.

Suppose firm's short-run production function depends on fixed input capital k_i (with the corresponding capacity level of output given by $\bar{q}_{it}$), a composite variable input x_{it}—e.g., $x_{it} = l_{it}^{\beta} m_{it}^{\gamma}$, where l_{it} and m_{it} are labour and raw materials, respectively—, and a firm productivity a_{it} term à la Melitz (2003). In the short run, the cost of capacity (capital) is sunk. Assuming a constant returns to scale Cobb-Douglas technology, the cost-minimising problem is:

$$\min_{x_{it}} wx_{it} + \varphi k_i$$
$$s.t.\ q_{it} \leq a_{it} x_{it}^{\alpha} k_i^{1-\alpha}, \tag{4}$$

where w and φ are the input prices common to all firms, α is the output elasticity with respect to variable input (with $0 < \alpha < 1$). Thus, there are two sources of firm heterogeneity: capital stock, which is observable in our data, and productivity, which is observable by the firm when making its input and output decisions but is not observable in our data. Solving the constraint (3) for x_{it} at *efficient capacity (capital) utilisation*, we obtain:

$$x_{it} = k_i^{\frac{\alpha-1}{\alpha}} \left(\frac{q_{it}}{a_{it}}\right)^{\frac{1}{\alpha}}. \tag{5}$$

Substituting this into the objective function, we can then write firm *i*'s short-run cost function c_{it} as follows:

$$c_{it} = wk_i^{\frac{\alpha-1}{\alpha}} \left(\frac{q_{it}}{a_{it}}\right)^{\frac{1}{\alpha}} + \varphi k_i. \tag{6}$$

Differentiating the cost function with respect to q_{it}, we have firm *i*'s marginal cost:

$$mc_{it} = \frac{w}{\alpha} a_{it}^{-\frac{1}{\alpha}} \left(\frac{q_{it}}{k_i}\right)^{\frac{1-\alpha}{\alpha}}, \tag{7}$$

with $q_{it} = q_{it}^{D} + q_{it}^{X}$. Marginal cost varies with the firm's output level, which implies that demand shocks in one market affect the output decision in the other market, then the markets cannot be treated independently.

Given its revenue and cost functions, firm *i* chooses the output in each market to maximise the sum of domestic and export profits. The first-order condition for each market output q_{it}^{j} implies equating marginal revenue to marginal cost, which leads to the following optimal quantities $q_{it}^{D^*}$ and $q_{it}^{X^*}$—in the treatment below, to avoid complicating the notation and unnecessary additional mathematical complexity, we assume $\eta_D = \eta_X$:

$$\begin{cases} q_{it}^{D^*} = \left(\frac{\alpha(\eta-1)}{\eta w}\right)^{\frac{\eta\alpha}{\mu}} (D_t^D z_{it}^D)^{\frac{\alpha}{\mu}} (a_{it})^{\frac{\eta}{\mu}} (k_i)^{1-\frac{\alpha}{\mu}} \left(1 + \frac{D_t^X z_{it}^X}{D_t^D z_{it}^D}\right)^{\frac{\alpha}{\mu}-1} \\ q_{it}^{X^*} = \left(\frac{\alpha(\eta-1)}{\eta w}\right)^{\frac{\eta\alpha}{\mu}} (D_t^X z_{it}^X)^{\frac{\alpha}{\mu}} (a_{it})^{\frac{\eta}{\mu}} (k_i)^{1-\frac{\alpha}{\mu}} \left(1 + \frac{D_t^D z_{it}^D}{D_t^X z_{it}^X}\right)^{\frac{\alpha}{\mu}-1} , \end{cases} \tag{8}$$

with $\mu = \alpha + \eta(1-\alpha) > 1$ and $q_{it}^* = q_{it}^{D^*} + q_{it}^{X^*} = \bar{q}_{it}$. Therefore, the firm's output in each market depends on aggregate market conditions and firm-specific capital stock, productivity and demand shock. Furthermore, how much the firm wishes to sell in one market is dependent on how much it sells in the other market (note that $\frac{\alpha}{\mu} - 1 < 0$, thus $\partial q_{it}^j / \partial D_t^l < 0$, with $j \neq l$).

If the firm chooses to export, export revenue function is—substituting (8) into (2):

$$r_{it}^X = \left(\frac{\alpha(\eta-1)}{\eta w}\right)^{\frac{\eta}{\mu}-1} (D_t^X z_{it}^X)^{\frac{1}{\mu}} (a_{it})^{\frac{\eta-1}{\mu}} (k_i)^{1-\frac{1}{\mu}} \left(1 + \frac{D_t^D z_{it}^D}{D_t^X z_{it}^X}\right)^{\frac{1}{\mu}-1} . \tag{9}$$

Therefore, a negative shock in domestic market has a positive effect on export revenue ($\partial r_{it}^X / \partial D_t^D < 0$). However, it should be noted that the impact on total output is unknown ($\partial q_{it}^D / \partial D_t^D \lesseqgtr |\partial q_{it}^X / \partial D_t^D|$).[4]

So, what will be the firm's response to a slump in domestic demand? We will have to look at the new levels of output after domestic demand shock ($q_{it}^{D'}$ and $q_{it}^{X'}$) and their impact in average cost. Note that, the average cost function,

$$ac_{it} = w {a_{it}}^{-\frac{1}{\alpha}} \left(\frac{q_{it}}{k_i}\right)^{\frac{1-\alpha}{\alpha}} + \varphi \frac{k_i}{q_{it}}, \tag{10}$$

typically, first decreases then increases as q_{it} increases. *If the firm i is currently exporter*, after the drop in domestic demand, according to (8) and (9), the total output level will be q_{it}', with $q_{it}^{D'} < q_{it}^{D^*}$ and $q_{it}^{X'} > q_{it}^{X^*}$, and the export revenue will be $r_{it}^{X'} > r_{it}^{X^*}$. If $q_{it}' > \bar{q}_{it}$, the firm has a capacity constraint, thus, it will limit its sales in the domestic or/and foreign market. On the contrary, if the drop-in output is large and $ac_{it}(q_{it}) > mc(q_{it})$, it may be strategic for firm i to export more than $q_{it}^{X'}$ in order to increase its capacity utilisation. Since productivity a_{it} is fixed in the period, the only way to gain competitiveness in the foreign markets is to reduce the profit margin (i.e., $p_{it} - mc_{it}$; note that the average cost decreases as q_{it} increases)—the "vent-for-surplus" hypothesis.

[4] For the sake of simplicity, we only analyse a global demand shock (D_t^D). However, the shock may vary from firm to firm (z_{it}^D). This does not change the conclusions.

If the firm i is not currently an exporter, it has to decide what to do with the capacity freed up with the drop in domestic sales (i.e., $\bar{q}_{it} - q_{it}^{D'}$). The firm's decision to export involves a comparison of the expected profit from exporting $q_{it}^{X'}$ relative to remaining in the domestic market with the fixed costs and sunk costs of exporting, f_X and s_X. Thus, the export-market participation decision rule can be written as $e_{it} = I(\Delta\pi_{it}^X > 0)$, where $I(\cdot)$ is an indicator function—i.e., e_{it} is a dummy variable that equals one if firm *i* starts to export in year *t*—, with

$$\Delta\pi_{it}^X = r_{it}^{X'} - \int_{q_{it}^{D'}}^{q_{it}^{X'}} mc_{it}(q_{it})dq_{it} - f_X - s_X. \tag{11}$$

As in the standard Melitz's (2003) model, firms whose current productivity a_{it} is above a certain threshold have a positive marginal profit of exporting, so they are willing to start exporting. However, in this case of a collapse in domestic sales and the resulting excess capacity, some firms whose productivity is below the critical threshold may decide to reduce their profit margin to start exporting—again the "vent-for-surplus" hypothesis.

2.3 *Empirical model*

To test the "vent-for-surplus" hypothesis, according to which the domestic slump may have pushed producers to sell their products in foreign markets by freeing up production capacity, we will first focus on continuing exporters increasing their exports (i.e. intensive margin) and then on entering the export market (i.e. extensive margin).

2.3.1 *Intensive margin*

In the case of current exporters, taking logs, we can rewrite export revenue function (9) as:

$$\begin{aligned} \ln r_{it}^X = \left(\frac{\eta}{\mu} - 1\right)\ln\frac{\alpha(\eta-1)}{\eta w} + \frac{1}{\mu}\ln(D_t^X z_{it}^X) + \frac{\eta-1}{\mu}\ln a_{it} + \left(1 - \frac{1}{\mu}\right)\ln k_i \\ - \left(1 - \frac{1}{\mu}\right)\ln\left(1 + \frac{D_t^D z_{it}^D}{D_t^X z_{it}^X}\right). \end{aligned} \tag{12}$$

The Portuguese government has implemented several measures to reduce labour costs as part of the Memorandum of Understanding signed by the IMF, ECB and EU troika in 2011—the minimum wage was frozen from 2011 to 2014, the labour market was made more flexible, among others. This was seen as an economic competitive enhancer in a context of stickiness of the real exchange rate originated by a fixed exchange rate system and low inflation. Additionally, as domestic demand dropped, Portuguese firms may have cut their profit margins to gain competitiveness in foreign markets (the "vent-for-surplus" hypothesis). In this context, in the empirical model developed below, it is important to decompose the first term of Equation (10) into these two components, that is:

$$\left(\frac{\eta}{\mu}-1\right)\ln\frac{\alpha(\eta-1)}{\eta w}=\left(\frac{\eta}{\mu}-1\right)\ln\alpha-\left(\frac{\eta}{\mu}-1\right)\ln w+\left(\frac{\eta}{\mu}-1\right)\ln\left(1-\frac{1}{\eta}\right),$$

where $1/\eta=(p_{it}-mc_{it})/p_{it}$ represents the firm's Lerner index (L_{it}). As can be seen, the lower is the labour price/markup, the higher will be the export revenue (i.e., $\partial r_{it}^{X}/\partial w<0$ and $\partial r_{it}^{X}/\partial L_{it}<0$).

Foreign demand is not observable in our data. Since Portugal is a small open economy, firms take aggregate market conditions as given when determining their optimal output. We assume that the aggregate demand shifter D_t^X is constant in the short run. This allows us to proxy D_t^X with a market dummy variable, D^{X_j}, where j is the firm's market. The only difference is that the export demand shock z_{it}^X is not included explicitly but rather captured in the error term (ε_{it}).[5]

Then the stochastic version of Equation (12) can be written simply as (static model):

$$\begin{aligned}\ln r_{it}^{X}=\beta_0+\beta_1\ln L_{it}+\beta_2\ln a_{it}+\beta_3\ln D_t^{D}+\beta_4\ln z_{it}^{D}+\beta_5 D^{X_j}+\beta_6\ln k_i\\+\beta_7\ln w_{it}+\varepsilon_{it},\end{aligned}\tag{13}$$

with $\beta_0<0$, $\beta_1<0$, $\beta_2>0$, $\beta_3\leq 0$, $\beta_4\leq 0$, $\beta_5>0$, and $\beta_6>0$. The coefficient β_1 enables the test of the vent-for-surplus hypothesis, while β_2 supports the self-selection hypothesis. Furthermore, the coefficients β_3 and β_4 test the hypothesis of interrelated markets (independents, complements or substitutes). We relax the assumption of equal wages between firms and, as a consequence, $\beta_7\lesseqgtr 0$. Finally, given that the model is in log-log form, the parameters can be interpreted as elasticities.

To avoid having to repay the sunk costs of entering the foreign markets, exporters may not easily leave the export market (Roberts and Tybout, 1997; Das et al., 2007; Aw et al., 2011). This means that the firm's past export status is a state variable for the firm's export decision. Thus, to control for the effect of past exports and test the sunk cost hypothesis, the model (13) can be rewritten as fellows (dynamic model):

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[5] The market dummies D_t^X capture not only the aggregate demand, but also all other unobservable characteristics of the markets, such as market concentration, use of technology or firm-specific behaviour by industry. Alternatively, Berman et al. (2015) use product and destination information to estimate foreign demand addressed to the firm. However, in our empirical model, this methodology does not improve the efficiency of estimates.

$$\ln r_{it}^{X} = \beta_0 + \omega \ln r_{i(t-1)}^{X} + \beta_1 \ln L_{it} + \beta_2 \ln a_{it} + \beta_3 \ln D_t^{D} + \beta_4 \ln z_{it}^{D} + \beta_5 D^{X_j} + \beta_6 \ln k_i + \beta_7 \ln w_{it} + \varepsilon_{it}, \tag{14}$$

with $\omega > 0$ in the presence of sunk costs.

2.3.2 Ex*tensive margin*

The theoretical model specifies a firm's export decision as a binary choice. In particular, Equation (11) states that this decision depends on the same variables of the export revenue function. The model in reduced form can therefore be written as

$$e_{it}^{*} = \beta_0 + \beta_1 \ln L_{it} + \beta_2 \ln a_{it} + \beta_3 \ln D_t^{D} + \beta_4 \ln z_{it}^{D} + \beta_5 D^{X_j} + \beta_6 \ln k_i + \beta_7 \ln w_{it} + \varepsilon_{it}, \tag{15}$$

with $\Pr(e_{it} = 1) = \Pr(e_{it}^{*} > 0)$. The constant β_0 includes fixed costs and sunk costs of exporting. The expected values of the coefficients are similar to those in model (13). However, in times of domestic crisis, firms are more willing to pay both sunk and fixed export costs, therefore, β_2 can be not significant.

3 Data and empirical strategy

3.1 *The dataset*

The raw data used in this study was drawn from *Sistema de Contas Integradas das Empresas* (SCIE), a database administered by the Portuguese Statistical Office (INE) that covers the universe of Portuguese non-financial firms. Specifically, the sample used in this study covers all firms that operate in the manufacturing and service tradable sectors over the period 2010–2014—i.e., over the European budgetary crises period. Following Amador and Soares (2017), we define tradable sector as all manufacturing industries plus the ones exhibiting a ratio of exports-to-sales above 10% at the two-digit NACE Rev.2 level (Table A1 in the Appendix presents the list of the tradable industries). We also excluded from the sample micro-enterprises, that is, firms with less than 10 employees.[6] Our estimation dataset comprises a panel of 34,410 firms, making up 117,782 firm-year observations.

Table 1 provides a definition of the variables used in our analysis. The variables total factor productivity (TFP) and markup are not directly observable in our data. The (log) TFP was defined as the difference between the firms' output and the weighted sum

[6] In general, these firms do not have an exporter profile.

of inputs (capital, labour and materials). To compute the TFP, we estimated the factor elasticity parameters of a Cobb–Douglas production function (in log form) assumed in Equation (4) for each industry (NACE Rev.2 two-digit level) using the semiparametric method proposed by Levinsohn and Petrin (2003) and controlling for endogenous exit (Rovigatti and Mollis, 2018).[7] The TFP was normalised by the mean value of the industry.

The markup index was estimated using the micro-approach proposed by De Loecker (2011) at the NACE Rev.2 two-digit level.[8] This method links the production function, input shares and the price-cost margin, which is advantageous not only because it uses directly observable data, but also because it does not require information on demand (De Loecker and Warzynski, 2012).

Table 1 Description of the variables

Variable		Definition
r_{it}^X	Exports	Value of export of goods and services.
a_{it}	Productivity / TFP	Total factor productivity (TFP) estimated using the Levinsohn and Petrin (2003) method (in log deviation from the industry mean).
L_{it}	Markup	Markup index estimated using the micro-approach proposed by De Loecker and Warzynski (2012).
z_{it}^D	Domestic sales	Domestic firm's sales of goods and services.
w_{it}	Wage	Ratio of labour cost, which includes the sum of wages, social security contributions, and other labour costs, to the number of employees.
D_t^D	Domestic demand	Domestic (aggregate) demand index, which includes the private consumption, government current expenditure and gross capital formation (2010=1).
D^{X_j}	Foreign demand	Proxied by industry dummy variables (at two-digit NACE Rev.2 level).
q_{it}	Output	Value of gross production of goods and services, which includes sales of goods and services, adjusted for changes in inventory of final goods, self-consumption of own production and other operating revenues.
k_{it}	Capital	Capital stock computed by applying the perpetual inventory method to the change in total net assets.
l_{it}	Labour	Number of employees.
m_{it}	Materials	Cost of intermediate inputs, which includes raw materials purchases, energy and fuel costs and other paid services.

Notes: All variables are at the firm level, except domestic and foreign demand. The monetary variables are in constant 2004 euros and have been deflated using adequate price indices.

Table 2 provides the descriptive statistics of firm-level variables, broken down by export status: non-exporters and exporters; continuing exporters and export starters

[7] We used the "prodest" command of Stata software to compute the TFP (Rovigatti and Mollisi, 2020).

[8] We used the "markupest" command of Stata software to compute markup indices (Rovigatti, 2020).

(correlation matrix is given in Table A2 in the Appendix). On average, about 49% of all firms in tradable sector are exporters (i.e., they report positive exports). Furthermore, about 44% of all firms that report exports in at least two consecutive years (continuous exporters), while 5% of all firms that report exports in a given year do not reported exports in the previous year (export starters). As can be seen in Table 2, sales of exporting firms on the foreign markets are, on average, 3.2 million euros against 3.7 million euros on the domestic market. Note however that there is a large disparity between exporters, the standard deviation is ten times higher than the mean. Exporting firms pay higher wages than non-exporters and have lower markup—although De Loecker and Warzynski (2012) observed the opposite, Amador and Soares (2017) also found in the Portuguese case that markups are lower in the tradable sector than in the non-tradable sector. Conversely, exporters are on average less productive than non-exporters. One plausible explanation for this is that exporters, which have a higher production capacity than non-exporters (proxied by capital), may not fully utilise their production capacity in times of crisis and are therefore they are less efficient.

Table 2 Descriptive statistics by export status

Variable	All firms	Non-exporters	Exporters	Continuing exporters	New exporters
Exports	1,578		3,198	3,502	458
	(21,900)		(31,200)	(32,700)	(8,638)
Domestic sales	2,612	1,543	3,709	3,936	1,662
	(27,500)	(8,090)	(38,200)	(40,200)	(6,397)
TFP (normalised)	0.000	0.042	-0.043	-0.051	0.025
	(0.453)	(0.485)	(0.413)	(0.412)	(0.414)
Markup	0.750	0.879	0.617	0.605	0.724
	(0.820)	(0.965)	(0.611)	(0.602)	(0.678)
Wage	14.2	12.5	16.0	16.2	14.2
	(10.6)	(10.6)	(10.2)	(10,3)	(9.0)
Capital	7,889	6,431	9,386	9,923	4,557
	(98,700)	(108,000)	(88,500)	(92,200)	(41,400)
Number of observations	117,782	59,666	58,116	52,306	5,810

Notes: Means and standard deviations (in parentheses) of the firm-level variables used in models (13) and (14). See Table 1 for the definition of the variables. Monetary values are in 10^3 Euros. Column (1), ‘‘All firms’’, refers to pooled yearly values, 2010–2014. Columns (2) and (3) split the sample into firms that are observed to export at the current year (“Exporters”) and those that do not export (“Non-exporters”). Columns (4) and (5) include only observations from firms that export at least two consecutive years (“Continuing exporters”) and those that start to export (“New Exporters”).

3.2 *Estimation*

3.2.1 *Intensive margin*

We begin by estimating the effects of the explanatory variables on current exporters' decision to reduce or increase their export activity during the domestic recession. The static model (13) can be estimated using our firm-level panel data. Multicollinearity may be a potential problem. Therefore, we calculated the variance inflation factors (VIF) for the independent variables specified in the model.

We estimate Equation (13) using the fixed-effects panel data model because, first, the Breusch-Pagan test found the presence of individual effects—i.e., rejected the null hypothesis that the preferred model is the pooled ordinary least-squares (OLS) model—and second, the Hausman test rejected random effects in favour of the fixed-effects model—i.e., $\varepsilon_{it} = \upsilon_i + \nu_{it}$. Furthermore, after performing the modified Wald test for groupwise heteroscedasticity in the fixed-effects regression model, we concluded that robust estimation was required. Thus, we used the (Huber-White) sandwich estimator to calculate robust standard errors clustered at the firm level.

The inclusion of the lagged dependent variable as an explanatory variable in the dynamic model (14) leads to a correlation between this lagged variable and the fixed effects in the error term, resulting in biased estimates of the coefficient ω. To overcome this problem, Arellano and Bond (1991) propose a first-differenced Generalized Method of Moments estimator (Difference-GMM). By using the first difference of model (14), the firm-specific effects υ_i can be removed. However, $\Delta r_{i(t-1)}^{X} = r_{i(t-1)}^{X} - r_{i(t-2)}^{X}$ still remains potentially endogenous, as $r_{i(t-1)}^{X}$ is correlated with $\varepsilon_{i(t-1)}$. To obtain consistent estimates, Arellano and Bond (1991) then suggest using lagged levels of the dependent and independent variables as instruments.

Blundell and Bond (1998) point out that the Difference-GMM estimator is likely to perform poorly when the autoregressive process is highly persistent (i.e., a high value for ω) and the time dimension of the panel is short, as in our case. The reason is that under these conditions, the lagged levels of the variables are weak instruments for the subsequent first differences. Furthermore, the process of differencing to remove the firm-specific effects also eliminates information on the cross-firm variation in levels (Arellano and Bover, 1995). To solve this problem, Arellano and Bover (1995) and Blundell and Bond (1998) propose to estimate a system of two simultaneous equations, the equation in first differences and the equation in levels using the lagged differences of the variables as instruments (System-GMM).

We used two-step robust GMM estimates because they are asymptotically more efficient. Considering our theoretical model, the variables *Domestic demand*, *Capital* and industry dummies were treated as (weakly) exogenous, while the dependent variable and the other explanatory variables were treated as endogenous—the hypothesis was checked by the Difference-in-Hansen test of exogeneity of instrument subsets. Too many instruments is a well-known problem in dynamic GMM panel data. The validity of the instruments was checked by the Sargan and Hansen tests for overidentification restrictions. Finally, the consistency of the GMM estimator depends on there being no second-order serial correlation, which was checked using the Arellano-Bond test.[9]

3.2.2 Ex*tensive margin*

We estimate firms' discrete decisions to entry in the export sector during domestic crisis using a logistic regression model for binary panel data. The Pearson $\mathcal{X}^2$ goodness-of-fit test, which examines whether the observed and expected proportions differ significantly, indicates that our model (15) fits reasonably well. To address concerns about multicollinearity, we again relied on the VIF.

The Hausman test statistic was not significant, suggesting that the random effects model is a reasonable general framework for the new exporters' data. Furthermore, the pooled model and random-effects model have very similar both Akaike information criterion (AIC) and Bayesian information criterion (BIC)—i.e., there is a small difference between the AIC/BIC values—, indicating that they have similar fitting performance.

The coefficients (log-odds ratio) in the logit model have no meaning in themselves other than the direction and magnitude of the relationship. Therefore, we also estimated the marginal effects, that is, the change in the probability of a firm starting to export in response to a one-unit change in the covariate, holding all other variables constant. Specifically, we calculated the marginal effects at the mean of the covariates.

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[9] We used the "xtabond2" command of Stata software to run Difference-GMM and System GMM estimations (Roodman, 2009).

4 Empirical analyses

4.1 *Intensive margin*

Our primary analysis will focus on whether continuing exporters increasing their exports during the domestic recession. Table 3 presents the fixed-effects estimates of the empirical model (13)—OLS, between-effects and random-effects estimates are given in Table A3 in the Appendix. Column (1) refers to the entire sample of exporting firms-year ("Exporters"); column (2) to the sub-sample of exporting firms that are exporting in the current year and in the previous one ("Continuing exporters"); and column (3) to those firms with export-to-sales ratio above the median (21.7%) ("High-export firms").

Table 3 Intensive margin during domestic recession (static model)

Variable	Exporters (1)	Continuing exporters (2)	High-export firms (3)
TFP	1.152***	1.197***	1.162***
	(0.064)	(0.068)	(0.047)
Markup	-0.236***	-0.226***	-0.247***
	(0.020)	(0.020)	(0.012)
Domestic sales	-0.254***	-0.235***	-0.076***
	(0.012)	(0.012)	(0.005)
Domestic demand	-1.861***	-1.813***	-0.389***
	0.102)	(0.102)	(0.049)
Wage	0.195***	0.124***	0.086***
	(0.046)	(0.048)	(0.030)
Capital	0.940***	0.934***	0.841***
	(0.031)	(0.032)	(0.020)
No. of observations	54,207	48,739	26,069
No. of firms	17,370	15,423	8,943
F statistic	159.78***	153.53***	509.68***
R^2 (overall)	0.2925	0.3203	0.7288

Notes: Fixed-effects regression of static model (13). See Table 1 for the definition of the variables (all variables in logarithms). "Exporters" denotes firms that are observed to export. "Continuing exporters" denotes firms that export in at least two consecutive years. "High-export firms" denotes firms with export-to-sales ratio above the median. All regressions include two-digit NACE Rev.2 level dummies and constant term. F-statistic denotes the test statistic for the null hypothesis that all coefficients are equal to zero. Firm-cluster robust standard errors are given in parentheses. ***, **, * denote statistical significance at the 0.01, 0.05, and 0.10 levels, respectively.

As we can see in Table 3, both the coefficients of aggregate domestic demand and firm's domestic sales in the three regressions are statistically significant at the 0.01 level and different from zero, which confirms our theoretical assumption that the markets are interdependent. Furthermore, the signs are negative, which supports the hypothesis of substitution between internal and external markets in times of crisis. All other things being equal, for example, a 1 per cent decline in aggregate domestic demand increases foreign sales of continuing exporters by 1.81 per cent—we focus on the results of column (2). This effect is even greater if the decline in domestic demand is amplified by a negative shock to the firm's domestic sales (i.e., as expected $\beta_3 < 0$ and $\beta_4 < 0$). However, these two elasticities are much lower for firms with a high export intensity (column (3)), perhaps because they are less dependent on the domestic market or because they have capacity constraints, as we found in the results of the theoretical model—we should observe that the magnitudes of the remaining coefficients are comparable to those observed in the other regressions.

The productivity coefficient has a positive sign and is statistically significant at the 0.01 level. This confirms that firms with a TFP above the industry average tend to export more, which is consistent with the self-selection hypothesis ($\beta_2 > 0$). If the relative productivity of firms increases by 1 per cent, then exports increase by 1.20 per cent.

Portuguese firms seem to increase their exports through lower markups during the recession—a 1 per cent decrease in markups leads to a 0.23 per cent increase in exports (i.e., as expected $\beta_1 < 0$). To utilise the capacity freed up by the domestic recession, exporting firms have apparently lowered their profit margins to increase their competitiveness in foreign markets, the "vent-for-surplus" hypothesis. However, we cannot rule out the hypothesis that the low markups are due to a more intense competitive environment in foreign markets (Amador and Soares, 2017).

Finally, as expected, the greater the capacity (capital) of the exporting firm, the higher the export level. As far as the average wage is concerned, exporters that pay higher wages seem to have a competitive advantage, contrary to expectations. One explanation for this could be that high wages mean a high level of skills (i.e., wage is a proxy for human capital intensity), which in turn leads to higher product quality and thus to a competitive advantage abroad (Bernard et al., 1995).

The results from Difference-GMM and System GMM estimations of the dynamic model (14) are displayed in Table 4. The Arellano-Bond test of AR(1) corroborates that there is a serial correlation in all estimates. However, as the p-value of AR(2) shows, the serial correlation in the error terms is not second-order. The validity of the instruments is also confirmed, as shown by the p-values of the Sargan and Hansen tests. Accordingly, considering all test statistics we can conclude that the estimated models are adequately specified.

Table 4 Intensive margin during domestic recession (dynamic model)

Variable	Difference-GMM		System GMM	
	Continuing export. (1)	High-export firms (2)	Continuing export. (3)	High-export firms (4)
Lagged Exports	0.238***	0.505***	0.235***	0.457***
	(0.064)	(0.034)	(0.057)	(0.043)
TFP	1.998***	1.992***	1.999***	2.064***
	(0.377)	(0.358)	(0.333)	(0.479)
Markup	-0.640***	-0.857***	-0.587***	-0.746***
	(0.126)	(0.158)	(0.097)	(0.163)
Domestic sales	-0.461***	-0.379***	-0.450***	-0.660***
	(0.063)	(0.044)	(0.052)	(0.219)
Domestic demand	0.308	-0.126	0.285	0.340
	(0.276)	(0.224)	(0.250)	(0.364)
Wage	-0.201	0.840**	-0.236	0.772*
	(0.344)	(0.397)	(0.280)	(0.426)
Capital	0.884***	0.620***	0.969***	1.335***
	(0.114)	(0.135)	(0.239)	(0.260)
No. of observations	22424	12662	35479	18858
No. of firms	9308	5495	12735	7119
Wald test	242.30***	618.19***	832.06***	616.20***
No. of instruments	38	44	55	51
AR(1) (*p*-value)	0.000	0.000	0.000	0.000
AR(2) (*p*-value)	0.981	0.881	0.942	0.320
Sargan test (*p*-value)	0.968	0.912	0.297	0.013
Hansen test (*p*-value)	0.495	0.148	0.818	0.256

Notes: Difference-GMM and System GMM estimates of dynamic model (14). See notes to Table 3. All regressions include two-digit NACE Rev.2 level dummies. System GMM also include constant term. Wald test denotes the test statistic for the null hypothesis that all coefficients are equal to zero. Firm-cluster robust standard errors are given in parentheses. ***, **, * denote statistical significance at the 0.01, 0.05, and 0.10 levels, respectively.

The general pattern holds in the dynamic model. However, we should note that more than a general slump in domestic demand, continuing exporters respond to a negative shock in their own domestic sales, supporting the substitutability hypothesis in times of crisis. Additionally, the results show that the previous year's exports have a positive impact on the current year's exports—the coefficient of lagged exports is positive and statistically significant in all regressions—, corroborating the sunk cost hypothesis. The export persistence effect is higher for firms with a high export intensity.

4.2 *Extensive margin*

We will now analyse whether the non-exporters of the previous year start exporting in the current year because they are more productive, as postulated by the self-selection hypothesis, or because they reduce the markup, as suggested by the vent-for-surplus hypothesis. Table 5 shows the random-effects logit coefficients and the marginal effects of the empirical model (15)—pooled and population-averaged logit models estimates are given in Table A4 in the Appendix.

Table 5 Extensive margin during domestic recession

Variable	New exporters		Permanent new exporters	
	Coefficients (1)	Marginal effects (2)	Coefficients (3)	Marginal effects (4)
TFP	0.361***	0.034***	0.503***	0.035***
	(0.053)	(0.005)	(0.063)	(0.004)
Markup	-0.352***	-0.034***	-0.402***	-0.028***
	(0.020)	(0.002)	(0.024)	(0.002)
Domestic sales	-0.368***	-0.035***	-0.457***	-0.032***
	(0.025)	(0.002)	(0.031)	(0.002)
Domestic demand	-0.713*	-0.068*	-0.827*	-0.058*
	(0.390	(0.037)	(0.485)	(0.034)
Wage	0.407***	0.039***	0.464***	0.033***
	(0.045)	(0.004)	(0.056)	(0.004)
Capital	0.332***	0.032***	0.032***	0.029***
	(0.022)	(0.002)	(0.002)	(0.002)
No. of observations	47,959		46,284	
No. of firms	19,749		19,598	
Log pseudolikelihood	-15915.244		-12124.816	
Wald test	1962.70***		1506.05***	

Notes: Random-effects logit regression of static model (15). Marginal effects are evaluated at the mean value of covariates. “Permanent new exporters” denotes new exporters that export at least two consecutive years. All regressions include two-digit NACE Rev.2 level dummies and constant term. Wald test denotes the test statistic for the null hypothesis that all coefficients are equal to zero. Firm-cluster robust standard errors are given in parentheses. ***, **, * denote statistical significance at the 0.01, 0.05, and 0.10 levels, respectively.

The average probability of a firm venturing into foreign markets is 11.4 per cent. Most of the results predicted by the theoretical model are observed. In times of domestic crisis, firms seem to be more willing to pay the sunk costs of entering the foreign markets.

A marginal decrease in the domestic (macroeconomic) demand increases the estimated probability of the start to export by 6.8 percentage points (column (2) of Table 5). This effect can be 3.5 percentage points greater if the effect of the crisis has repercussions on the firm's domestic sales.

Firms with higher productivity levels and lower markups are more likely to become exporters. Specifically, at the average point, an increase in the TFP by 1 per cent raises the export probability by 3.4 percentage points, all else constant, a result that is favourable to the self-selection hypothesis. Furthermore, the likelihood of entering the export market increases also by 3.4 percentage points, if the markup decreases by 1 per cent, which is a rather confirmation of vent-for-surplus hypothesis.

Aw et al. (2008; 2011) emphasise a pre-export learning process in which firms invest in research and development (learning-to-export). We hypothesise that firms that strategically intend to become exporters (self-selection hypothesis), in contrast to firms that pursue a survival-driven export strategy (vent-for-surplus), tend to survive longer in foreign markets and are less impacted by the negative shock of domestic demand. To test this hypothesis, we re-estimated model (15) excluding sporadic exporters from the sample—we define sporadic exporters as firms that export for only one year (one-off exporters). The results can be found in columns (3) and (4) of Table 5.

As expected, the result shows a significant difference in the marginal effects between the two estimates (columns (2) and (4)). A decline in domestic demand increases the likelihood of being a permanent exporter by 5.8 percentage points, 1 percentage point less than in the whole sample. Furthermore, the marginal effects of domestic sales and markup are also smaller, 0.3 and 0.6 percentage points, respectively. Another notable fact is that while the marginal effect of productivity is only slightly higher for permanent exporters, the marginal effect for sporadic exporters is not statistically significant (result not shown).

5 Conclusion

An open question in the literature is which factors explain the negative relationship between exports and domestic demand. Our hypothesis is that the domestic slump, which freed up production capacity, may have pushed producers to export. This survival-driven exports strategy, which is not caused by an increase in productivity level, was perhaps only possible by lowering the profit margin. We used the Portuguese sovereign debt crisis between 2010 and 2014 to address this issue.

Based on a panel that covers all Portuguese firms from the tradable (manufacturing and services) sectors, our results support the hypothesis of substitution between internal and external markets in times of crisis. The intensive and extensive margin estimates, using static and dynamic models, show that more productive firms tend to export more, which is consistent with the self-selection hypothesis. However, they also show that during the recession, firms seem to increase their exports by lowering markups. In order to utilise the capacity freed up by the domestic recession, exporting firms appear to have lowered their profit margins to increase their competitiveness in foreign markets, the vent-for-surplus hypothesis.

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