International trade, organizational capital and interest rates

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Abstract

Do interest rates affect firm-level choices of internationalization? We answer this question through both theoretical modeling and empirical analysis. First, we develop a dynamic heterogeneous-firm trade model à la Melitz (2003) that incorporates two novel channels: (i) a temporal gap between export production costs and revenue realization, and (ii) a dynamic accumulation of organizational capital, which endogenously affects firm productivity. These mechanisms imply that higher interest rates reduce both firms' extensive and intensive margin of internationalization, the more so for firms with lower stocks of organizational capital. Second, we test these predictions using detailed panel data on nearly 100,000 Portuguese firms from 2006 to 2022. We construct firm-level measures of organizational capital using selling, general, and administrative expenses, and assess the impact of changes in monetary policy rates on exports through fixed-effects regressions and pseudo-Poisson maximum likelihood estimation. Our results confirm that organizational capital significantly mitigates the negative effect of interest rates on export performance. The findings underscore the policy relevance of fostering organizational capital as a buffer against adverse monetary shocks in open economies.

1 Introduction

The past few decades have been characterized by a remarkable expansion and evolution in global trade, with countries becoming increasingly integrated through their participation in global value chains, trade connections, and the presence of multinational enterprises. At the same time, following the global financial crises, central banks have actively intervened with monetary policies to stimulate growth and address deflationary and, more recently, inflationary pressures. In this context, our research question is to what extent the cost of capital faced by firms, influenced by monetary policies, impacts on their export performance.

Our contribution is twofold. We first develop a dynamic model of international trade with heterogeneous firms *à la* Melitz (2003) to study the interplay between interest rates and the export decisions of firms, on both the intensive and the extensive margin. The model highlights two channels through which the interest rate affects firms' exporting behavior. First, it incorporates the notion of a temporal discrepancy between the moment in which production costs are sustained and the time in which revenues from sales in foreign markets are collected, along the lines of Manova (2013) and Antràs (2023). Second, it introduces a dynamic process of accumulation of organizational capital (Prescott and Visscher (1980), Atkeson and Kehoe (2005)), which is driven by dedicated workers (managers) and is assumed to influence the (endogenous) firm's productivity. As a result, a change in the interest rate affects the firms' exporting choices in two ways: by altering the working capital needs associated with foreign market participation due to the temporal dimension of exporting activities, and by reshaping the firms' incentives to invest in organizational capital. Through these channels, the model predicts that a rise in the interest rate reduces the intensity of firms' exporting activities on both the extensive and intensive margin, the more so the lower is the stock of organizational capital that the firm is endowed with.

In the second part of our paper we verify empirically the predictions of the theoretical model, using a rich firm-level panel dataset obtained from the Central Balance Sheet - Harmonized Panel provided by the Bank of Portugal (Banco de Portugal, Microdata Research Laboratory (2023)), which contains information on exports and balance sheet characteristics for almost 100.000 Portuguese firms over the period 2006-2022. Following the empirical literature, we estimate firm-specific organizational capital using information on selling, general and administrative expenses (Eisfeldt and Papanikolaou, 2013). Adopting the methodology suggested by Félix et al. (2021), we build two alternative measures of organizational capital, focusing respectively on total fixed operating costs and on fixed labor costs, that we cumulate using the perpetual inventory method to obtain a stock measure, as in Eisfeldt and Papanikolaou (2013). In our baseline specification, we measure the impact of monetary policy on firm exports using as a reference the ECB key policy rates adjusted for Portugal's expected inflation, but we also verify that our results are confirmed using the average real interest rate on loans to Portuguese firms.

We estimate the impact of monetary policy and organizational capital on the extensive margin of trade using a linear probability model, while, for the intensive margin of trade, we use a pseudo-Poisson maximum likelihood model. All our specifications include firm-specific fixed effects and control for time-varying firm size, productivity and profitability. To control for the impact of aggregate macroeconomic conditions, we instead follow two alternative approaches. In our baseline specification, we introduce time fixed effects, which guarantee that the impact of any aggregate macroeconomic characteristic is perfectly controlled for, but do not allow to measure the direct impact of characteristics that do not vary across firms, including the monetary policy interest rates. In the robustness checks, we exclude time dummies and directly include a set of macroeconomic controls.

Our results provide full support to the predictions of the theoretical model. In particular, we find robust evidence that the impact of an increase in interest rates on both the extensive and the intensive margin of trade is smaller for firms that have a larger stock of organizational capital. In the specifications with explicit macroeconomic controls, we also verify that higher interest rates have a negative impact on firm internationalization, while the mitigating effect of organizational capital is confirmed. Results based on sample splits point to a degree of heterogeneity of the mitigation effect of organizational capital on the relation between export participation and interest rate variations, which depends on firm size and external finance dependence.

Our analysis has relevant policy implications, suggesting that incentives to the accumulation of organizational capital can help reducing the effect of exogenous shocks on export performance.

THE REST OF THE PAPER IS ORGANIZED AS FOLLOWS

2 The theoretical framework

We introduce organizational capital into a model of international trade with monopolistically competitive heterogeneous firms (Melitz (2003)). In our framework, the stock of organizational capital at each firm's disposal is accumulated by dedicated workers (that we call managers) and is assumed to raise its productivity. All active firms solve an intertemporal profit maximization problem to determine the number of workers they are willing to employ in manufacturing activities or in the process of accumulating organizational capital. In addition, in our model only firms involved in exporting activities are subject to an extra cost associated with a temporal discrepancy between the moment in which production costs are sustained and the time in which revenues from sales in foreign markets are collected.

2.1 Domestic market

Demand The economy is populated by a measure L of agents, whose individual preferences are represented by a CES utility function over a continuum of differentiated goods:

$$U = \left[\int_{\Omega} c(\omega)^{\frac{\sigma-1}{\sigma}} d\omega \right]^{\frac{\sigma}{\sigma-1}}, \tag{1}$$

where $\omega \in \Omega$ denotes a good variety, $c(\omega)$ is consumption of good ω, and $\sigma > 1$ is the elasticity of substitution between any two goods.

The individual demand for each variety ω is given by

$$c(\omega) = \left[\frac{p(\omega)}{P} \right]^{-\sigma} \frac{w}{P}, \tag{2}$$

where w is the wage rate, and P is the price index dual to (1), given by

$$P = \left[\int_{\Omega} p(\omega)^{1-\sigma} d\omega \right]^{\frac{1}{1-\sigma}}. \tag{3}$$

Technology The domestic production of variety ω, y_d, takes place according to the following technology:

$$y_d = \varphi \Lambda_d (l_d - f_d), \tag{4}$$

where φ is the stochastic productivity, whose cumulative distribution is denoted by $G(\varphi)$. l_d is labor employed in producing y_d, and f_d is the fixed production cost sustained to serve the domestic market. To ease notation, from now on we drop the variety index ω or the productivity index φ in all endogenous variables.

Λ_d, a measure of the contribution of organizational capital z_d to labor productivity, is a positive and concave function of the stock of organizational capital:

$$\Lambda_d = a z_d^{\psi}, \tag{5}$$

where $a \in R_+$ and $\psi \in (0,1)$ are two parameters.

Organizational capital is accumulated through a sort of "learning by doing" mechanism described as follows:[1]

$$\dot{z_d} = b n_d^{\varepsilon} - \delta z_d, \tag{6}$$

where n_d is the managerial labor involved in the continuous organizational process of the domestic activities of the firm, bn_d^{ε} is the gross investment in organizational capital, $\delta > 0$ is the (exogenous) rate of depreciation, ε is a parameter between 0 and 1 and $b \in R_+$.[2] We assume that managers receive the same wage as manufacturing workers. The idea is that managerial practices remain in the firm in terms of accumulated practical knowledge useful to solve organizational problems.

Firm's optimization problem Denoting by r the real interest rate, the intertemporal optimization problem of a single firm is

$$\max_{l_d, n_d, z_d} \int_0^{\infty} \pi_d e^{-\int_0^t r ds} dt, \tag{7}$$

subject to the accumulation of organizational capital (6), the production technology (4), the initial condition $z(0) = z_0$, and the definition of firm's profit:

$$\pi_d = p_d y_d - w\left(l_d + n_d\right). \tag{8}$$

The production of the firm is equal to total demand of a single variety, that is, $y_d = c_d L$. Using the individual demand function (2), the current-value Hamiltonian for the firm's maximization problem is

$$H = P^{\frac{\sigma-1}{\sigma}} (wL)^{\frac{1}{\sigma}} \left[\varphi \Lambda_d (l_d - f_d)\right]^{\frac{\sigma-1}{\sigma}} - w(l_d + n_d) + \lambda \left(b n_d^{\varepsilon} - \delta z_d\right), \tag{9}$$

where λ, the Lagrange multiplier associated with (6), measures the shadow value of organizational capital for a single firm.

The first-order conditions of this problem are

[1] See Nickell et al. (2001) for an analysis of new management practices and the reorganization of production methods adopted by firms during recessions.

[2] The gross investment in organizational capital could also depend on z_d. If such a function were linearly homogeneous in its arguments, the final result would be qualitatively unaffected.

$$p_d = \frac{\sigma}{\sigma - 1} \frac{w}{\varphi \Lambda_d}, \tag{10a}$$

$$\lambda b \varepsilon n_d^{\varepsilon - 1} = w, \tag{10b}$$

$$-\dot{\lambda} + \lambda(r + \delta) = \frac{\psi w}{z_d}(l_d - f_d). \tag{10c}$$

Steady state Since at the steady state $\dot{\lambda} = 0$ and $b n_d^{\varepsilon} = \delta z_d$, after using (10b), equation (10c) can be written as

$$n_d = \frac{\varepsilon \delta \psi}{r + \delta} \frac{y_d}{\varphi \Lambda_d}. \tag{11}$$

We normalize w to 1. Using (10a) and (11), after rearranging, we obtain:

$$\pi_d = \Gamma \frac{y_d}{\varphi \Lambda_d} - f_d, \tag{12}$$

where

$$\Gamma \equiv \frac{r + \delta - (\sigma - 1)\psi \varepsilon \delta}{(\sigma - 1)(r + \delta)}.$$

Using(10a), goods market clearing implies

$$y_d = \left(\frac{\sigma - 1}{\sigma}\right)^{\sigma} L P^{\sigma - 1} (\varphi \Lambda_d)^{\sigma}. \tag{13}$$

Substituting for (13) into (12), we obtain:

$$\pi_d = B (\varphi \Lambda_d)^{\sigma - 1} - f_d, \tag{14}$$

where:

$$B \equiv L P^{\sigma - 1} \Gamma \left(\frac{\sigma - 1}{\sigma}\right)^{\sigma}.$$

Plugging (13) into (11), we get

$$n_d = \frac{\varepsilon \delta \psi}{r + \delta} \left(\frac{\sigma - 1}{\sigma}\right)^{\sigma} L P^{\sigma - 1} (\varphi \Lambda_d)^{\sigma - 1}. \tag{15}$$

Recalling that in the steady state $n_d = \left(\frac{\delta}{b} z_d\right)^{1/\varepsilon}$ and $\Lambda_d = a z_d^{\psi}$, (15) can be written as

$$\left(\frac{\delta}{b} z_d\right)^{1/\varepsilon} = \frac{\varepsilon\delta\psi}{r+\delta} \left(\frac{\sigma-1}{\sigma}\right)^{\sigma} L P^{\sigma-1} (\varphi a z_d^{\psi})^{\sigma-1}, \tag{16}$$

which can be solved for z_d to obtain

$$z_d = \left[\frac{\Delta}{a} \varphi^{\frac{(\sigma-1)\varepsilon\psi}{1-(\sigma-1)\varepsilon\psi}}\right]^{1/\psi}, \tag{17}$$

where

$$\Delta \equiv \left[\left(\frac{b}{\delta}\right)^{\frac{1}{\varepsilon}} \frac{\psi\varepsilon\delta}{r+\delta} \left(\frac{\sigma-1}{\sigma}\right)^{\sigma} L P^{\sigma-1}\right]^{\frac{\varepsilon\psi}{1-(\sigma-1)\varepsilon\psi}} a^{\frac{1}{1-(\sigma-1)\varepsilon\psi}}.$$

Substituting (17) into (14), we can finally write the expression for domestic profits as

$$\pi_d = B \Delta^{\sigma-1} \varphi^{\frac{\sigma-1}{1-(\sigma-1)\varepsilon\psi}} - f_d. \tag{18}$$

Setting $\pi_d = 0$, the zero-cutoff-profit (ZCP_d) condition in the domestic market is obtained as

$$\underline{\varphi}_d^{\frac{\sigma-1}{1-(\sigma-1)\varepsilon\psi}} = \frac{f_d}{B\Delta^{\sigma-1}}. \tag{19}$$

2.2 Foreign market

Since collecting revenues from foreign markets takes time (Antràs (2023); Hummels and Schaur (2013)), while production costs are borne immediately, this temporal discrepancy is reflected, through the interest rate, in the expression for the profits from sales in the foreign market:

$$\pi_x = p_x y_x - e^{r\overline{s}} (l_x + n_x), \tag{20}$$

where p_x, y_x are the foreign market price and quantity, r is the real interest rate, $\overline{s}$ is the (exogenous) time interval between sustaining costs and collecting revenues, and the wage has been normalized to 1. Variables indexed by subscript x, instead of subscript d, refer to analogous variables for the export market.

Foreign production is obtained according to the following technology:

$$y_x = \frac{\varphi\Lambda_x}{\tau}(l_x - f_x),$$

where $\tau > 1$ is a parameter capturing iceberg variable trade costs. We suppose $f_x > f_d$. As Melitz (2003), we assume for simplicity that the world economy consists of identical countries. Under this symmetry assumption, wages in all countries are equal (and therefore can all be normalized to unity). Aggregate expenditures, revenues and the price index are also identical across countries.

Solving the firm's intertemporal optimization problem along the lines developed in Section 2.1, using the pricing rule – $p_x = \frac{\sigma}{\sigma-1}\frac{\tau}{\varphi\Lambda_x}e^{r\bar{s}}$ – and focusing on the stationary equilibrium, we can express the profit function in the foreign market as

$$\pi_x = e^{r\bar{s}}\left(\Gamma\frac{y_x\tau}{\varphi\Lambda_x} - f_x\right),$$

where Γ is given in (13).

Following the same steps as in Section 2.1, we get

$$\pi_x = e^{r\bar{s}}\left[B\Delta^{\sigma-1}e^{-\frac{\sigma r\bar{s}}{1-(\sigma-1)\varepsilon\psi}}\tau^{-\frac{(\sigma-1)}{1-(\sigma-1)\varepsilon\psi}}\varphi^{\frac{\sigma-1}{1-(\sigma-1)\varepsilon\psi}} - f_x\right].$$

Setting $\pi_x = 0$, the zero-cutoff-profit (ZCP_x) condition for the export market is obtained as

$$\underline{\varphi}_x^{\frac{\sigma-1}{1-(\sigma-1)\varepsilon\psi}} = \frac{f_x e^{\frac{\sigma r\bar{s}}{1-(\sigma-1)\varepsilon\psi}}\tau^{\frac{\sigma-1}{1-(\sigma-1)\varepsilon\psi}}}{B\Delta^{\sigma-1}}. \tag{21}$$

2.3 Equilibrium with international trade

The cutoff ratio can be written as

$$\left(\frac{\underline{\varphi}_x}{\underline{\varphi}_d}\right)^{\frac{\sigma-1}{1-(\sigma-1)\varepsilon\psi}} = \frac{f_x e^{\frac{\sigma r\bar{s}}{1-(\sigma-1)\varepsilon\psi}}\tau^{\frac{\sigma-1}{1-(\sigma-1)\varepsilon\psi}}}{f_d}. \tag{22}$$

Note that, under plausible parameter values, we find that $\underline{\varphi}_x > \underline{\varphi}_d$. The free entry condition for the domestic and for the exporting markets, according to which the entrant's ex-ante expected profits must be equal to the sunk cost f_e paid by all entrants (as in Melitz (2003)), is

$$\begin{aligned}&\int_{\underline{\varphi}_d}^{\infty}\left[B\Delta^{\sigma-1}\varphi^{\frac{\sigma-1}{1-(\sigma-1)\varepsilon\psi}} - f_d\right]dG(\varphi)+\\ &+\int_{\underline{\varphi}_x}^{\infty}\left[B\Delta^{\sigma-1}e^{-\frac{\sigma r\bar{s}}{1-(\sigma-1)\varepsilon\psi}}\tau^{-\frac{(\sigma-1)}{1-(\sigma-1)\varepsilon\psi}}\varphi^{\frac{\sigma-1}{1-(\sigma-1)\varepsilon\psi}} - f_x\right]dG(\varphi) = f_e.\end{aligned} \tag{23}$$

The system of equations (19), (21), (23) determines the triple $(\varphi_d, \varphi_x, P)$.

Trade equilibrium under Pareto distribution Now assume that the stochastic productivity follows a Pareto distribution, whose cumulative density is given by $G(\varphi) = 1-\varphi^{-\kappa}$, for $\varphi \geq 1$ and $\kappa > \Xi \equiv \frac{\sigma-1}{1-\varepsilon\psi(\sigma-1)} > 0$. Under the Pareto distribution hypothesis, the free-entry condition (23) can be expressed as

$$\underline{\varphi}_d^{-\kappa} + \frac{f_x}{f_d}\underline{\varphi}_x^{-\kappa} = \frac{f_e}{f_d}\frac{\kappa - \Xi}{\Xi}. \tag{24a}$$

Rewrite the cutoff ratio (22) as:

$$(\underline{\varphi}_x)^{-\kappa} = \left(\frac{f_x}{f_d}\right)^{-\frac{\kappa[1-\varepsilon\psi(\sigma-1)]}{\sigma-1}} e^{-\frac{\kappa\sigma r\bar{s}}{\sigma-1}}\tau^{-\kappa}(\underline{\varphi}_d)^{-\kappa}. \tag{24b}$$

The solution to the system of equations (24a)-(24b) gives the fraction of firms producing for the domestic and exporting market $(\underline{\varphi}_d^{-\kappa}, \underline{\varphi}_x^{-\kappa})$.

Denoting by M_x the mass of exporting firms and by $\hat{R}_x$ the firm's expected revenues, we can express the country's total exports (X) as

$$X = \underbrace{M_x}_{ext.margin} \times \underbrace{\hat{R}_x}_{int.margin}. \tag{25}$$

We now study these two components in order.

Mass of producing and exporting firms The mass of producing firms (M) is given by the mass of entering firms (M_e) times the probability of success:

$$M = M_e[1 - G(\underline{\varphi}_d)]. \tag{26}$$

The labor market clearing condition writes as

$$L = M\int_{\underline{\varphi}_d}^{\infty}\frac{l_d + n_d}{1-G(\underline{\varphi}_d)}dG(\varphi) + M_x\int_{\underline{\varphi}_x}^{\infty}\frac{l_x + n_x}{1-G(\underline{\varphi}_x)}dG(\varphi) + M_e f_e, \tag{27}$$

where M_x is the mass of exporting firms, which is given by

$$M_x = \int_{\underline{\varphi}_x}^{\infty}\frac{M}{1-G(\underline{\varphi}_d)}dG(\varphi) = M\frac{1-G(\underline{\varphi}_x)}{1-G(\underline{\varphi}_d)} < M. \tag{28}$$

Condition (27) can be rewritten as

$$L = M(l_d + n_d) + M_x(l_x + n_x) + M_e f_e. \tag{29}$$

Using the first-order conditions (10), the production function and the implied expression for profits, we obtain[3]

$$l_d + n_d = \frac{(r + \delta + \psi\varepsilon\delta)(\sigma - 1)}{r + \delta - (\sigma - 1)\psi\varepsilon\delta}\left[\frac{f_e}{1 - G(\underline{\varphi}_d)} + f_d\right] + f_d. \tag{30a}$$

Similarly, the expression for total labor in foreign markets is

$$l_x + n_x = \frac{(r + \delta + \psi\varepsilon\delta)(\sigma - 1)}{r + \delta - (\sigma - 1)\psi\varepsilon\delta}\left[\frac{f_e}{1 - G(\underline{\varphi}_x)} + f_x\right] + f_x. \tag{30b}$$

Substituting for (30a) and (30b) into (29), and solving by the mass of active firms M, we finally obtain:

$$M = \frac{[r + \delta - (\sigma - 1)\psi\varepsilon\delta]L}{\sigma(r + \delta)F^T}, \tag{31}$$

where F^T, representing the average fixed costs of active firms, can be expressed as

$$F^T = \frac{f_e}{1 - G(\underline{\varphi}_d)} + f_d + \frac{1 - G(\underline{\varphi}_x)}{1 - G(\underline{\varphi}_d)} f_x. \tag{32}$$

Notice that, under the Pareto distribution,

$$\frac{M_x}{M} = \frac{1 - G(\underline{\varphi}_x)}{1 - G(\underline{\varphi}_d)} = \left(\frac{\underline{\varphi}_x}{\underline{\varphi}_d}\right)^{-\kappa} = \left(\frac{f_x}{f_d}\right)^{-\frac{\kappa[1-\varepsilon\psi(\sigma-1)]}{\sigma-1}} e^{-\frac{\kappa\sigma r\bar{s}}{\sigma-1}}\tau^{-\kappa}. \tag{33}$$

where M_x/M is the fraction of the surviving firms that produce for the export market (extensive margin). We are now ready for the following

Proposition 1

The probability that a firm exports is negatively affected by the interest rate ($\frac{\partial(M_x/M)}{\partial r} < 0$); the magnitude of this effect is higher (in absolute value), the lower is the firm's level of organizational capital ($\frac{\partial^2(M_x/M)}{\partial r \partial n_x} > 0$).

Proof. See Appendix A. ■

[3]Analytical details are provided in appendix A.

Firms' revenues (intensive margin) Recall that expected profits from the foreign market can be expressed as

$$\hat{\pi}_x = f_x \int_{\underline{\varphi}_x}^{\infty} \left[\left(\frac{\varphi}{\underline{\varphi}_x} \right)^{\frac{\sigma-1}{1-(\sigma-1)\varepsilon\psi}} - 1 \right] dG(\varphi). \tag{34}$$

Since $\hat{\pi_x} = \hat{R}_x/\sigma - f_x$, where $\hat{R}_x$ denotes the expected firm's revenues from foreign markets, we get

$$\hat{R}_x = \sigma f_x \int_{\underline{\varphi}_x}^{\infty} \left(\frac{\varphi}{\underline{\varphi}_x} \right)^{\frac{\sigma-1}{1-(\sigma-1)\varepsilon\psi}} dG(\varphi). \tag{35}$$

We are now ready for the following

Proposition 2

Exports per firm are decreasing in the interest rate ($\frac{\partial \hat{R}_x}{\partial r} < 0$); the magnitude of this effect is higher (in absolute value), the lower is the firm's level of organizational capital ($\frac{\partial^2 \hat{R}_x}{\partial r \partial n_x} > 0$).

Proof. See Appendix A. ■

2.4 Asset (capital) market and the interest rate

The asset side of the economy is based on Caballero et al. (2008). Their model is used to obtain a constant steady state interest rate as done by Antràs (2023).

Suppose that in each instant of time the parametric birth rate of agents, θ, is equal to their death rate. Therefore, the size of population remains constant over time. Assume that agents receive a fixed endowment when born and save it until they die, when they consume their entire income.

The accumulation of financial wealth, W, can be described by the following equation

$$\dot{W} = (1-\mu)wL + rW - \theta W \tag{36}$$

where (1-μ)wL is the endowment received by the new born, an amount that is not capitalizable, rW the interest income from accumulated savings and θW is consumption, where the marginal propensity to consume wealth is equal to the death rate; μ is the fraction of the endowment received by the new born that is capitalized.

In the steady state, (36) becomes:

$$(\theta - r)W = (1-\mu)wL. \tag{37}$$

The resource constraint requires:

$$wL = \theta W. \tag{38}$$

Combining (37) with (38), we get:

$$r = \theta\mu. \tag{39}$$

Therefore, according to (39), the interest rate is parametrically determined by the birth/death rate and by the fraction of the endowment that can be capitalized.

3 Data description

This study adopts a dataset that combines two main data sources to capture both firm-level and macroeconomic dimensions, useful to conduct the empirical analysis.

Firm-level data are obtained from the Central Balance Sheet - Harmonized Panel (CBHP) data, provided by the Bank of Portugal.[4] The CBHP is a dataset constructed to provide longitudinal data concerning Portuguese non-financial firms, integrating several dimensions, such as general firm information, detailed economic and financial data extracted from balance sheets and profit and loss statements, employment details, trade information distinguished by destination markets (EU and non-EU), and records of corporate actions (Banco de Portugal, Microdata Research Laboratory, 2023). This dataset spans over the period 2006 – 2022 and is updated annually. The Bank of Portugal, in compiling and maintaining this dataset, ensures data comparability over time by adapting information to changes in national accounting standards.

The selection criteria adopted to construct the dataset for our empirical analysis ensure a comprehensive and representative sample of active Portuguese firms, excluding those that do not satisfy specific legal, economic, and financial conditions. Firms were selected based on their legal form, including exclusively public limited companies, limited partnerships, and private limited companies. Economic activity is used to exclude firms operating in financial and insurance activities, public administration and defense, compulsory social security, household activities, and extraterritorial organizations. Only firms that were in business

[4]For more details, see `https://msites-dee-bplim-prd.azurewebsites.net/content/central-balance-sheet-harmonized-panel-cbhp`

were retained, and a minimum threshold of five employees was established for firm selection. Additionally, firms with negative total expenses were excluded. The final dataset includes more than 98,900 Portuguese firms and about 660,000 observations.

The main dependent variable in this study is a dummy that identifies whether a firm is involved in exporting activities towards the EU and/or extra-EU markets, or it operates exclusively on the domestic market. Another variable captures the export intensity, that is the proportion of total sales obtained from exports.

Our main explanatory variable, organizational capital, is proxied using alternative indicators, providing a general view of firms' ability to improve its efficiency and productivity and to face international markets. The literature (e.g., Eisfeldt and Papanikolaou (2013)) usually adopts a measure of organizational capital based on selling, general and administrative expenses (SG&A). However, the balance sheet dataset used in this paper does not allow to adopt SG&A for Portuguese firms. For this reason, we follow Félix et al. (2021) in the measures adopted. The paper by Félix et al. (2021) analyzes the fixed operating costs of Portuguese firms using a risk management approach. Specifically, the authors consider costs to be fixed only if firms cannot reduce them easily within a short period and at a reasonable cost.

Félix et al. (2021) estimate an equation that separates the effect of current and past sales on operating costs, allowing the estimation of the impact of sales shocks on firms' cost structures. The key aspect of the analysis is the ability of firms to adjust their operating costs to changes in sales. If a firm's operating costs do not vary significantly in response to fluctuations in sales, it implies a higher proportion of fixed costs.

After predicting the operating costs, we applied the perpetual inventory method (Eisfeldt and Papanikolaou, 2013; Hasan et al., 2018), accumulating the deflated values (with a depreciation rate of 20%) of total expenses, which include the cost of goods sold, external services, employee expenses, depreciation, amortization, interest expenses, and income tax. An alternative measure focuses on labour costs, including the total salaries paid to employees, and again is constructed applying the perpetual inventory method. A third indicator considers intangible assets, obtained as the difference between total fixed tangible and intangible assets and fixed tangible assets, from the CBHP database.

Concerning macroeconomic variables, our main sources are the ECB and IMF data portal and the Eurostat database. To capture the effects of monetary policy variables on firm performance, three measures of real Portuguese interest rates, adjusted for expected inflation, are included in the analysis.[5] The first measure reflects the cost of traditional corporate borrowing, excluding revolving loans and overdrafts. The second measure incorporates the interest rate on revolving loans and overdrafts, representing the short-term liquidity costs. The third measure is a composite cost-of-borrowing indicator, providing a broader assessment of credit conditions.[6] Similarly, three key measures of ECB interest rates are included, again adjusted for Portugal's expected inflation. The deposit facility rate represents the interest banks receive for overnight deposits at the ECB. The main refinancing rate reflects the cost of weekly liquidity provision to banks against collateral. The marginal lending facility rate is the highest of the three, offering overnight credit. Both Portuguese and ECB interest rates allow an assessment of the impact of credit market and, in general, of monetary policy conditions on firm's exporting behaviour.

Control variables at the firm level include standard determinants of exports: (*i*) size, measured by the number of employees; (*ii*) return on assets (ROA), derived from operating net income relative to total assets; (*iii*) productivity, based on value added per employee; and (*iv*) firm age, measured as the number of years since its founding.

Macroeconomic controls include: (*i*) Portugal's annual real effective exchange rate, computed against 37 trading partners, using consumer price index deflators, to capture changes in international competitiveness, (*ii*) GDP at constant prices, and (*iii*) the unemployment rate.[7] Finally, industry-level controls account for total exports, computed at the two-digit CAE level from CBHP data.

In order to analyse firm heterogeneity, additional industry-level measures (at the two-digits CAE level) are considered, including financial vulnerability, assessed through asset tangibility (Manova, 2013), and external financial dependence measured through different approaches. One follows the seminal paper by Rajan and Zingales (1998), defining external financial dependence, for US industries, as the proportion of capital expenditures not covered by internal cash flow. This index assumes that industry-level financial dependence is a stable technological characteristic that remains constant over time and across countries. The measure is calculated using data from US firms in the 1980s. It has been widely used in empirical research to analyse financial development and economic growth. Kroszner et al. (2007) provided an alternative approach to measure external financial dependence, recog-

[5]Inflation projections are obtained from the IMF country and regional perspectives: https://www.imf.org/en/Publications/WEO

[6]For more details, see the section on loans to Euro-area non-financial corporation: https://data.ecb.europa.eu/publications/financial-markets-and-interest-rates/3030664

[7]For more details, see https://ec.europa.eu/eurostat/databrowser/view/ei_mfef_m/default/table?lang=en

nizing potential biases in the original Rajan and Zingales (1998) index. Instead of relying exclusively on US data, they constructed an external financial dependence index averaging external financial dependence across 18 non-crisis countries during the 1990s banking crisis. Financial dependence is calculated as the ratio of capital expenditure minus funds from operations to capital expenditure. A third measure, developed by Villani (2021), revises the original concept of Rajan and Zingales (1998) by replacing cash flow with corporate savings to capture firms' internal liquidity. This is a time-varying measure and is calculated for the G7 countries. We choose to adopt the measure obtained by Villani (2021) for the US, Germany and Italy, since Portugal does not belong to the G7.

4 Descriptive statistics

[TO BE COMPLETED]

5 The empirical model

The empirical analysis studies how interactions of measures of interest rates (either Portuguese or ECB) and firm indicators of organizational capital (total expenses, labour costs, intangibles) affect export activity, considering both the extensive margin and the intensive margin of trade. For the extensive margin, we adopt a linear probability model (LPM) estimated on a dichotomous dependent variables, accounting for the export status of the firm i at time t. For the intensive margin, we follow Silva and Tenreyro (2006) and use instead a Pseudo-Poisson Maximum Likelihood (PPML) estimator. In our baseline specifications, the impact of time-varying aggregate macroeconomic conditions on firm internationalization is perfectly controlled for through the inclusion of time fixed effects.

The model is specified as follows:

$$\begin{aligned} Export_{it} = \beta_0 + \beta_1 OrgK_{it} + \beta_2 (IntRate_{ct} \times OrgK_{it}) + \\ + \beta_3 X_{it} + \gamma_i + \eta_t + \varepsilon_{it} \end{aligned} \tag{40}$$

where: the dependent variable $Export_{it}$ is a dummy variable indicating whether the firm is an exporter in the version for the extensive margin of trade, and it is the share of revenues from exports in the case of the intensive margin; $OrgK_{it}$ is the stock of organizational capital of firm i at time t; $IntRate_{ct}$ is the interest rate on ECB's main refinancing operations, deflated using Portugal's inflation rate; X_{it} are firm-level time-varying characteristics (i.e. size, measured by the number of employees, age, ROA, and labour productivity, as described in Section 3); γ_i are firm fixed effects; η_t are time fixed effetcs and ε_{it} is mean-zero error term.

To test the empirical prediction that the international activities of firms with a larger stock of organizational capital are better protected from fluctuations in monetary policy interest rates, the key explanatory variable is the interaction between organizational capital and interest rates, $OrgK_{it} \times IntRate_{ct}$. Since we expect (and we will verify in the robustness checks) that an increase in monetary policy rates causes a drop in international activities, a positive coefficient β_2 would imply that the negative effect of a tightening of monetary policy rates is reduced by a larger endowment of organizational capital.

The inclusion of firm fixed effects, γ_i, allows us to control for unobserved heterogeneity specific to each firm, capturing time-invariant characteristics that may influence exports decisions. This approach reduces the risk of omitted variable bias: the inclusion of country and firm indicators permits us to control for factors that are unique to each country and firm. To account for potential correlation in the error terms within the same industry and year, we cluster standard errors at the sector-year level. This ensures robust inference by allowing for correlation of residuals within each sector-year combination, thereby addressing intra-group correlation and relaxing the requirement that the observations be independent within industry-time groups.

However, since the inclusion of time fixed effect does not allow to identify the direct impact of interest rates, in the robustness checks we also estimate a specification that does not include time dummies but includes instead a set of macroeconomic controls:

$$\begin{aligned} Export_{it} = \beta_0 + \beta_1 IntRate_{ct} + \beta_2 OrgK_{it} + \beta_3 (IntRate_{ct} \times OrgK_{it}) + \\ + \beta_4 X_{it} + \beta_5 T_{ct} + \gamma_i + \varepsilon_{it} \end{aligned} \tag{41}$$

where T_{ct} are time-varying macroeconomic variables affecting firm exports: the real effective exchange rate, GDP and the unemployment rate.

6 Baseline results

Table 1 presents the results of the estimation of Equation 40 on the extensive margin of trade. Column (1) presents the results obtained with the stock of organizational capital estimated using the total value of operating costs. Column (2) presents the results obtained with the alternative measure of organizational capital based on labour costs only.

Consistent with the predictions of our theoretical model, in both specifications the coefficient of the interaction term of organizational capital with monetary policy interest rates, β_2, is positive and statistically significant at the 1% level, with a value of 0.020 for the broader measure of organizational capital and of 0.011 for the measure based on labour costs.

This confirms that the export status of firms with a larger stock of organizational capital is less sensitive to fluctuations in monetary policy interest rates than that of firms with fewer organizational capital. Organizational capital, whose effect can be identified despite the inclusion of the time fixed effects thanks to its firm-level variability, also has a positive and statistically significant for both measures, as shown by the positive coefficients of, respectively, 0.083 for the broader measure and 0.054 for the alternative measure. It is worth recalling that these results are even more compelling considering that our specification includes firm fixed effects, and therefore the identification of firm-level characteristics is entirely made on the time dimension (i.e., our cell of analysis is the same firm through time).

Possibly due to the inclusion of firm fixed-effects, not all firm-level controls have a statistically significant impact on the extensive margin of trade. Indeed, we do find evidence confirming that larger, older and more productive firms are more likely to be exporters, but we do not find a statistically significant impact of profitability and of the aggregate level of export in the same sector of operation.

Table 2 mirrors Table 1, but focuses on the intensive margin. The results confirm on all dimensions the findings of the regression on the probability that a firm is an exporter. In particular, the positive and statistically significant coefficients of the interaction term of organizational capital and monetary policy interest rates – respectively 0.049 for the broad measure and 0.031 for the measure based on labour costs only – confirm the moderating effect of organizational capital on the negative impact that a rise of monetary policy rates has on the share of firm export revenues over total revenues. As for the extensive margin, larger, older and more productive firms have a larger share of export revenues, while profitability and the aggregate level of export in the same sector of operation have no statistically significant impact on firm-level performance.

7 Additional results

[TO BE COMPLETED]

8 Discussion and conclusions

[TO BE COMPLETED]

Table 1: Impact of monetary policy rates on extensive margin of trade

	(1)	(2)
Interest rate × organizational capital (total)	0.020***	
	(0.004)	
Interest rate × organizational capital (labour)		0.011***
		(0.002)
Organizational capital (total)	0.083***	
	(0.010)	
Organizational capital (labour)		0.054***
		(0.007)
Sector total exports (log)	-0.005	-0.006
	(0.009)	(0.009)
Firm employees (log)	0.066***	0.060***
	(0.006)	(0.006)
Firm ROA	0.021	0.025
	(0.017)	(0.017)
Firm age (years log)	0.012*	0.003
	(0.006)	(0.007)
Firm productivity (log)	0.005***	0.005***
	(0.001)	(0.001)
Observations	137,297	135,942
Adjusted R^2	0.659	0.658

Notes: Organizational capital is estimated using the procedure of Félix et al. (2021) based on total fixed operating costs (total) or fixed labour costs (labour); Interest rate is the interest rate on ECB's main refinancing operations deflated by expected inflation in Portugal. All other variables have customary definitions and are described in detail in Section 3. Standard errors clustered at the sector and year level are reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 2: Impact of monetary policy rates on intensive margin of trade

	(1)	(2)
Interest rate × organizational capital (total)	0.049***	
	(0.005)	
Interest rate × organizational capital (labour)		0.031***
		(0.003)
Organizational capital (total)	0.040***	
	(0.014)	
Organizational capital (labour)		0.053***
		(0.011)
Sector total exports (log)	-0.008	-0.010
	(0.011)	(0.011)
Firm employees (log)	0.111***	0.095***
	(0.009)	(0.010)
Firm ROA	0.027	0.032
	(0.031)	(0.031)
Firm age (years log)	0.053***	0.036***
	(0.012)	(0.013)
Firm productivity (log)	0.008***	0.007***
	(0.002)	(0.002)
Observations	105,540	104,306
Pseudo R^2	0.079	0.080

Notes: Organizational capital is estimated using the procedure of Félix et al. (2021) based on total fixed operating costs (total) or fixed labour costs (labour); Interest rate is the interest rate on ECB's main refinancing operations deflated by expected inflation in Portugal. All other variables have customary definitions and are described in detail in Section 3. Standard errors clustered at the sector and year level are reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

References

Antràs, P. (2023): "Interest Rates and World Trade: An "Austrian" Perspective," in *AEA Papers and Proceedings*, American Economic Association 2014 Broadway, Suite 305, Nashville, TN 37203, vol. 113, 65–69.

Atkeson, A. and P. J. Kehoe (2005): "Modeling and measuring organization capital," *Journal of political Economy*, 113, 1026–1053.

Banco de Portugal, Microdata Research Laboratory (2023): "Central Balance Sheet Harmonized Panel," Version V1, Extraction June 2023. Accessible at: 10.17900/CB.CBHP.Jun2023.V1.

Caballero, R. J., E. Farhi, and P.-O. Gourinchas (2008): "An equilibrium model of "global imbalances" and low interest rates," *American economic review*, 98, 358–393.

Eisfeldt, A. L. and D. Papanikolaou (2013): "Organization capital and the cross-section of expected returns," *The Journal of Finance*, 68, 1365–1406.

Félix, S., P. Moreira, and N. Silva (2021): "On the measurement of Portuguese firms' fixed operating costs," *Banco de Portugal Economic Studies*.

Hasan, M. M. et al. (2018): "Organization capital and firm life cycle," *Journal of corporate finance*, 48, 556–578.

Hummels, D. L. and G. Schaur (2013): "Time as a trade barrier," *American Economic Review*, 103, 2935–2959.

Kroszner, R. S., L. Laeven, and D. Klingebiel (2007): "Banking crises, financial dependence, and growth," *Journal of financial Economics*, 84, 187–228.

Manova, K. (2013): "Credit constraints, heterogeneous firms, and international trade," *Review of Economic Studies*, 80, 711–744.

Melitz, M. J. (2003): "The impact of trade on intra-industry reallocations and aggregate industry productivity," *Econometrica*, 71, 1695–1725.

Nickell, S., D. Nicolitsas, and M. Patterson (2001): "Does doing badly encourage management innovation?" *Oxford Bulletin of Economics and Statistics*, 63, 5–28.

Prescott, E. C. and M. Visscher (1980): "Organization capital," *Journal of political Economy*, 88, 446–461.

Rajan, R. and L. Zingales (1998): "Financial Dependence and Growth," *American Economic Review*, 88, 559–86.

Silva, J. S. and S. Tenreyro (2006): "The log of gravity," *The Review of Economics and statistics*, 641–658.

Villani, D. (2021): "Revisiting the external financial dependence index in light of the rise of corporate net lending: What do we really measure?" *Structural Change and Economic Dynamics*, 58, 361–376.

A Technical notes and proofs

We here derive an expression for $l_d + n_d$ given in (30a). As $l_d = \frac{y_d}{\varphi\Lambda_d} + f_d$ and $n_d = \frac{\psi\varepsilon\delta}{r+\delta}\frac{y_d}{\varphi\Lambda_d}$ then

$$l_d + n_d = \frac{y_d}{\varphi\Lambda_d}\frac{r+\delta+\psi\varepsilon\delta}{r+\delta} + f_d. \tag{42}$$

After using the pricing rule, the profit function can be expressed as

$$\pi_d = \frac{y_d}{\varphi\Lambda_d}\Gamma - f_d. \tag{43}$$

Combining the two previous equations, we obtain

$$l_d + n_d = \frac{(r+\delta+\psi\varepsilon\delta)(\sigma-1)}{r+\delta-(\sigma-1)\psi\varepsilon\delta}(\pi_d + f_d) + f_d. \tag{44}$$

Considering that the ex-ante expected profits of active firms (those whose productivity is above the cutoff) are given by

$$\pi_d = \frac{f_e}{1 - G(\underline{\varphi}_d)}, \tag{45}$$

we obtain (30a). Using the same procedure with exporting variables, we obtain (30b).

Proof of Proposition 1 Using the expression $l_x - f_x = \dfrac{r+\delta}{\psi\varepsilon\delta}n_x$ into (30b) and rearranging, we obtain

$$n_x = \frac{(\sigma-1)\psi\varepsilon\delta}{r+\delta-(\sigma-1)\psi\varepsilon\delta}\left[\frac{f_e}{1-G(\underline{\varphi}_x)} + f_x\right]. \tag{46}$$

After substituting (46) into (33) for $1 - G(\underline{\varphi}_x)$, using the above Pareto distribution and rearranging, we obtain

$$\frac{M_x}{M} = \frac{f_e}{\underline{\varphi}_d^{-\kappa}}\frac{(\sigma-1)\psi\varepsilon\delta}{\{n_x[r+\delta-(\sigma-1)\psi\varepsilon\delta] - f_x(\sigma-1)\psi\varepsilon\delta\}}. \tag{47}$$

The impact of the interest rate on the fraction of exporting firms is given

$$\frac{\partial\left(M_x/M\right)}{\partial r}=-\frac{M_x}{M}\left[\frac{1}{\underline{\varphi}_d^{-\kappa}}\underbrace{\frac{\partial\left(\underline{\varphi}_d^{-\kappa}\right)}{\partial r}}_{(+)}+\frac{n_x}{\{n_x[r+\delta-(\sigma-1)\psi\varepsilon\delta]-f_x(\sigma-1)\psi\varepsilon\delta\}}\right]<0. \tag{48a}$$

The effect of organizational capital (i.e., n_x) on the multiplier (48a) is

$$\frac{\partial^2\left(M_x/M\right)}{\partial r\partial n_x}=\frac{M_x}{M}\left\{\frac{f_x(\sigma-1)\psi\varepsilon\delta}{\{n_x[r+\delta-(\sigma-1)\psi\varepsilon\delta]-f_x(\sigma-1)\psi\varepsilon\delta\}^2}\right\}+$$
$$-\left[\frac{1}{\underline{\varphi}_d^{-\kappa}}\underbrace{\frac{\partial\left(\underline{\varphi}_d^{-\kappa}\right)}{\partial r}}_{(+)}+\frac{n_x}{\{n_x[r+\delta-(\sigma-1)\psi\varepsilon\delta]-f_x(\sigma-1)\psi\varepsilon\delta\}}\right]\frac{\partial\left(M_x/M\right)}{\partial r}>0. \tag{48b}$$

The extensive margin is negatively affected by the interest rate. However, this effect, when measured in absolute terms, diminishes as the level of organizational capital increases.

Proof of Proposition 2 As r increases, $\underline{\varphi}_x$ also increases, and thus the integral contained in (35), which is proportional to the intensive margin, goes down.

The role played by organizational capital for the effect of the interest rate on the intensive margin can be analyzed as follows. Considering the Pareto distribution for firm productivity φ as specified above, expected revenues of exporting firms can be expressed as

$$\hat{R}_x=\frac{\kappa}{\kappa-\Xi}\underline{\varphi}_x^{-\kappa}. \tag{49}$$

After using $G(\underline{\varphi}_x)=1-\underline{\varphi}_x^{-\kappa}$ in (46), the fraction of exporting firms becomes

$$\underline{\varphi}_x^{-\kappa}=\frac{f_e(\sigma-1)\psi\varepsilon\delta}{n_x[r+\delta-(\sigma-1)\psi\varepsilon\delta]-f_x(\sigma-1)\psi\varepsilon\delta}. \tag{50}$$

Substituting (50) into (49) we get

$$\hat{R}_x=\frac{\kappa f_e(\sigma-1)\psi\varepsilon\delta}{\kappa-\Xi}\frac{1}{[r+\delta-(\sigma-1)\psi\varepsilon\delta]n_x-f_x(\sigma-1)\psi\varepsilon\delta}. \tag{51}$$

The effect of an increase in the interest rate on expected revenues from exports, for a given value of organizational capital (i.e., managerial labor), is

$$\frac{\partial\hat{R}_x}{\partial r}=-\frac{\kappa f_e(\sigma-1)\psi\varepsilon\delta}{\kappa-\Xi}\frac{n_x}{\{[r+\delta-(\sigma-1)\psi\varepsilon\delta]n_x-f_x(\sigma-1)\psi\varepsilon\delta\}^2}<0. \tag{52a}$$

By taking the partial derivative of the multiplier (52a) with respect to n_x, we get

$$\frac{\partial^2 \hat{R}_x}{\partial r \partial n_x} = \frac{\kappa f_e(\sigma-1)\psi\varepsilon\delta}{\kappa - \Xi} \frac{\{[r+\delta-(\sigma-1)\psi\varepsilon\delta]n_x + f_x(\sigma-1)\psi\varepsilon\delta\}}{\{[r+\delta-(\sigma-1)\psi\varepsilon\delta]n_x - f_x(\sigma-1)\psi\varepsilon\delta\}^3} > 0. \tag{52b}$$

An increase in the interest rate reduces the intensive margin. The effect of an interest rate change on the intensive margin, when measured in absolute value, is smaller the greater the organizational capital. Therefore, exporting firms with more organizational capital are less exposed to the costs of an interest rate hike.