

# Financial Development and International Trade

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## ABSTRACT

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This paper studies the industry-level and aggregate implications of financial development on international trade. I set up a multi-industry general equilibrium model of international trade with heterogeneous firms subject to financial frictions. Industries differ in capital-intensity, which leads to differences in external finance dependence. The model is parameterized to match key features of firm-level data. Financial development leads to substantial reallocation of international trade shares from labor- to capital-intensive industries. At the aggregate-level, there are moderate effects under international financial integration, but negligible under international financial autarky. These findings are consistent with estimates from cross-country industry- and aggregate-level data.

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# 1 Introduction

International trade costs are large, particularly in developing countries. While recent studies have estimated large gains from reducing these costs, identifying specific policies that may allow poor countries to reduce them remains an important challenge.<sup>2</sup>

Recent papers suggest that the development of financial markets may be one such policy. For instance, Beck (2003) and Manova (2013) find that better financial markets lead industries with higher dependence on external finance to export relatively more. Similarly, Minetti and Zhu (2011) and Amiti and Weinstein (2011), among others, document strong links between measures of access to external finance and international trade at the firm level, suggesting that firms' export decisions are significantly distorted by financial frictions.<sup>3</sup> Furthermore, recent quantitative studies, such as Kohn, Leibovici, and Szkup (2016) and Gross and Verani (2013), find that financial frictions are a key driver of the dynamics of new exporters and, therefore, an important barrier to international trade.

Several features of international trade indeed make it a more finance-intensive activity than production for the domestic market. For instance, entering a foreign market typically involves a variety of upfront investments, such as market research, product customization, or the development of distribution networks (Baldwin and Krugman 1989, Dixit 1989). Limited access to external finance can prevent firms with low internal funds from undertaking such investments. Similarly, international trade transactions are typically subject to higher variable trade costs, due to shipping expenses, duties, or freight insurance. By lowering the profits from foreign sales, these costs reduce the extent to which firms can use them to overcome distortions on export decisions

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<sup>2</sup>Anderson and van Wincoop (2004) show that international trade costs are large in developing countries. Waugh (2010) estimates large welfare gains from reducing them to the level of rich countries.

<sup>3</sup>Hur, Raj, and Riyanto (2006) and Svaleryd and Vlachos (2005) report similar findings at the industry level, while Bellone, Musso, Nesta, and Schiavo (2010) and Berman and Hericourt (2010) document additional firm-level evidence. For a more exhaustive review of the empirical evidence, see Contessi and de Nicola (2013).

along the intensive margin.<sup>4</sup>

The goal of this paper is to investigate the industry-level and aggregate implications of financial development on international trade through the lens of a standard general equilibrium trade model with one key ingredient: frictions in financial markets. In particular, I study a multi-industry model that features firms heterogeneous in productivity and subject to financial frictions. Individuals endogenously choose whether to be workers or entrepreneurs, and entrepreneurs endogenously choose the industry in which to operate. Industries differ in capital-intensity, which leads to differences in their dependence on external finance. International trade is subject to export entry costs, fixed export costs, and variable trade costs.<sup>5</sup> I parameterize the model to match key features of firm-level data and use it to quantify the impact of financial frictions on international trade relative to production sold domestically.

Financial frictions reduce industry-level and aggregate trade shares through two channels. First, financial frictions distort the production decisions of exporters relative to non-exporters, reducing the share of output that is sold internationally. While financial frictions reduce the production scale of both exporters and non-exporters by limiting the capital that can be financed externally, exporters are distorted relatively more since they have a higher optimal scale: they face a larger market and are also typically more productive. Second, financial frictions distort export entry decisions, leading firms to delay export entry until sufficient internal funds are accumulated to make it a profitable investment. This reduces the share of firms that export and, thus, the share of output sold internationally.

To study the quantitative impact of financial frictions on international trade, I estimate the parameters of the model to match moments from Chilean firm-level data. In particular, I follow a Simulated Method of Moments (SMM)

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<sup>4</sup>Foley and Manova (2015) conduct a comprehensive survey of recent studies that investigate the channels through which financial frictions distort international trade decisions.

<sup>5</sup>International trade is modeled following Melitz (2003) and Chaney (2008), with the dynamic features of Alessandria and Choi (2014). Financial frictions are modeled following Midrigan and Xu (2014) and Buera and Moll (2015). The approach to modeling the interaction between financial frictions and international trade builds on earlier theoretical work by Chaney (2016) and Manova (2013).

approach to target moments of the data that are informative about firms' export decisions and the extent to which financial constraints distort production.

I use the parameterized economy as a laboratory to study the impact of financial frictions on international trade at the industry and aggregate levels. To do so, I contrast the stationary equilibrium of the estimated model with the stationary equilibria of economies featuring alternative levels of financial development. On the one hand, I contrast the estimated model to an economy without credit. On the other hand, I contrast it to an economy in which financial frictions are relaxed to resemble a financially developed economy.

I first study the effect of financial development on industry-level trade shares. I find that financial development has a heterogeneous impact across industries. In capital-intensive industries, highly dependent on external finance, relaxing the financial constraint increases the trade share since it allows more firms to finance the export entry investment and to increase their scale relative to non-exporters. In contrast, the trade share decreases in labor-intensive industries, with low dependence on external finance, since higher equilibrium factor prices offset the increased incentives to trade and expand production.

To contrast these findings with estimates from industry-level data, I construct an empirical counterpart to the model's quantitative implications. To do so, I use the model to derive an empirical specification that explains an industry's trade share in a given country and year as a function of the country's level of financial development, the industry's capital intensity, and the interaction between them. I estimate the empirical specification using the cross-country industry-level dataset from Manova (2013), with financial development measured as the ratio of aggregate credit to GDP. I extend this dataset to include a measure of industry-level capital intensity, which I compute using firm-level U.S. data from Compustat following the approach of Rajan and Zingales (1998). Finally, I use the estimated specification to compute the change of industry-level trade shares associated with a change in financial development of the same magnitude implied by the quantitative model.

The empirical estimates are qualitatively and quantitatively consistent with the industry-level implications of the model. While financial development is

associated with an increase of the trade share in capital-intensive industries, it is associated with a decrease of the trade share in labor-intensive ones. Moreover, I find that the trade share changes featured by the industries of the model account for more than 84.4% of the changes implied by their empirical counterpart.

I then study the impact of financial development on international trade at the aggregate level. In contrast to the strong relationship between trade and finance implied by the model at the industry level, I find that financial frictions lead to a moderate increase of the trade share at the aggregate level. The substantial reallocation of industry-level trade shares largely offset each other, implying that the change of the aggregate trade share is considerably lower.

Moreover, I find that the aggregate implications of the model depend significantly on the degree of international financial integration. While financial development leads to a moderate increase of the aggregate trade share in the baseline with internationally integrated financial markets, the aggregate trade share remains unchanged under international financial autarky. In this case, financial development leads to an increase in the real interest rate, reducing the incentives to trade internationally when the credit constraints are relaxed.

To contrast these findings with estimates from data at the country-level, I aggregate the cross-country industry-level dataset across industries. I use this data to examine the relationship between financial development and aggregate trade shares, and its dependence on the degree of international financial integration.<sup>6</sup> To do so, I estimate a specification analogous to the one estimated at the industry level, controlling additionally for the interaction between financial development and a measure of international financial integration. Consistent with the implications of the model, the empirical estimates imply that there is

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<sup>6</sup>Evidence on the relationship between trade and finance at the aggregate level has been elusive given the econometric challenge to interpret such estimates in a causal fashion. Amiti and Weinstein (2011) and Paravisini, Rappoport, Schnabl, and Wolfenzon (2015) overcome these difficulties by exploiting rich firm-level data that allow them to estimate the average response of trade-related outcomes across firms with differential exposure to banks affected by an aggregate shock.

a positive relationship between financial development and the aggregate trade share in economies with internationally integrated financial markets. However, as in the model, the estimates imply that there is no relationship between them under international financial autarky.<sup>7</sup>

This paper is closely related to previous empirical studies, such as Beck (2003) and Manova (2013), which investigate the relationship between financial development and the level of international trade flows across industries. In particular, these studies document that better financial markets lead to larger trade flows in finance-intensive industries. To the best of my knowledge, this is the first paper to document that such findings hide a qualitatively heterogeneous response of trade shares across industries: financial development is associated with higher trade shares in capital-intensive industries, but lower trade shares in labor-intensive ones.<sup>8</sup> Moreover, the quantitative implications of the model suggest that the strong reallocation observed in the data is, to a large extent, a causal response to the development of financial markets. My findings also show that this heterogeneity across industries is key for understanding the aggregate impact of financial development on international trade.

The paper is also related to a growing literature that studies the aggregate implications of financial frictions on international trade flows through the lens of equilibrium models. For instance, Wynne (2005), Matsuyama (2005), and Antras and Caballero (2009) study their qualitative impact on the pattern of comparative advantage. Brooks and DAVIS (2013) and Caggese and Cuñat (2013) investigate their quantitative impact on the gains from reducing trade barriers. My paper combines the quantitative approach of the latter with the multi-industry approach of the former to investigate the extent to which frictions in financial markets act as a barrier to international trade.

Finally, this paper is also broadly related to a literature that investigates

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<sup>7</sup>While Beck (2002) documents a strong link between trade and finance at the aggregate level, his measure of interest, the ratio of manufacturing exports to total GDP, is not directly comparable to the one I study: it captures the combined impact of financial development on the size of the manufacturing sector relative to total GDP and the manufacturing trade share.

<sup>8</sup>In the Online Appendix, I also investigate the impact of financial development on the level of international trade flows.

the role of domestic institutions as a barrier to trade. In particular, frictions in product markets, labor markets, and financial markets, among others, have been documented to distort the pattern of comparative advantage across countries, suggesting they may have important implications at the aggregate level — for a review of this literature, see Nunn (2014). My paper examines the extent to which this is the case for frictions in financial markets.

The paper is organized as follows. Section 2 presents the model. Section 3 discusses the channels through which financial frictions distort international trade flows. Section 4 presents the quantitative analysis. Section 5 contrasts the quantitative findings with estimates from the data. Section 6 concludes.

## 2 Model

The model consists of an economy populated by a unit measure of infinitely-lived individuals, as well as by final-good producers, sectoral-good producers, and the rest of the world. Individuals choose whether to be workers or entrepreneurs, and entrepreneurs choose the sector in which to operate. There are four types of goods in the economy: final goods, sectoral goods, imported goods, and domestic varieties. Final goods are produced by final-good producers and used by individuals for consumption and investment. Sectoral and imported goods are produced by sectoral-good producers and the rest of the world, respectively, and purchased by final-good producers. Finally, domestic varieties are produced by entrepreneurs and sold to sectoral-good producers and the rest of the world. Only domestic varieties and imported goods can be traded internationally.

### 2.1 Individuals

#### 2.1.1 Preferences

Individuals have preferences over streams of consumption of final goods, which are represented by the expected lifetime discounted sum of a constant relative risk-aversion period utility function. The utility function is given by  $\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \frac{c_t^{1-\gamma}}{1-\gamma}$ , where  $\gamma$  denotes the coefficient of relative risk aversion;  $\beta$  is the subjective discount factor; and  $\mathbb{E}_0$  denotes the expectation operator

taken over the idiosyncratic realization of productivity shocks described below, conditional on the information set in period zero.

### 2.1.2 Occupational choice

Every period individuals choose whether to be workers or entrepreneurs. Individuals that choose to be entrepreneurs then decide whether to operate a labor- or capital-intensive technology. Choosing the latter requires them to pay a fixed operation cost  $M$  denominated in units of labor; choosing to be a worker or a labor-intensive entrepreneur is costless.

I refer to the set of labor-intensive and capital-intensive entrepreneurs as sectors  $L$  and  $H$ , respectively; throughout the paper, I use the terms “sectors” and “industries” interchangeably.

### 2.1.3 Workers

Individuals that choose to be workers supply labor inelastically to entrepreneurs through a competitive labor market. They supply a unit of labor and are paid a wage rate  $w_t$ . Workers then allocate their labor income and stock of savings, between consumption and savings to carry over to the following period at a risk-free interest rate  $r$ ; workers cannot borrow.

### 2.1.4 Entrepreneurs

**Technology** Entrepreneurs produce a differentiated variety by operating a constant-returns-to-scale production technology  $y_t = z_t k_t^\alpha n_t^{1-\alpha}$ , where  $z_t$  denotes their idiosyncratic level of productivity;  $k_t$  is the capital stock;  $n_t$  is the amount of labor hired; and  $\alpha \in (0, 1)$  is the capital share. Labor-intensive entrepreneurs operate the production technology with a low capital share  $\alpha = \alpha_L$ , and capital-intensive entrepreneurs operate it with a high capital share  $\alpha = \alpha_H$ , where  $\alpha_L < \alpha_H$ .

Idiosyncratic productivity  $z_t$  is time-varying and follows an autoregressive process of degree one such that  $\ln z_t = (1 - \rho_z) \ln \mu_z + \rho_z \ln z_{t-1} + \varepsilon_t$ , where  $\varepsilon_t$  is a shock distributed Normal with mean zero and standard deviation  $\sigma_z$ .

Capital is accumulated internally by transforming final goods invested in period  $t$ ,  $x_t$ , into physical capital  $k_{t+1}$  in period  $t + 1$ . Capital depreciates at rate  $\delta$  after being used for production, leading to a law of motion for capital

that is given by  $k_{t+1} = (1 - \delta)k_t + x_t$ .

**International trade** Entrepreneurs can trade internationally. To export, they need to pay export entry costs as well as fixed export costs. Export entry costs  $S$  are only paid if entrepreneurs didn't export in the previous period; in contrast, fixed export costs  $F$  are paid every period. Both  $S$  and  $F$  are denominated in units of labor. Exporters are, moreover, subject to a per-period ad-valorem iceberg trade cost  $\tau > 1$ , which requires firms to ship  $\tau$  units of the good exported for every unit sold at destination.

**Financial markets** Entrepreneurs have access to an internationally integrated financial market, in which they can save or borrow from each other, from workers, and from the rest of the world by trading a one-period risk-free bond. The bond is denominated in units of the final good and trades at interest rate  $r$ .

Entrepreneurs can borrow but are subject to a borrowing constraint, which limits the amount borrowed to a fraction  $\theta$  of the value of the capital stock at the time that the loan is due for repayment. Thus, while entrepreneurs can trade this bond to save as much as they desire, they can borrow an amount  $d_{t+1}$  that is limited by the borrowing constraint  $p_{t+1}d_{t+1} \leq \theta p_{t+1}k_{t+1}$  and the natural borrowing limit, where  $p_{t+1}$  denotes the price of final goods.

**Market structure** Within a given sector, entrepreneurs compete with each other under monopolistic competition, and choose the quantities and prices for each market subject to their respective demand schedules. In the domestic market, the demand schedule is such that it solves its respective sectoral-good producer's problem, while the demand schedule faced in the international market is the rest of the world's. These demand schedules are described in detail below. Denote a given entrepreneur's quantities and prices in the domestic (or "home") market by  $y_{h,t}$  and  $p_{h,t}$ , and those corresponding to the rest of the world (or "foreign") by  $y_{f,t}$  and  $p_{f,t}$ , respectively.

### 2.1.5 Timing protocol

A period begins with a given partition of individuals between workers and entrepreneurs, and a given partition of the latter between labor- and capital-

intensive entrepreneurs.

Then, the timing of the decisions of individuals is as follows. Workers begin the period by supplying labor to entrepreneurs. Entrepreneurs begin the period by hiring labor, producing their differentiated domestic variety, and then selling it in each of the markets in which they choose to operate. If they decide to export, then they also pay the fixed and variable export costs as well as the export entry costs (if applicable).

After productive activities have taken place, individuals repay their debt from the previous period (or receive the savings from the previous period, with interest), and choose how to allocate the remaining resources between consumption and net worth,  $a_{t+1}$ , to carry over to the following period.

At the end of the period, they observe the following period's productivity shock and, then, choose their next period's occupation: worker, labor-intensive entrepreneur, or capital-intensive entrepreneur. Finally, entrepreneurs choose the composition of net worth between debt (or savings) and physical capital.<sup>9</sup>

### 2.1.6 Individuals' problem

Given this setup, the individuals' problem at time zero consists of choosing sequences of consumption  $c_t$ , net worth  $a_t$ , and occupation  $m_t \in \{W, L, H\}$ , in order to maximize their lifetime expected utility; where  $m_t = W$  if the individual chooses to be a worker,  $m_t = L$  if the individual chooses to be a labor-intensive entrepreneur, and  $m_t = H$  if the individual chooses to be a capital-intensive entrepreneur.

Workers make these choices subject to a sequence of period-by-period budget constraints given by  $p_t c_t + p_t a_{t+1} = w_t + (1+r)p_t a_t$ .

Entrepreneurs also choose investment  $x_t$ , whether or not to export  $e_t$ , and prices and quantities  $y_{h,t}, p_{h,t}, y_{f,t}, p_{f,t}$  at which to sell their differentiated variety in each of the markets. If they choose to export, then  $e_t = 1$ ; otherwise,  $e_t = 0$ . In addition to the borrowing constraint  $p_{t+1} d_{t+1} \leq \theta p_{t+1} k_{t+1}$  described

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<sup>9</sup>The assumption that capital accumulation and savings decisions are made after observing next period's productivity follows Midrigan and Xu (2014) and Buera and Moll (2015), among others. This assumption simplifies the numerical solution of the model by making the capital accumulation decision risk-free; see the Online Appendix for details.

above and the market-specific demand schedules that are described below, their choices are subject to a sequence of period-by-period budget constraints, laws of motion of capital  $k_{t+1} = (1 - \delta)k_t + x_t$ , and production technologies  $y_{h,t} + \tau y_{f,t} = z_t k_t^\alpha n_t^{1-\alpha}$ . Their budget constraints in period  $t$  are given by  $p_t a_t = p_t k_t - \frac{p_t d_t}{1+r}$  and  $p_t c_t + p_t a_{t+1} + p_t d_t + w_t S \mathbb{I}_{\{e_t=1, e_{t-1}=0\}} + w_t F \mathbb{I}_{\{e_t=1\}} + w_t M \mathbb{I}_{\{m_t=H\}} + w_t n_t = p_{h,t} y_{h,t} + p_{f,t} y_{f,t} + (1 - \delta) p_t k_t$ , where  $p_t$  denotes the price of the final good;  $w_t$  denotes the wage rate; and  $\mathbb{I}_{\{\cdot\}}$  is an indicator function that is equal to one if its argument is true and zero otherwise.

## 2.2 Rest of the world

The rest of the world demands domestic varieties from entrepreneurs (the domestic economy's exports) and supplies foreign varieties to final-good producers (the domestic economy's imports). The demand for varieties produced by entrepreneurs of either type is assumed to be given by a downward-sloping demand function with constant elasticity of substitution  $\sigma$ ,  $y_{f,t} = \left(\frac{p_{f,t}}{\bar{p}^*}\right)^{-\sigma} \bar{y}^*$ , where  $\bar{y}^*$  and  $\bar{p}^*$  are parameters that denote the aggregate absorption and its associated price index, respectively, in the rest of the world. The supply of varieties from the rest of the world is assumed to be perfectly elastic at price  $\bar{p}_M$ , which is set to be the numeraire good.

Domestic entrepreneurs also trade with the rest of the world in international financial markets, where they face a perfectly elastic supply (or demand) of funds at exogenous interest rate  $r$ .

## 2.3 Sectoral-good producers

In each sector  $j \in \{L, H\}$ , there is a unit measure of sectoral-good producers who purchase differentiated varieties from the entrepreneurs in sector  $j$ , and aggregate them to produce sectoral good  $j$ . To do so, they operate a constant elasticity of substitution (CES) technology, with elasticity of substitution  $\sigma > 1$ . Let the set  $[0, 1]$  index the unit measure of individuals in the economy, and let  $\mathcal{S}_{j,t} \subset [0, 1]$  denote the set of individuals that choose to be entrepreneurs in sector  $j$ . Given prices  $\{p_{h,t}(i)\}_{i \in \mathcal{S}_{j,t}}$  charged by entrepreneurs in sector  $j$ , producers of sectoral good  $j$  choose the bundle of inputs of domestic varieties from this sector,  $\{y_{h,t}(i)\}_{i \in \mathcal{S}_{j,t}}$ , that maximizes their profits.

Then, the problem of producers of sectoral good  $j$  is given by:

$$\begin{aligned} & \max_{y_{j,t}, \{y_{h,t}(i)\}_{i \in \mathcal{S}_{j,t}}} p_{j,t} y_{j,t} - \int_{i \in \mathcal{S}_{j,t}} p_{h,t}(i) y_{h,t}(i) di \\ \text{subject to } & y_{j,t} = \left[ \int_{i \in \mathcal{S}_{j,t}} y_{h,t}(i)^{\frac{\sigma-1}{\sigma}} di \right]^{\frac{\sigma}{\sigma-1}} \end{aligned}$$

where  $p_{j,t}$  and  $y_{j,t}$  denote the price and quantity of the sectoral good. Given prices  $\{p_{h,t}(i)\}_{i \in \mathcal{S}_{j,t}}$ , the quantity of each variety  $i \in \mathcal{S}_{j,t}$  demanded by sectoral-good producers is given by the demand functions  $y_{h,t}(i) = \left[ \frac{p_{h,t}(i)}{p_{j,t}} \right]^{-\sigma} y_{j,t}$ .

## 2.4 Final-good producers

A unit measure of final-good producers purchase labor- and capital-intensive sectoral goods as well as imported goods, and aggregate them to produce a final good. To do so, they operate a constant-returns-to-scale Cobb-Douglas production technology  $y_t = y_{L,t}^{\omega_L} y_{H,t}^{\omega_H} y_{M,t}^{\omega_M}$  such that  $\omega_L + \omega_H + \omega_M = 1$ ; where  $y_{L,t}$  and  $y_{H,t}$  denote the amount of labor- and capital-intensive sectoral goods used in production, respectively, while  $y_{M,t}$  denotes the amount of imported goods used to produce. Given prices  $p_{L,t}$ ,  $p_{H,t}$ , and  $p_{M,t}$  charged by sectoral-good producers and the rest of the world, final-good producers choose the bundle of sectoral and imported goods that maximizes their profits. Then, the problem of final-good producers is given by:

$$\begin{aligned} & \max_{y_t, y_{L,t}, y_{H,t}, y_{M,t}} p_t y_t - p_{L,t} y_{L,t} - p_{H,t} y_{H,t} - p_{M,t} y_{M,t} \\ \text{subject to } & y_t = y_{L,t}^{\omega_L} y_{H,t}^{\omega_H} y_{M,t}^{\omega_M} \end{aligned}$$

where  $p_t$  and  $y_t$  denote the price and quantity of the final good, respectively. The demand for sectoral good  $j$  by final-good producers implies that the demand schedule faced by entrepreneur  $i \in \mathcal{S}_{j,t}$  in sector  $j$  is given by  $y_{h,t}(i) = \left[ \frac{p_{h,t}(i)}{p_{j,t}} \right]^{-\sigma} \frac{\omega_j p_t y_t}{p_{j,t}}$ .

## 2.5 Individuals' problem: Recursive formulation

Consider an individual at the end of a given period, after the following period's productivity level is realized but before occupation decisions are made. Let  $g(a, e, z)$  denote the value function of this individual; with net worth  $a$ , export status  $e$  (equal to one if exported in the previous period, and zero otherwise), and productivity level  $z$ . The individual first chooses whether to be a worker, a labor-intensive entrepreneur, or a capital-intensive entrepreneur:

$$g(a, e, z) = \max_{m \in \{W, L, H\}} g_m(a, e, z)$$

where  $g_m(a, e, z)$  denotes the value function conditional on occupation  $m \in \{W, L, H\}$ . If the individual chooses to be a worker, this is given by:

$$\begin{aligned} g_W(a, e, z) &= \max_d v_W(d, z) \\ \text{subject to } pa &= -\frac{pd}{1+r} \end{aligned}$$

where  $v_W(d, z)$  denotes the value function of a worker that begins the period with debt level  $d$  (savings, if negative) and productivity level  $z$ . This value function is given by:

$$\begin{aligned} v_W(d, z) &= \max_{c, a'} \frac{c^{1-\gamma}}{1-\gamma} + \beta \mathbb{E}_{z'} [g(a', 0, z')] \\ \text{subject to } pc + pa' + pd &= w, \quad a' \geq 0 \end{aligned}$$

If the individual chooses to be an entrepreneur that operates technology  $j \in \{L, H\}$ , the value function is equal to:

$$\begin{aligned} g_j(a, e, z) &= \max_{k, d} v_j(k, d, e, z) \\ \text{subject to } pa &= pk - \frac{pd}{1+r}, \quad pd \leq \theta pk \end{aligned}$$

where  $v_j(k, d, e, z)$  denotes the value function of an entrepreneur that operates technology  $j \in \{L, H\}$ , and begins the period with capital stock  $k$ , debt level

$d$ , export status  $e$ , and productivity level  $z$ . This value function is given by:

$$v_j(k, d, e, z) = \max_{c, a', e', p_h, y_h, p_f, y_f} \frac{c^{1-\gamma}}{1-\gamma} + \beta \mathbb{E}_{z'} [g(a', e', z')]$$

subject to

$$\begin{aligned} pc + pa' + pd &= p_h y_h + p_f y_f \mathbb{I}_{\{e'=1\}} - wn - wM \mathbb{I}_{\{j=H\}} \\ &\quad - wF \mathbb{I}_{\{e'=1\}} - wS \mathbb{I}_{\{e=0, e'=1\}} + (1-\delta)pk, \\ y &= zk^{\alpha_j} n^{1-\alpha_j}, \quad y_h = \left(\frac{p_h}{p_j}\right)^{-\sigma} \frac{\omega_j p y}{p_j}, \quad y_f = \left(\frac{p_f}{\bar{p}^*}\right)^{-\sigma} \bar{y}^*, \quad a' \geq 0 \end{aligned}$$

## 2.6 Equilibrium

Let  $\mathcal{S} := \mathcal{A} \times \mathcal{E} \times \mathcal{Z}$  denote the individuals' state space, where  $\mathcal{A} = \mathbb{R}^+$ ,  $\mathcal{E} = \{0, 1\}$ , and  $\mathcal{Z} = \mathbb{R}^+$  denote the set of possible values of net worth, export status, and productivity, respectively. Finally, let  $s \in \mathcal{S}$  denote an element of the state space.

Then, a *recursive stationary competitive equilibrium* of this economy consists of prices, policy functions, value functions, and a measure  $\phi : \mathcal{S} \rightarrow [0, 1]$  over individuals' states such that:

1. Policy and value functions solve the individuals' problem
2. Policy functions solve the sectoral-good producers' problem
3. Policy functions solve the final-good producers' problem
4. Labor market clears:

$$\int_{\mathcal{S}} [n(s) + M \mathbb{I}_{\{m(s)=H\}} + S \mathbb{I}_{\{e=0, e'(s)=1\}} + F \mathbb{I}_{\{e'(s)=1\}}] \phi(s) ds = \int_{\mathcal{S}} \mathbb{I}_{\{m(s)=W\}} \phi(s) ds$$

5. Final-goods market clears:  $\int_{\mathcal{S}} [c(s) + x(s)] \phi(s) ds = y$
6. Measure  $\phi$  is stationary

### 3 Mechanism

I now investigate the channels through which financial frictions distort international trade flows in this economy. While recent studies have examined the extent to which financial frictions distort allocations in a closed economy (see, for instance, Buera, Kaboski, and Shin, 2011; and Midrigan and Xu, 2014), the degree to which international trade flows may be relatively more distorted than production for the domestic market is much less understood. Therefore, I restrict attention to the effect of financial frictions on industry-level and aggregate trade shares rather than on the level of trade.<sup>10</sup>

The ratio of aggregate exports to aggregate domestic sales, the aggregate trade share,<sup>11</sup> in this economy is given by:

$$\frac{\text{Exports}}{\text{Domestic sales}} = \frac{\omega_L}{\omega_L + \omega_H} \frac{X_L}{D_L} + \frac{\omega_H}{\omega_L + \omega_H} \frac{X_H}{D_H}$$

where  $D_j$  and  $X_j$  denote the level of domestic sales and exports, respectively, in industry  $j \in \{L, H\}$ .<sup>12</sup> Therefore, to understand the impact of financial frictions on the aggregate trade share, it is key to investigate their effect on industry-level trade shares,  $\frac{X_j}{D_j}$ .

The ratio of exports to domestic sales in industry  $j \in \{L, H\}$  is given by:

$$\frac{X_j}{D_j} = \frac{\bar{y}^*}{y_j} \times \left( \frac{\bar{p}^*}{p_j} \right)^\sigma \times \hat{\tau}_j^{1-\sigma}, \quad (1)$$

where  $\hat{\tau}_j$  is an endogenous object that captures the impact of trade costs on firms' decisions and the trade share; I refer to it as a trade wedge and describe it below in more detail. On the one hand, financial frictions affect the trade share by distorting sectoral quantities and prices: they increase the trade share by reducing the domestic demand for sectoral goods  $y_j$ , and have an ambiguous

<sup>10</sup>I examine the impact of financial frictions on the level of exports, real output, TFP, and welfare in the Online Appendix.

<sup>11</sup>While the ratio of exports to domestic sales is not literally the trade share, it is a monotonic function of it:  $X/D = (\frac{1}{X/Y} - 1)^{-1}$ , where  $X$ ,  $D$ , and  $Y$  denote exports, domestic sales, and total sales. Thus, I refer to them interchangeably.

<sup>12</sup>Where  $D_j = \int_{\mathcal{S}_j} p_h(s) y_h(s) \phi(s) ds$ ,  $X_j = \int_{\mathcal{S}_j} p_f(s) y_f(s) \phi(s) ds$ ,  $\mathcal{S}_j = \{s \in \mathcal{S} | m(s) = j\}$ .

impact on it by distorting domestic prices  $p_j$ .<sup>13</sup> On the other hand, financial frictions distort trade decisions, increasing the trade wedge and leading to a lower trade share. To the extent that the latter effect dominates the former, financial frictions reduce the ratio of exports to domestic sales.

Given that distortions to sectoral prices and quantities have already been examined in detail in previous studies, I focus on the determinants of trade-specific distortions. To do so, I study the forces that determine the trade wedge  $\hat{\tau}_j$ , for  $j \in \{L, H\}$ :

$$\hat{\tau}_j = \left( \frac{E_j}{S_j} \right)^{\frac{1}{1-\sigma}} \times \frac{\left[ \frac{\frac{1}{E_j} \int_{\mathcal{X}_j} \left[ z(s) \left( \frac{r+\delta}{r+\delta+\mu(s) \frac{1+r-\theta}{1+r}} \right)^{\alpha_j} \right]^{\sigma-1} \phi(s) ds}{\frac{1}{S_j} \int_{\mathcal{S}_j} \left[ z(s) \left( \frac{r+\delta}{r+\delta+\mu(s) \frac{1+r-\theta}{1+r}} \right)^{\alpha_j} \right]^{\sigma-1} \phi(s) ds} \right]^{\frac{1}{1-\sigma}}}{\left[ \frac{1}{S_j} \int_{\mathcal{S}_j} \left[ z(s) \left( \frac{r+\delta}{r+\delta+\mu(s) \frac{1+r-\theta}{1+r}} \right)^{\alpha_j} \right]^{\sigma-1} \phi(s) ds \right]^{\frac{1}{1-\sigma}}} \times \tau, \quad (2)$$

where  $\mu$  is the Lagrange multiplier on the entrepreneurs' borrowing constraint;  $\mathcal{X}_j$  is the set of firms that export in sector  $j$ ;  $E_j$  denotes the measure of exporters in sector  $j$ ; and  $S_j$  is the measure of entrepreneurs in sector  $j$ .<sup>14</sup>

The first term is given by the share of firms that export. As I discuss below, financial frictions reduce the share of firms that export, which leads to a higher trade wedge  $\hat{\tau}$  and a lower trade share. The second term measures the relative production scale between exporters in industry  $j$  and all entrepreneurs that operate in industry  $j$ .<sup>15</sup> While their optimal scale is increasing in productivity, their scale of production is decreasing in the magnitude of the Lagrange multipliers. Then, to the extent that financial frictions reduce the average scale of exporters (the numerator) relative to that of all firms that sell in the domestic market (the denominator), they increase the trade wedge  $\hat{\tau}$  and, thus, reduce the trade share. The last term consists of the variable trade cost  $\tau$  and is, thus, unaffected by the extent of financial development.<sup>16</sup>

<sup>13</sup>The impact of financial frictions on domestic prices depends on the response of firms' marginal costs to lower factor prices and capital misallocation.

<sup>14</sup> $\mathcal{X}_j$ ,  $E_j$ , and  $S_j$  are given by  $\mathcal{X}_j := \{s \in \mathcal{S}_j | e'(s) = 1\}$ ,  $E_j := \int_{\mathcal{S}_j} \mathbb{I}_{\{e'(s)=1\}} \phi(s) ds$ , and  $S_j := \int_{\mathcal{S}} \mathbb{I}_{\{m(s)=j\}} \phi(s) ds$ , respectively.

<sup>15</sup>Scale is measured as the average productivity across firms, with firm-level productivities adjusted by the extent to which the financial constraints bind.

<sup>16</sup>However, the impact of variable trade costs on equilibrium allocations does depend on

### 3.1 Financial frictions reduce relative scale of exporters

I now argue that financial frictions indeed reduce the scale of exporters relative to all firms that sell domestically, leading to an increase in the second term of Equation 2.

Financial frictions distort entrepreneurs' production decisions by reducing the scale at which they operate the firm. If  $\theta < 1 + r$ , entrepreneurs with net worth  $a$  cannot operate the firm with a capital stock higher than  $\frac{1+r}{1+r-\theta}a$ , leading firms to hold sub-optimal levels of capital.<sup>17</sup> In contrast, if  $\theta \geq 1 + r$ , firms can operate with a capital stock that is as high as desired, regardless of their net worth  $a$ . The left panel of Figure 1 illustrates the relationship between net worth  $a$  and the total amount of output produced by exporters and non-exporters, conditional on states  $(e, z)$  and industry  $j$ : the solid and dashed lines illustrate the case with  $\theta = 0$  and  $\theta = \infty$ , respectively, while keeping all aggregate prices and quantities fixed.

The impact of financial constraints on firms' production decisions depends on their net worth and desired scale of operation. In particular, productive firms that sell to multiple markets have a relatively higher optimal scale than unproductive ones that only sell domestically. Therefore, conditional on a given level of net worth  $a$  in a given industry  $j$ , the model implies that the financial constraint of the former is relatively more binding, as the gap between their effective and optimal scale of operation is relatively larger. The right panel of Figure 1 shows that, indeed, conditional on states  $(e, a, z)$  in industry  $j$ , exporters have higher Lagrange multipliers than non-exporters.

### 3.2 Financial frictions reduce the share of exporters

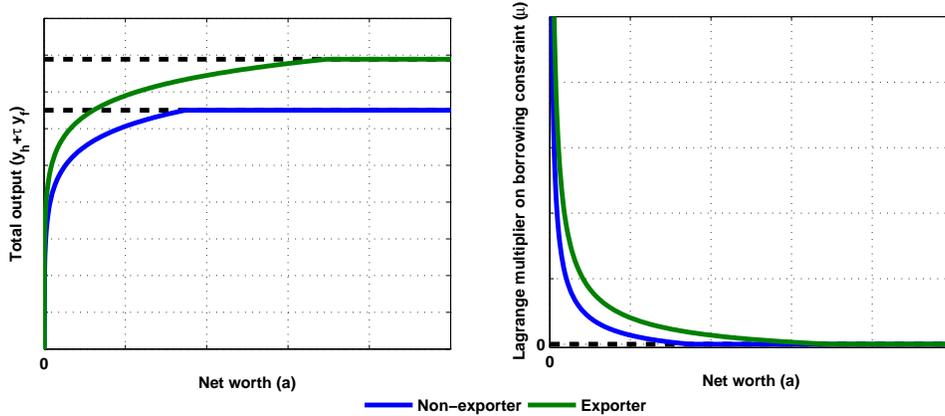
I now argue that financial frictions also reduce the share of firms that export, leading to an increase in the first term of Equation 2.

On the one hand, firms with sufficiently low net worth cannot afford to

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the degree of financial development: with financial frictions, higher variable trade costs reduce the extent to which firms can export to accumulate internal funds and overcome distortions on export decisions along the intensive margin.

<sup>17</sup>I focus on the reformulation of the individuals' problem derived in the Online Appendix, which separates dynamic from static decisions and also casts the problem with net worth  $a = k - \frac{d}{1+r}$  as an endogenous state variable in place of  $k$  and  $d$ .



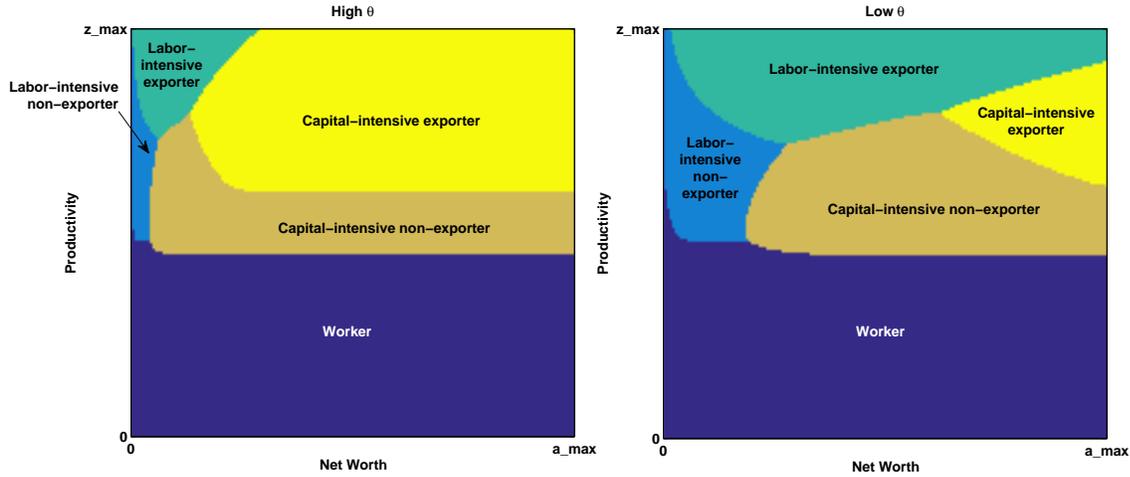
**Figure 1: Total output and Lagrange multipliers**

finance the sunk export entry cost using the external and internal funds available. On the other hand, the distortions to firms' production scale reduce the returns to exporting, leading firms with intermediate levels of net worth to avoid paying the entry and fixed export costs even if they can afford them. Thus, in either case, financial frictions induce productive firms with low net worth to avoid exporting, reducing the share of exporters.

To illustrate the impact of these forces on firms' decision to export, Figure 2 contrasts the optimal occupation and exporting decisions between economies at different levels of financial development: an environment with tight financial frictions (low  $\theta$ ), and one with developed financial markets (high  $\theta$ ; but lower than  $1+r$ , as in the quantitative analysis). To focus on the impact of financial frictions on export decisions, I keep all aggregate prices and quantities unchanged across the two economies.<sup>18</sup>

In both economies, productivity is an important determinant of the decision to be an entrepreneur and to export. However, in the economy with tight financial frictions these decisions are significantly more affected by the level of net worth. In particular, high-productivity but low-net-worth entrepreneurs

<sup>18</sup>To ease the exposition, I restrict attention to individuals that did not export in the previous period ( $e = 0$ ), and partition the rest of the state space according to their occupation-exporting choices.



**Figure 2: Occupation and Export Entry Decisions**

choose to export if they have access to developed financial markets but, instead, decide to only sell domestically if financial frictions are tight. Then, financial frictions reduce the share of firms that choose to export within a given industry.

But, as observed in Figure 2, financial frictions also distort the intensive and extensive margins of exports by affecting the individuals' choice between being a worker or an entrepreneur, and the entrepreneurs' choice between the labor- and capital-intensive technologies. Individuals only choose to be entrepreneurs, and entrepreneurs only choose the capital-intensive technology, if net worth is sufficiently high, since these choices require high levels of net worth to operate at a profitable scale. In the next section, I examine the overall impact of these additional channels by investigating the quantitative effect of financial frictions on international trade at the industry and aggregate levels.

## 4 Quantitative analysis

In this section, I quantify the extent to which financial frictions distort international trade flows in this economy. To do so, I begin by estimating the parameters of the model to match key features of firm-level data. I then use the estimated model as a laboratory to study the impact of financial frictions on international trade at the industry and aggregate levels. In Section 5, I

contrast my findings with estimates from the data.

## 4.1 Estimation

### 4.1.1 Data

I estimate the parameters of the model to match salient features of data from Chilean manufacturing firms over the period 1995 to 2007. The data were collected by the Chilean National Institute of Statistics (INE) as part of its Annual Census of Manufactures (ENIA). The census collects longitudinal data on all plants with more than ten workers and provides information on foreign and domestic sales, factor inputs, and other variables.<sup>19</sup> The dataset that I study contains information on 8,414 different firms over the 13-year period from 1995 to 2007, with 52,065 firm-year observations in total and 4,005 firms on average per year.

### 4.1.2 Parameterization

To choose the parameters of the model, I begin by partitioning the parameter space into two groups. The first group of parameters is set to standard values from the literature, as well as to values estimated directly from the data using analytical implications of the model. The second group of parameters is estimated simultaneously following a simulated method of moments (SMM) approach to match key features of Chilean manufacturing firms. The parameter values are presented in Table 1,<sup>20</sup> while the moments targeted and their model counterparts are presented in Table 2.<sup>21</sup>

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<sup>19</sup>I exclude firms with negative or missing sales in the domestic or foreign markets, as well as firms with zero or missing total sales. I also exclude observations from the following International Standard Industrial Classification (ISIC) rev. 3 categories given their large dependence on natural resource extraction: category 2720 (manufactures of basic precious and non-ferrous metals) and category 2411 (manufactures of basic chemicals except for fertilizers and nitrogen compounds). The quantitative results are robust to the inclusion of these industry categories.

<sup>20</sup>I report standard errors for the estimated parameters in the Online Appendix.

<sup>21</sup>The model is solved through value function iteration, as described in the Online Appendix. The idiosyncratic productivity process is approximated following Tauchen (1986). I use the stationary distribution of individuals, following the approach of Heer and Maussner (2005) described in the Online Appendix, to compute the statistics of the model that are only a function of the current period's state variables. I compute the rest of the moments by Monte Carlo simulation, as the average across 250 simulated panels of 40,000 individuals

The set of predetermined parameters consists of the preference parameters  $\gamma$  and  $\sigma$ , the depreciation rate  $\delta$ , the interest rate  $r$ , and the input shares in the production of final goods  $\omega_L$ ,  $\omega_H$ , and  $\omega_M$ . The coefficient of relative risk aversion  $\gamma$  is set to 2, which implies an intertemporal elasticity of substitution  $1/\gamma$  equal to 0.5. The elasticity of substitution across varieties  $\sigma$  is set to 4, and the rate of capital depreciation  $\delta$  is set to 0.06. These values are well within the range of values previously used in the literature to parameterize similar economic environments.<sup>22</sup> I set the interest rate to 5.54%, to match the average real interest rate in Chile over the period 1995-2007, as reported by the IMF's International Financial Statistics. The Cobb-Douglas technology of the final good producer implies that  $\omega_M = \frac{p_M y_M}{py}$ , so I choose  $\omega_M$  to equal the ratio of imported manufactures to manufacturing absorption in Chile over the period 1995-2007, which I compute from the OECD's input-output tables.

The set of estimated parameters consists of  $\beta$ ,  $\theta$ ,  $\alpha_L$ ,  $\alpha_H$ ,  $M$ ,  $\tau$ ,  $S$ ,  $F$ ,  $\sigma_z$ ,  $\rho_z$ , and  $\bar{y}^*$ . I estimate them simultaneously, following the simulated method of moments, to minimize the objective function  $MWM'$ , where  $W$  is a diagonal weighting matrix and  $M$  is a row vector whose elements are given by the log-difference between each target moment and its model counterpart.<sup>23</sup> I target the following statistics from Chilean firm-level data: (1) the ratio between the average sales at age five and the average sales at age one, among new firms that survive for at least five years; (2) the ratio of aggregate credit to aggregate value added; (3) the ratio between the aggregate capital stock and the aggregate wage bill; (4) the ratio between the average capital per worker across capital-intensive industries and the average capital per worker

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followed over 13 years; the baseline parameterization features approximately 4,000 firms per year on average.

<sup>22</sup>See Buera, Kaboski, and Shin (2011) and Midrigan and Xu (2014) for economic environments that use similar values of the coefficient of relative risk aversion and the rate of capital depreciation. The intertemporal elasticity of substitution falls within the range estimated by Guvenen (2006) and Blundell, Meghir, and Neves (1993), while the elasticity of substitution across varieties is in the range estimated by Broda and Weinstein (2006) and Simonovska and Waugh (2014).

<sup>23</sup>The weighting matrix allocates the same weight to each of the moments except to two key moments, which are assigned a higher weight: the ratio of aggregate credit to aggregate value added, and the ratio of aggregate exports to aggregate total sales.

**Table 1: Parameterization**

| <i>Predetermined parameters</i> |             |       |
|---------------------------------|-------------|-------|
| Risk aversion                   | $\gamma$    | 2     |
| Substitution elasticity         | $\sigma$    | 4     |
| Depreciation rate               | $\delta$    | 0.06  |
| Interest rate                   | $r$         | 0.055 |
| Share of imports in absorption  | $\omega_M$  | 0.304 |
| <i>Estimated parameters</i>     |             |       |
| Discount factor                 | $\beta$     | 0.904 |
| Borrowing constraint            | $\theta$    | 0.208 |
| Low capital share               | $\alpha_L$  | 0.134 |
| High capital share              | $\alpha_H$  | 0.660 |
| Capital-intensive fixed cost    | $M$         | 1.981 |
| Iceberg trade cost              | $\tau$      | 1.399 |
| Sunk export entry cost          | $S$         | 0.867 |
| Fixed export cost               | $F$         | 3.204 |
| Productivity dispersion         | $\sigma_z$  | 0.117 |
| Productivity persistence        | $\rho_z$    | 0.972 |
| Size of the rest of the world   | $\bar{y}^*$ | 2726  |

across labor-intensive industries; (5) the ratio between the average number of workers across capital-intensive industries and the average number of workers across labor-intensive industries; (6) the ratio of aggregate exports to aggregate total sales; (7) the share of firms that export; (8) the rate at which firms stop exporting, conditional on continuing to produce for the domestic market (the export exit rate); (9) the ratio between the average sales of exporters and the average sales of non-exporters; (10) the rate at which firms stop operating (the firms' exit rate);<sup>24</sup> and (11) the ratio between Chile's GDP and the rest of the world's. All target moments (1) – (10) are computed using the Chilean firm-level dataset described above. To compute (2), I also use the total stock of credit outstanding in the manufacturing sector, as reported by the Superintendencia de Bancos e Instituciones Financieras de Chile. To compute (11), I use data from the World Bank.

<sup>24</sup>In the model, I measure the firms' exit rate as the share of entrepreneurs in period  $t$  who become workers in period  $t + 1$ .

Moments (4) and (5) discipline the degree of heterogeneity featured by the industries in the model, by capturing capital-intensity and scale differences across industries in the data. To compute these moments, I first rank the industries in the data based on their capital-intensity.<sup>25</sup> To do so, I compute each firm’s average capital per worker (in constant 1995 prices), and compute each industry’s capital per worker as the median across all firms within the industry. Industries with capital per worker above the 90<sup>th</sup> percentile are defined as capital-intensive, while those below the 10<sup>th</sup> percentile are defined as labor-intensive.<sup>26</sup> In the model, I compare the capital per worker and number of workers between the two industries, where these industry-level statistics are computed as in the data. Given that I also target the aggregate ratio of capital to the wage bill, the model implies a realistic aggregate production technology while also featuring substantial heterogeneity in the technologies operated at the firm- and industry-level.

Finally, I assume that all differences across industries are technological and not driven by differences in demand. Then, I set  $\omega_L$  and  $\omega_H$  such that  $\omega_L = \omega_H$  and  $\omega_L + \omega_H + \omega_M = 1$ .<sup>27</sup> The remaining parameters are normalized: the price of imported goods  $p_M$ , the average level of productivity  $\mu_z$ , and the price level  $\bar{p}^*$  are all set to one.

I find that the model accounts reasonably well for the target moments, as well as for salient features of the dynamics and cross-sectional features of firms not targeted in the estimation; see the Online Appendix for details.

### 4.1.3 Identification

While all the estimated parameters simultaneously affect all the target moments, I now provide a heuristic argument to map the former to the latter.

The discount factor  $\beta$  determines the amount of net worth held by individuals when they become entrepreneurs, affecting the extent to which they are constrained upon entry and their growth thereafter. Similarly, the borrowing

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<sup>25</sup>I restrict attention to industries based on the ISIC rev. 2 industry classification to map the quantitative analysis of this section with the empirical analysis conducted in Section 5.

<sup>26</sup>The quantitative implications of the model are robust to parameterizations based on alternative classifications.

<sup>27</sup>I also implicitly assume that the demand from the rest of the world is not sector-specific.

**Table 2: Moments**

| <i>Moment</i>  | <i>Data</i> | <i>Model</i> |
|--|-------------|--------------|
| Average sales (age 5 / age 1)                            | 1.577       | 1.766        |
| Aggregate credit / Aggregate value added                 | 0.341       | 0.339        |
| Aggregate capital stock / Aggregate wage bill            | 4.713       | 4.575        |
| Capital per worker (capital-intensive/labor-intensive)   | 12.935      | 11.764       |
| Average # of workers (capital-intensive/labor-intensive) | 1.924       | 1.921        |
| Aggregate exports / Aggregate sales                      | 0.254       | 0.256        |
| Share of firms that export                               | 0.200       | 0.180        |
| Export exit rate   | 0.116       | 0.107        |
| Average sales (exporters/non-exporters)                  | 8.509       | 7.286        |
| Firms' exit rate   | 0.101       | 0.121        |
| GDP / World GDP  | 0.246%      | 0.246%       |

constraint parameter  $\theta$  determines the amount that firms borrow and, thus, the amount of credit in the economy.

The capital shares  $\alpha_L$  and  $\alpha_H$  affect the aggregate capital to wage-bill ratio as well as the relative capital per worker across industries. Given these technological differences, the fixed cost  $M$  to operate in the capital-intensive sector affects the relative scale of firms across industries.

The iceberg trade cost  $\tau$  and the size of the rest of the world  $\bar{y}^*$  play a key role in determining the aggregate ratio of exports to total sales as well as the size of the domestic economy relative to the rest of the world.<sup>28</sup> The sunk export entry cost  $S$  affects the export entry threshold and, thus, the share of firms that export; similarly, the fixed export cost  $F$  affects the export exit threshold and, thus, the rate at which firms stop exporting.

Finally, the dispersion  $\sigma_z$  and persistence  $\rho_z$  of idiosyncratic productivity determine the size of exporters relative to non-exporters as well as the firms' exit rate, respectively.

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<sup>28</sup>I interpret  $\tau$  broadly, as a residual that may capture channels not modeled explicitly which account for the amount of trade observed in the data. In particular, it may capture more than technological trade costs; for instance, it may also reflect unmodeled policy distortions or demand-side factors that affect international trade (Fieler 2011).

## 4.2 The experiment: Financial development

To study the impact of financial development on international trade flows, I contrast the stationary equilibrium allocations of the estimated model with those of two economies at different levels of financial development. In the first economy, I consider an environment in which firms have no access to external finance; to do so, I set  $\theta$  to zero, while keeping all other parameters unchanged. In the second economy, I set  $\theta$  to match the highest ratio of credit to value added observed in cross-country data, which I interpret as an economy with highly developed financial markets.<sup>29</sup> Specifically, I choose  $\theta$  to target Japan’s average ratio of private credit to value added, equal to 1.63, as reported by Manova (2013), based on data from 1985-1995. The value of  $\theta$  required to match this moment, while keeping all other parameters unchanged, is 0.756.

## 4.3 Industry-level implications

I first ask: to what extent do financial frictions affect the share of output traded internationally across industries that differ in their dependence on external finance?

I report the industry-level implications of the counterfactual experiment in Panel A of Table 3. The columns of the table report the equilibrium outcomes corresponding to the different economies under study. I label the economy with  $\theta = 0$  as “No credit,” the baseline model with  $\theta = 0.208$  as “Baseline,” and the economy with  $\theta = 0.756$  as “High credit.” The rows of this panel report equilibrium outcomes corresponding to each of the two types of entrepreneurs, or industries, in the economy.

I find that, as the financial constraint is relaxed, exports increase relative to domestic sales in the capital-intensive industry — the ratio between them increases from 0.31 in the economy without credit, to 0.84 in the high-credit environment. In contrast, I find that the ratio of exports to domestic sales decreases sharply in the labor-intensive industry — from 0.33 in the economy

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<sup>29</sup>While the frictionless benchmark is given by  $\theta = \infty$ , I restrict attention to degrees of financial development feasible to the most advanced economies of the world. Thus, I study the impact of improving financial markets to the level of developed economies, rather than to some abstract frictionless counterpart.

**Table 3: Financial development in the baseline model**

|                                       |                   | <i>No credit</i> | <i>Baseline</i> | <i>High credit</i> |
|---------------------------------------|-------------------|------------------|-----------------|--------------------|
| <i>A. Industry-level implications</i> |                   |                  |                 |                    |
| Exports                               | Labor-intensive   | 0.33             | 0.27            | 0.07               |
| Domestic sales                        | Capital-intensive | 0.31             | 0.41            | 0.84               |
| Share of                              | Labor-intensive   | 0.11             | 0.09            | 0.02               |
| exporters                             | Capital-intensive | 0.33             | 0.44            | 0.91               |
| <i>B. Aggregate implications</i>      |                   |                  |                 |                    |
| Agg. credit / Agg. value added        |                   | 0.00             | 0.34            | 1.63               |
| Agg. exports / Agg. domestic sales    |                   | 0.32             | 0.34            | 0.45               |
| Real wage ( $w/p$ )                   |                   | 0.96             | 1.00            | 1.16               |
| Real exchange rate ( $p^*/p$ )        |                   | 0.98             | 1.00            | 1.03               |
| Relative sectoral price ( $p_H/p_L$ ) |                   | 1.06             | 1.00            | 0.80               |

with no credit, to 0.07 in the economy with developed financial markets.

The response of industry-level trade shares to an increase in  $\theta$  depends on the relative magnitude of two opposing forces. On the one hand, financial development increases the amount that firms can borrow, allowing them to operate at a higher scale and to afford the export entry cost, thereby increasing the returns to exporting and the trade share. On the other hand, the higher scale of firms increases the demand for labor and, thus, the equilibrium wage (see Panel B of Table 3), reducing the returns to exporting and the trade share. Then, the overall effect of financial development on industry-level trade shares depends on the relative magnitude of these two opposing forces: to the extent that the former dominates, the trade share increases — and vice-versa.

Production decisions are relatively more distorted by financial frictions among firms in the capital-intensive industry, since they have a higher optimal capital stock. Thus, capital-intensive firms experience a relatively larger increase in the incentives to trade when financial markets develop. In contrast, the higher labor costs that result from financial development have a higher impact on the labor-intensive industry, given its higher use of labor in production. Therefore, firms in the capital-intensive industry experience a relatively larger net increase in the incentives to trade than labor-intensive producers, explaining the differential response of industry-level trade shares.

These findings show that financial development leads to a large reallocation of trade shares across industries. In Section 5, I study the extent to which these industry-level implications are quantitatively consistent with empirical estimates of these effects.

#### **4.4 Aggregate implications**

Next, I ask: to what extent do financial frictions affect the share of output that is traded internationally at the aggregate level?

To answer this question, I compute the aggregate trade share for each of the economies studied in the previous subsection. I report these results in Panel B of Table 3. As before, each column reports the equilibrium outcomes corresponding to the different economies.

On the one hand, as financial frictions are relaxed from the economy without credit to its financially-developed counterpart, firms increase the amount borrowed and the aggregate ratio of credit to value added increases sharply, from 0.00 to 1.63. On the other hand, financial development leads to a moderate increase in the aggregate trade share, from 0.32 to 0.45. With financial development, higher factor input prices partially offset the increased incentives to trade internationally that result from better access to external finance. Then, while financial frictions lead to a strong reallocation of industry-level trade flows, their impact on aggregate trade flows is considerably milder.

These findings also stand in contrast to the strong empirical relationship between trade and finance previously documented in the literature at the industry-level. While such evidence may suggest that financial frictions have a sizable impact on international trade flows at the aggregate level, my findings show that this is not necessarily the case.

#### **4.5 Role of international financial markets**

While the baseline economy is financially integrated with the rest of the world, economies with underdeveloped financial markets are, often, also closed to international financial integration. Therefore, I now ask: to what extent does the impact of financial development on international trade depend on the degree of international financial integration?

**Table 4: Financial development under financial autarky**

|                                       |                   | <i>No credit</i> | <i>Baseline</i> | <i>High credit</i> |
|---------------------------------------|-------------------|------------------|-----------------|--------------------|
| <i>A. Industry-level implications</i> |                   |                  |                 |                    |
| Exports                               | Labor-intensive   | 0.41             | 0.30            | 0.06               |
| Domestic sales                        | Capital-intensive | 0.47             | 0.58            | 0.82               |
| Share of                              | Labor-intensive   | 0.13             | 0.10            | 0.02               |
| exporters                             | Capital-intensive | 0.39             | 0.53            | 0.82               |
| <i>B. Aggregate implications</i>      |                   |                  |                 |                    |
| Agg. credit / Agg. value added        |                   | 0.02             | 0.48            | 1.63               |
| Agg. exports / Agg. domestic sales    |                   | 0.44             | 0.44            | 0.44               |
| Real wage ( $w/p$ )                   |                   | 0.96             | 1.00            | 1.13               |
| Real exchange rate ( $p^*/p$ )        |                   | 0.99             | 1.00            | 1.01               |
| Relative sectoral price ( $p_H/p_L$ ) |                   | 1.06             | 1.00            | 0.85               |
| Interest rate ( $r$ )                 |                   | -0.059           | 0.016           | 0.058              |

To answer this question, I focus on the extreme in which the economy operates under international financial autarky. In this environment, the value of the real interest rate is such that the domestic financial market clears.<sup>30</sup> Then, I recompute the experiment described in Section 4.2, keeping all parameters at the values estimated above; except for the value of  $\theta$  under financial development, which equals 0.777 to ensure that the ratio of credit to value added is 1.63.<sup>31</sup> The results are reported in Table 4.

In contrast to the economy under international financial integration, the interest rate now responds to changes in financial development. On the one hand, financial development leads to an increase in the demand for credit by entrepreneurs. On the other hand, the interest rate increases in order to clear the financial market: a higher interest rate increases the supply of savings, while reducing the increased demand for credit.

The increase of the real interest rate complements the impact of the wage on firms' production costs, further offsetting the increased incentives to trade internationally due to the looser financial constraints. At the industry-level, I

<sup>30</sup>The financial market clears if  $\int_{\mathcal{S}} d(s)\phi(s)ds = 0$ , where  $d = -(1+r)a$  for workers.

<sup>31</sup>I compute the results corresponding to the economy without credit under international financial autarky by setting  $\theta = 0.01$ . This ensures the existence of an equilibrium since, otherwise, workers have no counterpart that borrows their savings.

find that the trade shares experience a larger decline and a smaller increase in the labor- and capital-intensive industries, respectively. At the aggregate-level, I find that there is no change in the aggregate trade share.

Then, I find that there is a significant interaction between the development of financial markets and their integration with the rest of the world. To the extent that economies develop financially while isolated from international financial markets, the impact on trade may be significantly diminished. I contrast these findings with estimates from the data in Section 5.2.

## 4.6 Robustness

I now investigate the sensitivity of the quantitative results to alternative modeling assumptions. To ease the exposition, I abstract from some details about the estimation and their quantitative implications; see the Online Appendix for a more exhaustive presentation.

### 4.6.1 Model with multiple export destinations

First, I consider an economy where firms can choose the set of export destinations. I assume that firms have access to  $N$  export markets, indexed by  $i = 1, \dots, N$ . In each market, entrepreneurs face a destination-specific demand schedule  $y_{f,i} = \left(\frac{p_{f,i}}{\bar{p}_i^*}\right)^{-\sigma} \bar{y}_i^*$ , where  $\bar{y}_i^*$  and  $\bar{p}_i^*$  are exogenous parameters that denote the aggregate absorption and its associated price index in market  $i$ . While entrepreneurs need to pay a destination-independent sunk export entry cost  $S$  if they didn't export in the previous period, they are now subject to destination-specific fixed and variable export costs  $F_i$  and  $\tau_i$ . All fixed and sunk costs are denominated in units of labor.

This extension of the model introduces an additional extensive margin of adjustment: financial development may now lead continuing exporters to expand their exports by increasing the number of export destinations, a channel that is not present in the baseline model. To quantify the potential importance of this channel, I consider an economy with export destinations given by the different continents of the world. In particular, I set  $N = 4$  and explicitly model the entrepreneurs' decision to export to America, Europe, Asia-Oceania, and Africa. The extended model features 10 additional parameters, which I

discipline by targeting 10 additional destination-specific moments: (1) the ratio between aggregate exports to destination  $i$  and aggregate exports, (2) the share of exporters that export to destination  $i$ , and (3) the ratio between GDP and destination  $i$ 's GDP.<sup>32</sup> Moments (1) and (2) are targeted for America, Europe, and Asia-Oceania; moment (3) is targeted for all destinations.

I find that the industry-level and aggregate implications of the model are not significantly affected by allowing exporters to endogenously choose the set of export destinations served. As we move from the economy without credit to its financially developed counterpart, the trade share in the capital-intensive industry increases from 0.29 to 0.84 (0.31 to 0.84 in the baseline). In contrast, the trade share decreases from 0.35 to 0.06 in the labor-intensive industry (0.33 to 0.07 in the baseline). Finally, the aggregate trade share increases exactly as in the baseline, from 0.32 to 0.45.

#### 4.6.2 Model with working capital requirements

I also consider an extension of the model with entrepreneurs subject to working capital requirements: I assume that entrepreneurs need to pay all the firms' costs (fixed and sunk export costs, fixed operation costs, and labor costs) before production takes place and revenues are received.

This affects the timing of decisions: labor and export decisions are now made at the end of the previous period rather than in the same period in which production takes place. Specifically, after observing the following period's productivity shock and choosing next period's occupation, entrepreneurs now allocate their net worth  $a$  between physical capital  $k$ , labor  $n$ , export sunk and fixed costs, fixed operation costs, and debt  $d$  (or savings, if negative).

Given that external finance is now required to pay for additional production costs beyond capital, financial frictions may now distort international trade flows even more than in the baseline model. To quantify the potential importance of these additional distortions, I estimate the model following the same approach as in the baseline.<sup>33</sup> I find that the industry-level and aggregate implications of the model are not significantly affected by introducing work-

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<sup>32</sup>Destination  $i$ 's GDP is given by  $\bar{p}_i^* \bar{y}_i^*$ .

<sup>33</sup>This extension does not introduce additional parameters.

ing capital requirements. As we move from the economy without credit to its financially developed counterpart, the trade share in the capital-intensive industry increases from 0.29 to 0.85 (0.31 to 0.84 in the baseline). In contrast, the trade share decreases from 0.34 to 0.03 in the labor-intensive industry (0.33 to 0.07 in the baseline). Finally, the aggregate trade share increases from 0.31 to 0.44 (0.32 to 0.45 in the baseline).

## 5 Empirical evidence

In this section, I contrast the quantitative implications of the model with estimates from the data.

### 5.1 Industry-level estimates

I first ask: to what extent are the implications of the model consistent with the empirical relationship between financial development and international trade at the industry level?

To answer this question, I construct an empirical counterpart to the industry-level implications of the model. First, I use cross-country industry-level data to estimate the trade share of an industry in a given country and year as a function of two key variables: a measure of the country's level of financial development and its interaction with a measure of the industry's capital-intensity. Then, I use the estimated specification to compute the change in the trade share associated with a change in the level of financial development across industries with different degrees of capital-intensity. Finally, I contrast these empirical estimates with the implications of the model.

#### 5.1.1 Empirical specification

Equations (1) and (2) of the model imply that the trade share of an industry that operates a production technology with capital-intensity  $\alpha_j \in \{\alpha_L, \alpha_H\}$  in a given country can be expressed as:

$$\ln \frac{\text{Exports}_j}{\text{Domestic sales}_j} = \ln \left( \frac{\bar{p}^{1-\sigma} \bar{y}^{\sigma}}{p^{\sigma} y} \right) + (1 - \sigma) \ln \tau + \ln \left( \frac{p^{\sigma} y}{p_j^{\sigma} y_j} \right) + \ln \left( \frac{E_j}{S_j} \right) + \ln \left[ \frac{\frac{1}{E_j} \int \mathcal{X}_j \left[ z(s) \left( \frac{r+\delta}{r+\delta+\mu(s)} \frac{1+r-g}{1+r} \right)^{\alpha_j} \right]^{\sigma-1} \phi(s) ds}{\frac{1}{S_j} \int \mathcal{S}_j \left[ z(s) \left( \frac{r+\delta}{r+\delta+\mu(s)} \frac{1+r-g}{1+r} \right)^{\alpha_j} \right]^{\sigma-1} \phi(s) ds} \right].$$

To obtain an empirical counterpart to this expression, I follow an approach

analogous to Manova (2013) and Beck (2003). On the one hand, notice that the first two terms are identical across all industries within a given economy since they only depend on country-level characteristics (such as the level of financial development, the productivity distribution, and the variable trade cost). On the other hand, the rest of the terms are also a function of industry-level characteristics (such as their capital-intensity and the share of exporters).

Therefore, I estimate an industry’s trade share in a given country as a function of the country’s level of financial development, and its interaction with the industry’s capital-intensity. As in Manova (2013), I also include country, industry, and year fixed effects, as well as additional variables, to control for systematic differences in industry-level trade shares unrelated to financial development and capital-intensity. Given that the model assumes that the borrowing constraint parameter  $\theta$  is not industry-specific, I also control for differences in asset tangibility across industries following Manova (2013) and Braun (2003).

Then, I estimate:

$$\ln \frac{\text{Exports}_{ijt}}{\text{Domestic sales}_{ijt}} = \alpha_i + \beta_j + \gamma_t + \frac{\text{Credit}_{it}}{\text{GDP}_{it}} [\omega_1 + \omega_2 \times \text{Capital-per-worker}_j + \omega_3 \times \text{Tangibility}_j] + \boldsymbol{\vartheta} \times \mathbf{X}_{it} + \varepsilon_{ijt},$$

where  $i$ ,  $j$ , and  $t$  index countries, industries, and years, respectively;  $\alpha_i$ ,  $\beta_j$ , and  $\gamma_t$  are fixed effects corresponding to the different countries, industries, and years, respectively;  $\frac{\text{Exports}_{ijt}}{\text{Domestic sales}_{ijt}}$  denotes the ratio of total exports to total domestic sales;  $\frac{\text{Credit}_{it}}{\text{GDP}_{it}}$  denotes the ratio of credit to GDP, which is a widely-used outcome-based measure of financial development;  $\text{Capital-per-worker}_j$  denotes a measure of industry  $j$ ’s capital per worker;  $\text{Tangibility}_j$  denotes a measure of asset tangibility;  $\mathbf{X}_{it}$  is a vector of additional control variables; and, finally,  $\varepsilon_{ijt}$  is an error term.

### 5.1.2 Data

The data used to estimate the specification above are based on the dataset from Manova (2013) for manufacturing industries between 1985 and 1995.<sup>34</sup>

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<sup>34</sup>This dataset is publicly available from the publisher’s website.

I compute industry-level trade shares as the ratio between exports and domestic sales. Exports are obtained from Feenstra’s *World Trade Database* and aggregated to the 3-digit ISIC rev. 2 level using Haveman’s concordance tables. Domestic sales are computed by subtracting exports from gross output, as measured by the United Nations Industrial Development Organization (UNIDO) at the 3-digit ISIC rev. 2 level; both exports and gross output are measured in current U.S. dollars.<sup>35</sup>

Country-level credit-to-GDP is obtained from Beck, Levine, et al. (1999) and covers the total amount of credit issued by banks and other financial intermediaries to the private sector. This variable ranges from 0.04 in Guinea-Bissau in 1989, to 1.79 in Japan in 1995 (as mentioned above, Japan’s average over the whole sample is 1.63). The mean of this variable is 0.40, and its standard deviation is 0.35.

To measure the industries’ technological capital-intensity while abstracting from potential distortions and other factors that may affect an industry’s equilibrium capital-intensity, I follow an approach analogous to Rajan and Zingales (1998). I use firm-level data of publicly-listed U.S. companies from Compustat’s annual industrial files over the period 1985-1995. First, I compute a firm’s capital per worker as its average value over the period. Then, I let an industry’s capital per worker be given by the median capital per worker across all firms within the industry. This variable ranges from \$71.39 million U.S. dollars (at constant 1985 prices) per thousand workers for miscellaneous petroleum and coal products, to \$7.04 million per thousand workers for leather products. The mean of this variable is \$30.10 million per thousand workers, and its standard deviation is \$16.86 million per thousand workers.<sup>36</sup>

Analogous to Rajan and Zingales (1998), this measure is informative about the industries’ technological capital-intensity in different countries under the

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<sup>35</sup>Observations with negative industry-level domestic sales are dropped; this is the case for 10.88% of all observations. In the Online Appendix, I show that the estimation results are robust to accounting for these observations.

<sup>36</sup>I exclude petroleum refineries (ISIC rev. 2 code 353) as its capital per worker is an outlier relative to the rest of the industries; it is more than four times as large as the industry with the second-highest capital per worker.

following two assumptions: (i) given that the U.S. is one of the world’s most financially developed economies and that large public firms are the least likely to face credit constraints, I assume that the capital-per-worker of large U.S. firms provides an undistorted measure of the industries’ technological capital-intensity; and (ii) I also assume that differences in capital-per-worker across U.S. industries are representative of capital-intensity differences across industries in the rest of the world. While (i) has become a standard assumption following Rajan and Zingales (1998), there is also evidence in support of (ii): the correlation between industry-level capital per worker in the U.S. and Chile is 0.63, while their Spearman’s rank correlation is 0.57.

Following Manova (2013), I use Braun (2003)’s measure of asset tangibility based on data for publicly-listed U.S. companies from Compustat’s annual industrial files. At the firm-level, asset tangibility is measured as the share of net property, plant, and equipment in the book value of total assets; a firm’s book value may include assets that cannot be seized by a bank as easily as physical capital and, thus, may not be accepted as collateral. Then, industry-level tangibility is defined as the median tangibility across all firms within an industry. This variable ranges from 0.07 in the pottery, china, and earthenware industry to 0.56 in the paper industry, with a mean value of 0.27 and a standard deviation of 0.12.

Finally, I control for GDP per capita (PPP-adjusted) from the Penn World Tables 6.3. Then, the dataset consists of an unbalanced panel with 103 countries and 25 sectors at the 3-digit ISIC rev. 2 level, from 1985 to 1995.<sup>37</sup>

### 5.1.3 Regression estimates

Table 5 reports the ordinary least squares (OLS) estimates of the empirical specification above. I only report the coefficients on the aggregate ratio of credit to GDP and its interactions since these are the main objects of interest.

To examine the empirical relationship between financial development and international trade across industries with heterogeneous capital-intensity, I compute the partial derivative of the trade share (in logs) with respect to the

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<sup>37</sup>I examine the sources of missing observations in the Online Appendix; I show that my findings are robust to accounting for various sources of missing data.

**Table 5: Industry-level implications, regression estimates**

|  | $\ln(\text{Exports}/\text{Domestic sales})$ |
|--|---|
| Credit/GDP                             | -0.592<br>(0.151)                           |
| Credit/GDP $\times$ Capital per worker | 0.028<br>(0.002)                            |
| Credit/GDP $\times$ Tangibility        | -2.863<br>(0.329)                           |
| R-squared                              | 0.516                                       |
| Number of observations                 | 15,467                                      |

Note: Country, industry, and year fixed effects are included. I also control for GDP per capita (in logs). Heteroskedasticity-robust standard errors are reported in parentheses.

credit-to-GDP ratio, which is given by  $\omega_1 + \omega_2 \times \text{Capital-per-worker}_j + \omega_3 \times \text{Tangibility}_j$ . The estimate of  $\omega_2$ , which is positive and statistically significant, implies that capital-intensive industries have relatively higher trade shares in countries with better developed financial markets. These estimates are qualitatively consistent with the model’s industry-level implications, as well as with the evidence documented by Manova (2013).

#### 5.1.4 Model vs. empirical estimates

I now study the extent to which the model’s industry-level implications are quantitatively consistent with the empirical estimates reported above.

To do so, I use the regression estimates to compute the trade share change in capital- and labor-intensive industries associated with the development of financial markets. In particular, I consider a change of the credit-to-GDP ratio from 0.00 to 1.63, the same magnitude as in the model between the no-credit and high-financial-development economies.

To construct an empirical counterpart to the change of the trade share in the model’s capital-intensive industry, I evaluate the estimated regression at the average capital per worker across industries with capital per worker above the 90<sup>th</sup> percentile: \$ 69.60 million U.S. dollars (at constant 1985 prices) per thousand workers.<sup>38</sup> Similarly, I compute the empirical counterpart to the

<sup>38</sup>To contrast the same set of industries between the Chilean and cross-country industry-level datasets, I exclude industry 372 from the empirical counterfactual since capital per worker is not available in Chile for this industry. Similarly, I include industry 324 to compute

change of the trade share in the model's labor-intensive industry by evaluating the estimated regression at the average capital per worker across industries with capital per worker below the 10<sup>th</sup> percentile: \$ 7.15 million U.S. dollars (at constant 1985 prices) per thousand workers. This mapping between the industries in the model and those observed in the data is consistent with the approach that I follow to estimate the model.<sup>39</sup>

Finally, I evaluate the estimated regression at its average value of tangibility, equal to 0.27. Thus, I estimate the relationship between financial development and international trade in industries with an average degree of net worth collateralizability.

Table 6 contrasts the log-change of industry-level trade shares, in response to financial development, between the data and the model. In particular, I restrict attention to financial development as a move from the economy without credit to the financially-developed economy. I find that the baseline model under international financial integration can account for a large fraction of the trade share changes implied by the empirical specification estimated above.

On the one hand, both the model and the data imply that financial development is associated with a substantial increase of the ratio of exports to domestic sales in capital-intensive industries. In particular, it increases by 0.92 and 1.00 log-points in the data and the model, respectively. On the other hand, I find that there is a sharp decrease of the trade share in labor-intensive industries: by -1.92 and -1.62 log-points in the data and the model, respectively. Thus, the baseline model with international financial integration accounts for 108.7% and 84.3% of the log-changes of the trade share estimated from the data for capital- and labor-intensive industries, respectively.

Moreover, I find that the industry-level trade share changes estimated from the data are in-between their model-counterparts under the extreme international financial environments that I consider. In particular, the model under

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the empirical counterfactual since capital per worker is available in both datasets, but is not used to compute the regression estimates due to the lack of exports data.

<sup>39</sup>I estimate differences between the capital- and labor-intensive industries of the model to match their empirical counterpart between the set of industries with capital per worker above the 90<sup>th</sup> percentile and those below the 10<sup>th</sup> percentile, respectively.

**Table 6: Industry-level implications, model vs. data**

| $\Delta \ln \frac{\text{Exports}}{\text{Domestic sales}}$ | <i>Model</i> |                              |                          |
|---|--------------|------------------------------|--------------------------|
|   | <i>Data</i>  | <i>Financial integration</i> | <i>Financial autarky</i> |
| Labor-intensive   | -1.92        | -1.62                        | -1.97                    |
| Capital-intensive   | 0.92         | 1.00                         | 0.55                     |

international financial autarky implies a lower increase of the trade shares, accounting for 59.8% and 102.6% of the log-changes implied by the data for capital- and labor-intensive industries, respectively. These findings suggest that the countries in the data face an intermediate degree of international financial integration relative to the extremes considered.

I conclude that the model can quantitatively account for the empirical relationship between trade shares and financial development across industries with heterogeneous capital-intensity. These findings provide further support to the implications of the model and to the importance of its underlying mechanisms.

## 5.2 Aggregate-level estimates

Finally, I ask: to what extent are the implications of the model consistent with the empirical relationship between financial development and international trade at the aggregate level?

To answer this question, I aggregate the cross-country industry-level dataset across all industries, to obtain a panel where each observation corresponds to the manufacturing sector of a given country-year pair.<sup>40</sup> Then, I estimate a country-level empirical specification analogous to the one above, but excluding industry-level variables and industry fixed effects. To examine the role of international financial integration, I also introduce an interaction term between the level of credit to GDP and a measure of international financial integration. Then, I estimate:

$$\ln \frac{\text{Exports}_{it}}{\text{Domestic sales}_{it}} = \alpha_i + \gamma_t + \frac{\text{Credit}_{it}}{\text{GDP}_{it}} [\omega_1 + \omega_2 \times \text{Financial integration}_{it}] + \boldsymbol{\vartheta} \times \mathbf{X}_{it} + \varepsilon_{it},$$

where  $i$  and  $t$  index countries and years, respectively;  $\alpha_i$  and  $\gamma_t$  are coun-

<sup>40</sup>For every country-year pair, I only aggregate across industries with non-missing observations of exports and output.

**Table 7: Aggregate-level implications, regression estimates**

|   | $\ln(\text{Exports}/\text{Domestic sales})$ |
|---|---|
| Credit/GDP                                | 0.029<br>(0.228)                            |
| Credit/GDP $\times$ Financial integration | 4.060<br>(1.875)                            |
| R-squared                                 | 0.890                                       |
| Number of observations                    | 801   |

Note: Fixed effects for each country and year are included. I also control for distance, GDP per capita, and the level of international financial integration. Financial integration is measured as the absolute value of aggregate net exports relative to GDP. Heteroskedasticity-robust standard errors are reported in parentheses.

try and year fixed effects, respectively;  $\frac{\text{Exports}_{it}}{\text{Domestic sales}_{it}}$  denotes the ratio of total manufacturing exports to total manufacturing domestic sales;  $\frac{\text{Credit}_{it}}{\text{GDP}_{it}}$  denotes the ratio of credit to GDP;  $\text{Financial integration}_{it}$  denotes a measure of international financial integration;  $\mathbf{X}_{it}$  denotes a vector of additional control variables; and,  $\varepsilon_{it}$  is an error term.

To measure the extent of international financial integration, I use the absolute value of aggregate net exports relative to GDP, which I obtain from the World Bank.<sup>41</sup> From the lens of the model, this is a sharp indicator of international financial integration, equal to zero under international financial autarky but positive otherwise.

Finally, I control for distance, GDP per capita, and the *level* of international financial integration to avoid potential omitted variables bias through their simultaneous correlation with financial development and international trade.<sup>42</sup>

Table 7 reports the estimation results. I find that, while the coefficient on the credit-to-GDP ratio is statistically insignificant, its interaction with the absolute value of aggregate net exports relative to GDP is positive and strongly statistically significant. This implies that financial development is associated

<sup>41</sup>The empirical findings are robust to alternative measures of international financial integration, such as the total stock of foreign assets and liabilities relative to GDP, or the absolute value of net foreign assets relative to GDP, which I obtain from Lane and Milesi-Ferretti (2007).

<sup>42</sup>Distance is measured as the average distance between country  $i$  and its trade partners.

with higher aggregate trade shares unless aggregate net exports are equal to zero. These implications are qualitatively consistent with the aggregate implications of the model: financial development increases the aggregate trade share except under international financial autarky, when aggregate net exports are equal to zero.

I conclude by contrasting the quantitative implications of the model with estimates from the data. To do so, I use the regression estimates to compute the change of the aggregate trade share associated with a change in the credit-to-GDP ratio from 0.00 to 1.63, as in the quantitative experiment above. I evaluate this change at two alternative levels of international financial integration, as measured by the absolute value of aggregate net exports relative to GDP: *(i)* at zero, to contrast with the model under international financial autarky; and *(ii)* at 0.0696, the value implied by the model under international financial integration.

The empirical estimates imply that the increase of credit-to-GDP is associated with an increase of the aggregate trade share by 0.05 log-points under international financial autarky, and by 0.51 log-points under international financial integration. In the model, financial development leads to an increase of the aggregate trade share by 0.00 and 0.34 log-points in autarky and financial integration, respectively. I conclude that the causal impact of financial development on international trade accounts for a significant share of the empirical relationship between them at the aggregate level.

## 6 Conclusion

Recent studies have documented a strong empirical relationship between measures of access to external finance and the extent of international trade at both the firm and industry levels, suggesting that financial development has a significant impact on international trade. In this paper, I examine the extent to which this is the case using a quantitative general equilibrium model estimated to match salient features of firm-level data.

My findings show that financial frictions have a significant impact on international trade at the industry-level. At the aggregate-level, there is a moderate

impact under international financial integration, but the effects are negligible under international financial autarky. I show that these findings are consistent with evidence from cross-country industry-level and aggregate data.

These results point to the importance of general equilibrium effects in interpreting firm- or industry-level evidence. While some distortions may play an important role when studying firms or industries in isolation, their importance at the aggregate level can sometimes be offset by changes in equilibrium prices.

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