Financial Development and International Trade

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ABSTRACT

This paper studies the aggregate implications of financial frictions on international trade. I set up a multi-industry general equilibrium model of international trade with heterogeneous firms subject to export entry costs and financial frictions, where industries differ in the extent to which they depend on external finance. Financial frictions reduce the aggregate trade share through two channels. First, they reduce the share of firms that export by distorting firms’ export entry decisions. Second, they reduce the scale of exporters relative to non-exporters. I parameterize the model to match key features of plant-level data from Chile. I find that financial frictions have a large effect on the extent of international trade across industries with different degrees of dependence on external finance, consistent with estimates based on cross-country industry-level data. However, I find that the model implies a negligible effect of financial frictions on the share of output traded internationally at the aggregate-level. Relaxing the financial constraints increases the trade share in industries with high dependence on external finance, since it allows more firms to finance the export entry investments and to increase their scale relative to non-exporters. In contrast, the trade share decreases in industries with low dependence on external finance, since the increased incentives to trade and augment scale are offset by higher equilibrium factor prices. This reallocation of industry-level trade shares, combined with the change in the share of output accounted by each industry, offset each other almost exactly, implying a negligible effect on the aggregate trade share.
1 Introduction

International trade costs are large, particularly in developing countries. While recent studies have estimated large gains from reducing these costs, an important challenge is to identify policies that may allow poor countries to reduce them. The development of financial markets has been suggested as a policy objective with the potential to reduce the effective barriers to international trade, since recent papers have documented financial development plays an important role in accounting for the extent of international trade across industries with different degrees of dependence on external finance.

A key channel through which frictions in financial markets have been argued to reduce the extent of international trade in the economy is by distorting firms’ decisions to undertake the large export entry investments that are typically required to begin selling internationally, reducing the share of firms that do so. For instance, investments in technology and quality upgrading, the development of new product lines, marketing expenditures, setting up distribution networks, and the purchase of fixed capital equipment, are typically hard to finance with internal funds, preventing firms to undertake them when external finance is not available.

The goal of the paper is to evaluate the implications of this channel on the extent of international trade at the aggregate-level. To do so, I study a multi-industry general equilibrium model of international trade with heterogeneous firms subject to export entry costs and financial frictions, where industries differ in the extent to which they depend on external finance. I parameterize the model to match key features of plant-level data from Chile, and use it to study the quantitative effect of financial frictions on the share of aggregate output that is traded internationally.

I find that financial frictions can indeed account for the strong relationship between the degree to which industries depend on external finance and the extent of international trade observed in the data. Yet, I find that they have a negligible effect on international trade at the aggregate-level. Relaxing the financial constraints increases the trade share in industries with high dependence on external finance, since it allows more firms to finance the export entry investments and to increase their scale relative to non-exporters. In contrast, the trade share decreases in industries with low dependence on external finance, since the increased incentives to trade and augment scale are offset by higher equilibrium factor prices. This reallocation of industry-level trade shares, combined with the change in the share of output accounted by each industry, offset each other almost exactly, implying a negligible effect on the aggregate trade share.

The model consists of an economy populated by heterogeneous entrepreneurs who supply labor and operate a firm which produces differentiated goods. They produce using capital and labor, with labor hired from other entrepreneurs, and capital accumulated internally. Entrepreneurs are born with an idiosyncratic productivity level, a low initial level of capital, and a parameter corresponding to the capital-share of the production technology that they operate — and they die every period with a given

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3 Waugh (2010) finds poor countries can obtain large welfare gains from reducing international trade costs to the level of rich countries.
4 See Beck (2003) and Manova (2013).
probability. In this model, an industry is given by the set of entrepreneurs that operate a production technology with the same capital-share. Not only do they sell to domestic entrepreneurs, but they can also sell internationally. To do so, however, they need to undertake an export entry investment, and are also subject to an ad-valorem trade cost.\footnote{International trade is modeled following Melitz (2003) and Chaney (2008), and the dynamic features of Alessandria and Choi (2013).} Now, to accumulate capital as well as to finance the export entry investment, entrepreneurs can borrow from domestic financial markets. However, borrowing is subject to financial frictions which take the form of a collateral constraint, with the amount of credit available bounded by the value of capital at the time that loans are due for repayment.\footnote{For related closed-economy environments with heterogeneous firms subject to financial constraints, see Midrigan and Xu (forthcoming), Buera, Kaboski, and Shin (2011), and Buera and Moll (2013).}

Financial frictions reduce the aggregate trade share through two channels. First, financial frictions distort export entry decisions, reducing the share of firms that export. Firms with a sufficiently low capital stock produce at a low scale and can’t post enough collateral to secure external financing. This leads them to delay export entry until sufficient internal funds are accumulated to undertake the investment. Second, financial frictions distort exporters’ production decisions relatively more than those of non-exporters, thereby reducing the share of total sales that is sold internationally. While financial frictions distort the scale of production of all firms in the economy, by limiting the amount that can be borrowed to increase the capital stock, exporters are distorted relatively more given that they sell to multiple markets and, thus, have a higher optimal scale. Now, these distortions to firms’ production decisions exacerbate the distortions along the export entry margin. To the extent that firms operate at a sub-optimal scale upon entry to the export market, financial frictions reduce the returns to exporting and increase its opportunity cost, leading firms to delay the export entry investment until even more internal funds are accumulated.

While financial frictions reduce industry-level trade shares through the same channels described above, the extent to which trade shares are distorted across industries is a function of their dependence on external finance. Those which operate production technologies with higher capital-shares have higher optimal levels of the capital stock and, thus, stand to benefit relatively more from having access to external finance to accumulate capital and pay export entry costs. Therefore, the trade share of industries with higher capital-intensity is relatively more distorted than those which are relatively less capital-intensive.

To study the implications of financial frictions on international trade quantitatively, I calibrate the model to match moments from data on Chilean plants that have been previously used in the literature to discipline similar economic environments. The approach targets moments that discipline the mechanism through which firms choose to start exporting in the model, and the extent to which the financial constraints distort firms’ decisions. In addition, I choose the parameters of the model to make the model economy look at the data at the aggregate level, along key dimensions for the trade-finance nexus.

With a calibration of the model economy that resembles the data along key dimensions, I then proceed to conduct a series of experiments to study the effect of financial frictions on international
trade at the industry- and aggregate-level. The main experiment consists of contrasting the stationary equilibrium of the baseline calibration, with the stationary equilibria of two economies featuring levels of financial development at each end of the spectrum. On one end, I contrast it with an economy in which financial frictions are the tightest and entrepreneurs cannot borrow at all. On the other end, I contrast the stationary equilibrium of the baseline calibration with an economy in which there are no financial frictions and firms can borrow without posting collateral. I interpret the differences in the outcomes across these economies with differing degrees of financial development as informative about the effects of financial development.

I first use this experiment to study the effect of financial development on industry-level trade shares. Not only am I interested in the effect that differences in financial development may have on these, but I am also interested in the potential differences that these effects may exhibit across industries. I contrast these results with estimates based on a cross-country dataset at the industry-level that has been previously studied in the literature by Manova (2013). Specifically, I use this dataset to estimate an empirical specification which explains the trade share of an industry in a given country as a function of a measure of the country’s level of financial development, and an interaction between this measure and a proxy for the industry’s dependence on external finance. Not only does this comparison serve as an exercise to potentially validate the implications of the model, but it also serves to provide a structural general equilibrium interpretation to related empirical estimates that have been previously documented in the literature.

I find that financial frictions have a large effect on the extent of international trade across industries with different degrees of dependence on external finance that is consistent with estimates based on industry-level data. Relaxing the financial constraints increases the trade share in industries with high dependence on external finance, since it allows more firms to finance the export entry investments and to increase their scale relative to non-exporters. In contrast, the trade share decreases in industries with low dependence on external finance, since the increased incentives to trade and augment scale are offset by higher equilibrium factor prices.

With a model that implies a relationship between trade and finance across industries consistent with the data, I then proceed to use the experiment to study the effects of financial development on international trade at the aggregate-level. In contrast to the strong relationship between trade and finance observed at the industry-level, I find that financial frictions have a negligible effect on the extent of international trade at the aggregate-level. The reallocation of industry-level trade shares that results from a relaxation of financial frictions, combined with the change in the share of output accounted for by each industry, offset each other almost exactly, implying that the aggregate trade share remains virtually unchanged.

Finally, I show that the magnitude of the export entry cost plays a key role in determining the extent to which financial frictions distort aggregate trade flows. Specifically, I show that a parameterization of the model that makes trade relatively more intensive in finance, by increasing the export entry cost and reducing the variable trade cost, implies a large increase in the aggregate trade share in response to a relaxation of financial frictions. Thus, I conclude that my aggregate finding is not a generic feature of the model, but a result of the parameterization that I study. I then contrast the magnitude
of my estimated export entry cost with previous estimates from the literature, to examine whether my results are driven by a calibration procedure that implies export entry costs that are relatively lower than previously estimated. I show that my estimate of the export entry cost is actually higher than a previous estimate reported in the literature, suggesting that, if anything, my experiment may in fact overstate the aggregate impact of financial frictions on international trade.

My findings show that, even though we may observe a strong relationship between measures of external finance dependence and industry-level trade shares, they need not imply that financial frictions have a strong effect on the share of aggregate output that is sold in foreign markets. Introducing financial frictions to a standard model of international trade and calibrating it following previous papers in the literature, I find that the model implies an industry-level relationship between trade and finance that is consistent with the data, even though it implies a negligible effect of financial frictions on international trade at the aggregate-level.

Similarly, even though we may observe a strong relationship between financial factors and firms’ export entry decisions, my findings suggest that they need not imply a strong relationship between trade and finance at the aggregate-level. In my model, firms’ export entry decisions are certainly associated and determined by firms’ financial conditions, and yet they fail to distort the share of aggregate output that is exported.

The remainder of the paper is organized as follows. Section 2 presents the model. Section 3 discusses the mechanism through which financial frictions distort aggregate trade flows. Section 4 presents the quantitative analysis of the model. Section 5 concludes.

2 Model

I now present the setup of the model and the definition of an equilibrium for this economy.

2.1 Setup

The model consists of an economy populated by a unit measure of entrepreneurs and final good producers who trade with the rest of the world. There are two types of goods in the economy: final goods and intermediates. Only intermediates goods can be traded internationally. Entrepreneurs produce differentiated intermediates using capital and labor. Final goods are used by entrepreneurs to consume and invest, and are produced by final good producers using domestic and foreign intermediates. The rest of the world demands intermediates from entrepreneurs, and supplies foreign intermediates to final good producers.

8 Using Italian data, Minetti and Zhu (2011) show that “credit rationed” firms are less likely to export and, to the extent that they do, they are likely to export less. In a similar spirit, Bellone, Musso, Nesta, and Schiavo (2010) report a negative relationship between firms’ “financial health” and both their export status and export intensity. Suwantaradon (2012) uses data from the World Bank Enterprise Survey to show that firms with higher net worth are more likely to export.

2.1.1 Entrepreneurs

Preferences  Entrepreneurs are risk averse, with preferences over streams of consumption of final goods represented by the expected lifetime discounted sum of a constant relative risk aversion (CRRA) period utility function:

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t c_t^{1-\gamma},$$

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 realizations of a death shock described below, conditional on the information set in period zero.

Technology  Entrepreneurs produce a differentiated intermediate good 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, $k_t$ denotes the capital stock, and $n_t$ is the amount of labor hired. Idiosyncratic productivity $z$ is distributed log-normal with mean $\mu_z$ and standard deviation $\sigma_z$, and is fixed over their lifetime.

There are two types of entrepreneurs who differ only in the capital-intensity $\alpha$ of their production technology. A fixed share $\eta \in (0,1)$ of entrepreneurs operate a capital-intensive technology, with $\alpha = \alpha_h$, while a share $1-\eta$ of them operate a non-capital-intensive technology, with $\alpha = \alpha_l$ such that $\alpha_l < \alpha_h$. The two types of entrepreneurs are otherwise identical. In the quantitative analysis of the model, I think of these two types of entrepreneurs as capturing two industries that operate different production technologies.

Entrepreneurs are endowed with a unit of labor that is supplied inelastically in a competitive labor market, and hired by other entrepreneurs on a period-by-period basis.\(^\text{10}\) Capital is accumulated internally by investing $x_t$ units of the final good. Investment takes a period to be transformed into capital, and capital depreciates at rate $\delta$. Therefore, the law of motion for capital is given by $k_{t+1} = (1-\delta)k_t + x_t$.

Entrepreneurs can trade internationally conditional on payment of export entry and variable trade costs. A firm’s export status at time $t$ is denoted by $e_t$, and is equal to one if the firm can export in period $t$, and is zero otherwise. A firm that cannot export in period $t$ has to pay a sunk export entry cost $F$ in that period in order to begin selling internationally in period $t+1$. This cost is denominated in units of the final good. A firm that can export in the current period can export in every subsequent period. Furthermore, exporters face an ad-valorem trade cost $\tau > 1$, which requires firms to ship $\tau$ units for every unit that arrives at destination.

Financial markets  Entrepreneurs have access to domestic financial markets, where they can borrow or save from each other by trading a one-period risk-free bond at interest rate $r_t$, denominated in units.
Entrepreneurs face a borrowing constraint, which limits the amount that they can borrow 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 $d_{t+1}$ subject to $d_{t+1} \leq \theta k_{t+1}$ and the natural borrowing limit. Given that the bond is only traded among domestic agents, the interest rate $r_t$ is an endogenous price that will clear the domestic bond market in a competitive equilibrium.

**Entry and exit** At the end of every period, entrepreneurs die with probability $\nu$. While constrained in their capacity to borrow, entrepreneurs have access to perfect annuity markets to insure themselves against the event of death. Every period, after financial market and capital accumulation decisions are made, entrepreneurs purchase an annuity contract. The contract specifies that, upon death, their savings and capital are seized to be transferred to surviving entrepreneurs. Upon survival to the following period, the contract specifies that agents receive $\nu \frac{1}{1-\nu}$ units of capital per unit of capital held. Similarly, their savings are increased by $\nu \frac{1}{1-\nu}$ units per unit of savings held. Note that, given that entrepreneurs have no bequest motive, they always find it optimal to sign these contracts.

Dead entrepreneurs are replaced, at the end of the period, by a measure $\nu$ of entrepreneurs that is born. These newborn entrepreneurs begin life with an initial endowment of capital $k$, financed via a lump-sum tax $T_t$ levied on all entrepreneurs, an idiosyncratic productivity level drawn from the stationary productivity distribution, and zero debt.

**Market structure** Entrepreneurs compete with each other under monopolistic competition, and choose the quantities and prices at which to sell in each market subject to their respective demand schedules. In the domestic market, the demand schedule is such that it solves the final good producer’s problem, while the demand schedule faced in the international market is determined by the rest of the world. Denote the 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.

**Timing protocol** The timing of the decisions of entrepreneurs are as follows. Entrepreneurs begin the period by hiring labor, producing their variety of the intermediate good, and then selling it across each of the markets in which they operate. Then, entrepreneurs simultaneously issue new debt, choose their level of investment, and repay their old debt. The remaining resources are used to pay the lump-sum tax, to consume, and to pay the export entry cost. At the end of the period, death shocks are realized, and the resources from dead entrepreneurs are transferred to surviving ones. Dead entrepreneurs are finally replaced by newborn ones, who receive an initial endowment of capital from the taxes paid by entrepreneurs earlier in the period.

**Entrepreneurs’ problem** Given this setup, the entrepreneurs’ problem at time zero consists of choosing sequences of consumption $c_t$, labor $n_t$, investment $x_t$, next period’s export status $e_{t+1}$, and prices and quantities $\{y_{h,t}, p_{h,t}, y_{f,t}, p_{f,t}\}$ at which to sell the intermediate good in each of the markets,

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11If in debt, their stock of debt is increased by $\nu \frac{1}{1-\nu}$ units per unit owed.
in order to maximize lifetime expected utility subject to the constraints that they face. In addition to the borrowing constraint \( d_{t+1} \leq \theta k_{t+1} \) described above and the market-specific demand schedules that are described below, their choices are subject to a sequence of period-by-period budget constraints, annuity-adjusted law of motions of capital, and production technology constraints. Their budget constraint in period \( t \) is given by

\[
p_t c_t + p_t x_t + p_t d_t + p_t F [\varepsilon_t = 0, \varepsilon_{t+1} = 1] = w_t + p_h_t y_{h,t} + p_f,t y_{f,t} - w_t n_t + p_t d_{t+1} \frac{1 - \nu}{1 + r_t} - T_t,
\]

where \( p_t \) denotes the price of the final good, and \( F \) is an indicator function that is equal to one if its argument is true and zero otherwise. The law of motion of capital adjusted for the annuity returns accrued conditional on survival is given by

\[
k_{t+1} = \frac{1}{1 - \nu} [(1 - \delta) k_t + x_t],
\]

and, finally, the production technology constraint is given by \( y_{h,t} + \tau y_{f,t} = z_t k_t^{\alpha} n_t^{1-\alpha} \). A recursive formulation of this problem is presented below.

### 2.1.2 Final good producers

Final good producers purchase intermediates from entrepreneurs and the rest of the world, and aggregate them to produce a final good. 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 entrepreneurs in the economy. Then, given prices \( \{p_{h,t}(i)\}_{i \in [0,1]} \) and \( p_{m,t} \) charged by entrepreneurs and the rest of the world, respectively, final good producers choose the bundle of inputs of domestic and imported intermediates, \( \{y_{h,t}(i)\}_{i \in [0,1]} \) and \( y_{m,t} \), respectively, that maximizes their profits. Then, the problem of final good producers is given by:

\[
\max_{y_{h,t}(i), y_{m,t}} p_t y_t - \int_0^1 p_{h,t}(i) y_{h,t}(i) di - p_{m,t} y_{m,t}
\]

subject to

\[
y_t = \left[ \int_0^1 y_{h,t}(i) \frac{\sigma^1}{\sigma} di + y_{m,t} \right] \frac{\sigma^1}{\sigma},
\]

where \( p_t \) and \( y_t \) denote the price and quantity of the final good, respectively.

Given prices \( \{p_{h,t}(i)\}_{i \in [0,1]} \) and \( p_{m,t} \), the quantity of each intermediate good demanded by final good producers is given by the following demand functions:

\[
y_{h,t}(i) = \left( \frac{p_{h,t}(i)}{p_t} \right)^{-\sigma} y_t,
\]

\[
y_{m,t} = \left( \frac{p_{m,t}}{p_t} \right)^{-\sigma} y_t,
\]
where these are the demand schedules faced by entrepreneurs and the rest of the world.

### 2.1.3 Rest of the world

The rest of the world demands intermediates from entrepreneurs (the domestic economy’s exports), and supplies intermediates to final good producers (the domestic economy’s imports). The demand for intermediates produced by entrepreneurs 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 quantity and price indexes of the rest of the world. The supply of intermediates from the rest of the world, imported by final good producers, is assumed to be perfectly elastic at price $\bar{p}_m$, which is set to be the numeraire good.

While the domestic economy interacts with the rest of the world in goods markets, I assume that there is no interaction in financial markets. Specifically, I assume that the economy cannot borrow or lend to the rest of the world and, thus, operates in an environment of international financial autarky.

### 2.2 Recursive formulation of the entrepreneur’s problem

Before defining the recursive stationary competitive equilibrium of this economy, I present the recursive formulation of the entrepreneurs’ problem. Given the setup described above, this problem can be represented as the following dynamic programming problem:

$$v(k, d; z, \alpha) = \max_{c, x, n, k', d', e} \frac{c^{1-\gamma}}{1-\gamma} + \beta(1-\nu)v(k', d', e; z, \alpha)$$

subject to

1. Budget constraint:
   $$pc + px + pd + wn + pF \mathbb{1}_{e=0, e'=1} = w + ph y_h + pf y_f + pd \left( \frac{1-\nu}{1+r} \right) - T$$

2. Law of motion of capital:
   $$k' = \frac{1}{1-\nu} [(1-\delta)k + x]$$

3. Collateral constraint:
   $$d' \leq \theta k'$$

4. Production function:
   $$y_h + \tau y_f = z k^\alpha n^{1-\alpha}$$

5. Demand schedule of final good producers:
   $$y_h = \left( \frac{p_h}{p} \right)^{-\sigma} y$$

6. Demand schedule faced in the rest of the world:
   $$y_f = \left( \frac{p_f}{\bar{p}^*} \right)^{-\sigma} \bar{y}^*$$

where (1) is the budget constraint; (2) is the law of motion of capital; (3) is the collateral constraint; (4) is the production function; (5) is the demand schedule of final good producers; and (6) is the demand schedule faced in the rest of the world.
2.3 Equilibrium

I now define an equilibrium of this economy. Before proceeding, I introduce a few definitions to simplify the notation from here onwards. Let $\mathcal{S} := \mathcal{K} \times \mathcal{D} \times \mathcal{E} \times \mathcal{Z} \times \mathcal{I}$ denote the state space of entrepreneurs, where $\mathcal{K} = \mathbb{R}^+$, $\mathcal{D} = \mathbb{R}$, $\mathcal{E} = \{0, 1\}$, $\mathcal{Z} = \mathbb{R}^+$, and $\mathcal{I} = \{\alpha_l, \alpha_h\}$ denote the set of possible values of capital, debt, export status, productivity, and capital-intensity, 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 $\{r, w, p\}$
- Policy functions $\{d', k', e', c, n, y_d, y_x, p_d, p_x, y, y_m\}$
- Value function $v$
- Measure $\phi : \mathcal{S} \rightarrow [0, 1]$

such that

1. Policy and value functions solve the entrepreneurs’ problem
2. Policy functions solve the final good producers’ problem
3. Labor market clears:
   \[ \int_{\mathcal{S}} n(s)\phi(s)ds = 1 \]
4. Domestic intermediate good market clears: $y_D(i) = y_D(s)$ if $s_i = s$
5. Final good market clears:
   \[ \int_{\mathcal{S}} \left[ c(s) + x(s) + F\Pi_{e=0,e'(s)=1} \right] \phi(s)ds + \nu_k = y \]
6. Financial market clears:
   \[ \int_{\mathcal{S}} d'(s)\phi(s)ds = 0 \]
7. Measure $\phi$ is stationary

3 Financial frictions and aggregate trade flows

In this section, I study the mechanisms through which financial frictions distort aggregate trade flows in the model. Given that the goal of the paper is to study the extent to which international trade flows are relatively more distorted by financial frictions than domestic output, I restrict attention to
the effect of financial frictions on the aggregate trade share\textsuperscript{12} — that is, the ratio of aggregate exports to aggregate domestic sales.\textsuperscript{13} Decreases in this ratio in response to a tightening of financial frictions, thus, would reflect that these frictions distort international trade flows relatively more than production for the domestic market.

I begin by examining the channels through which financial frictions distort the aggregate trade share of the economy presented in the previous section. I first show that financial frictions affect the trade share in this economy through aggregate- and trade-specific channels. While the aggregate-channel is standard in the literature, arising from distortions to aggregate productivity and output, the trade-specific channel is a function of the relative impact of financial frictions on firms engaged in international trade relative to those that only sell domestically. Specifically, I show that reductions in the number of firms that trade internationally, as well as in the scale of exporters relative to non-exporters, can reduce the trade share of the economy at the aggregate level.

I then show that this is indeed how financial frictions distort decisions at the firm-level. I first show that financial frictions distort firms’ export entry decisions, leading to a reduction in the number of firms that trade internationally. I subsequently show that financial frictions distort the production decisions of exporters relatively more, reducing the scale of exporters relative to non-exporters.

Finally, I study the extent to which financial frictions have a differential impact on the trade share of the set of capital-intensive firms relative to non-capital-intensive ones. As mentioned above, for the rest of the paper, I interchangeably refer to the set of capital-intensive (non-capital-intensive) firms as the capital-intensive (non-capital-intensive) industry or sector. I show that firms that rely relatively more on physical capital for production are also likely to rely relatively more on external finance to pay for their capital and export entry investments. Therefore, financial frictions distort the trade share of capital-intensive firms relatively more than that of non-capital-intensive ones.

### 3.1 Aggregate trade share

The ratio of aggregate exports to domestic sales in this economy is given by:

$$\frac{\text{Exports}}{\text{Domestic sales}} = \frac{\bar{p}^\sigma \bar{y}^s}{\bar{p}^\sigma y} \times \hat{\tau}^{1-\sigma}$$

where \(\hat{\tau}\) is an endogenous object that is a function of the interaction between trade costs and the decisions of all firms in the economy, which I describe below in more detail, and which I refer to as the \textit{trade wedge}. The first term captures the relative aggregate demand of the rest of the world relative to the domestic economy. Everything else equal, the aggregate trade share is increasing in the size of the

\textsuperscript{12}In addition, the response of the aggregate trade share is the key statistic determining the welfare gains from a reduction in trade costs for a large class of models of international trade (Arkolakis, Costinot, and Rodriguez-Clare 2012). To the extent that estimates of trade costs based on these models capture, to a certain extent, distortions of international trade flows due to financial frictions, policies that relax these frictions may act as a reduction in the barriers to trade faced by poor countries, with potentially a very large impact on welfare \textit{via changes in the aggregate trade share} (Waugh 2010).

\textsuperscript{13}While the ratio of exports to domestic sales is not literally the trade share (that is, the share of output that is exported), it is a monotonic function of it. I thus refer to them interchangeably.
rest of the world relative to the domestic economy. The second term adjusts the contribution of the relative size of the economies in determining the aggregate trade share by the magnitude of the trade wedge — given that \( \sigma > 1 \), everything else equal, a larger trade wedge decreases the amount of trade in the economy.

Financial frictions affect each of these terms in different ways. A tightening of financial frictions leads to an increase in the first term, since it decreases aggregate output and productivity, thus decreasing \( p^* \sigma y \) while leaving \( \tilde{p}^* \sigma \tilde{y}^* \) unchanged.\(^{14}\) This is what I refer to as the aggregate channel through which the aggregate trade share is distorted. While it increases the trade share, it does so at the expense of shrinking the domestic economy and making it a less attractive destination. In contrast, a tightening of financial frictions leads to a decrease in the second term, since it increases the trade wedge \( \tilde{\tau} \), as I argue below. I refer to this as the trade-specific channel through which the aggregate trade share is distorted — in this model, financial frictions can only lead to reductions in the trade share through this channel. To the extent that the trade-specific channel is relatively more distorted than the aggregate-channel, financial frictions reduce the aggregate ratio of exports to domestic sales of this economy.

But what determines \( \tilde{\tau} \)? It is straightforward to show that \( \tilde{\tau} \) is given by:

\[
\tilde{\tau} = \tau \times \left[ \frac{\int_{S} z \left( \frac{\tau + \delta}{\tau + \delta + \mu(s)} \right)^{\alpha} \sigma^{-1} \phi(s) ds}{\frac{1}{E} \int_{\mathcal{X}} z \left( \frac{\tau + \delta}{\tau + \delta + \mu(s)} \right)^{\alpha} \sigma^{-1} \phi(s) ds} \right]^{\frac{1}{\sigma - 1}} \times \left( \frac{1}{E} \right)^{\frac{1}{\sigma - 1}}
\]

where \( \mu_\theta \) is the Lagrange multiplier on the entrepreneurs’ borrowing constraint, \( \mathcal{X} \) is the set of firms that export, and \( E \) denotes the share of exporters.\(^{15}\)

The first term is given by the variable trade cost \( \tau \) and is, thus, unaffected by the extent of financial development. As in standard model of international trade, a ceteris paribus increase in the variable trade cost leads to an increase in the trade wedge \( \tilde{\tau} \) and, thus, to a decrease in the aggregate trade share.

The second term captures the relative size of exporters relative to all firms active in the domestic market. The integral in the numerator computes the average productivity across all firms active in the domestic market, where each productivity is weighted by a term that is lower than one when the Lagrange multiplier corresponding to the given element of the state space is positive — that is, as long as the given firm is financially constrained. This integral is, thus, a measure of the average scale of these firms: while their optimal level of total sales is increasing in productivity, their sales are reduced when financial constraints are binding — thus the weighting of productivity in the integral, and its interpretation as a measure of average scale. Therefore, a tightening of financial frictions decreases the measure of average scale in the domestic market that is computed in the numerator. The integral in the denominator is identical to the one in the numerator, except that it computes this measure

\(^{14}\)While this is an artifact of the small-open-economy nature of the model, multi-country extensions of this setup imply that a tightening of financial frictions in the domestic economy have a quantitatively negligible impact on the aggregate demand they face from the rest of the world.

\(^{15}\)Formally, \( \mathcal{X} \) and \( E \) are given by \( \mathcal{X} := \{ s \in S | e = 1 \} \) and \( E := \int_{S} \mathbb{I}_{\{e=1\}} \phi(s) ds \), respectively.
of average scale only across exporters. In this case, financial frictions affect the average scale not only by increasing the Lagrange multipliers, but also by changing the set of firms that export $X$. Now, everything else equal, to the extent that a tightening of financial frictions reduces the measure of average scale of exporters (the denominator) relative to that of all firms that sell in the domestic market (the numerator), it leads to an increase in the trade wedge $\hat{\tau}$ and, thus, to a decrease in the aggregate trade share. I argue below that this will indeed the case, as I confirm in the quantitative analysis.

Finally, the last term is a function of the share of firms that export. Ceteris paribus, to the extent that financial frictions lead to a reduction in the share of firms that export, they lead to an increase in the trade wedge $\hat{\tau}$ and, thus, to decrease in the aggregate trade share. As with the second term, I argue below that financial frictions indeed lead to a reduction in the share of firms that export, therefore reducing the aggregate trade share through this channel.

I have now described the different channels through which financial frictions affect the aggregate trade share. I have argued that, to the extent that financial frictions reduce the share of firms that export, as well as their average scale relative to all firms that sell domestically, they lead to an increase in $\hat{\tau}$, therefore leading to a decrease in the aggregate trade share via the trade-specific channel. In the next subsections, I show that, indeed, this is the case.

### 3.2 Financial frictions reduce the share of exporters

As described above, to the extent that the share of firms that export decreases with financial frictions, it leads to a ceteris paribus reduction in the aggregate trade share. I now show that, indeed, financial frictions prevent firms from financing their export entry investments, leading some of them to delay or cancel their entry to the foreign market. Thus, at the aggregate level, these distortions lead to a reduction in the share of firms that export.

Whether or not entrepreneurs are subject to financial constraints, they choose to start exporting as long as the lifetime expected utility from starting to export is at least as high as that from remaining a non-exporter — in that case, they pay the sunk export entry cost $F$ and begin to sell internationally starting in the following period.

To see this formally, it is instructive to focus on the version of the entrepreneurs' problem that I present in Appendix A, which reformulates their problem by getting rid of an endogenous state variable, and presents the choice of whether to export or not, the consumption-savings decision, and the static production decisions, as separate decision problems. Specifically, I show in Appendix A that an equivalent formulation of the entrepreneurs' problem can be specified with net worth $a := k - \frac{d}{1+\tau}$ as a state variable, instead of $k$ and $d$.

A firm that cannot currently export ($e = 0$) chooses to pay the export entry cost to start exporting.

---

16The idea is that the net worth of entrepreneurs is a sufficient statistic to capture their wealth and borrowing capacity. At an intuitive level, entrepreneurs with low capital relative to debt — that is, with low net worth — have low wealth and borrowing capacity, conditional on the tightness the financial constraint. In contrast, entrepreneurs with high capital relative to debt have high net worth and, thus, are both wealthier and have a higher borrowing capacity.
in the following period \((e' = 1)\) according to the following condition:

\[
\text{Pay sunk export entry cost } (e' = 1) \iff \tilde{g}(a, 0, 1; z, \alpha) \geq \tilde{g}(a, 0, 0; z, \alpha)
\]

where \(\tilde{g}(a, e, e'; z, \alpha)\) is defined in Appendix A as the lifetime expected utility of a firm with net worth \(a\), export-status \(e\), productivity \(z\), and capital-intensity \(\alpha\), conditional on choosing next period’s export status \(e'\).

Financial frictions affect firms’ export entry decisions by distorting the value of \(\tilde{g}(a, 0, 1; z, \alpha)\) relative to \(\tilde{g}(a, 0, 0; z, \alpha)\) at different levels of net worth and productivity. They lower the value of exporting through three channels. First, firms with sufficiently low net worth cannot afford to finance the sunk export entry cost using the external and internal funds available. Low net worth implies having limited internal funds (low capital stock, low profits from production), as well as limited access to external financing. For these firms, choosing \(e' = 1\) is not a feasible option, and thus \(\tilde{g}(a, 0, 1; z, \alpha)\) is defined to be \(-\infty\). Now, even though firms with higher levels of net worth may afford this investment, their decisions are also distorted. For these firms, financial frictions reduce the entrepreneurs’ potential to smooth out the payment of sunk costs across their lifetime and, thus, are forced to rely relatively more on internal funds, leading to a larger drop in consumption upon entry — given that they dislike such drops, many entrepreneurs choose to delay their decision to enter the foreign market until they accumulate higher levels of net worth. Finally, and as I show below in more detail, financial frictions reduce the firms’ scale of operation upon entry to foreign markets, lowering their expected returns from making the export entry investment. With low expected returns, firms without sufficient net worth choose to delay their decision to enter the foreign market until they are able to increase their scale to make the profits from exporting worth the export entry investment.

To contrast the entrepreneurs’ decision to make the export entry investment under financial frictions with a frictionless environment, Figure 1 illustrates the export entry policy functions from the model with and without financial constraints. To make the comparison as sharp as possible, I contrast the export entry policy functions from an environment with \(\theta = 0\) to one from an environment with \(\theta = \infty\), while keeping all aggregate prices and quantities fixed.

The panel on the left plots the export entry policy function for the model without financial constraints. As in standard models of international trade with firms heterogeneous in productivity, there is a threshold level of productivity such that firms above it choose to export (that is, \(e' = 1\)), while those below it choose not to. The reason is simple: Firms’ profits in the foreign market are increasing in \(z\), while the cost of entry to this market is independent of productivity. Thus, when productivity is sufficiently low, lifetime expected profits from starting to export are lower than the sunk export entry cost, and these firms do not export.

The panel on the right plots the export entry policy function for the model with financial constraints. As in the frictionless model, and for the same reasons, there is a threshold level of productivity such that only firms above it choose to export. In addition, productive firms with sufficiently low net worth do not export — only those above a minimum level of net worth choose to do so. As discussed earlier, with financial constraints, firms with low net worth either cannot afford to finance
the sunk export entry cost, or they do not find it profitable to start exporting. Given the constrained scale at which they would export, and the drop in internal funds and consumption required to pay for the entry cost, only firms with high enough net worth choose to export. Note that the minimum level of net worth at which these firms start exporting is decreasing in productivity: Firms with higher productivity make relatively higher profits, per unit of net worth, from exporting, thus finding it more profitable to pay the sunk cost, conditional on being able to afford it.

We have, thus, seen that financial frictions distort entrepreneurs’ export entry decisions, leading ones with sufficiently low levels of net worth to postpone their decision to start selling internationally. At the aggregate level, this reduces the share of firms that export $E$, which leads to an increase in the trade wedge $\hat{\tau}$ and, thus, to a decrease in the aggregate trade share.

3.3 Financial frictions reduce the relative scale of exporters

I now argue that, not only do financial frictions distort firms’ export entry decisions, but they also reduce their scale of operation relative to non-exporters. I first show that the scale of all firms in the economy is distorted by financial frictions. Then, I argue that the distortions induced by financial frictions are likely to be larger for exporters. To the extent that this is the case, financial frictions lead to a decrease in the trade share, as we have seen earlier in this section.

In order to examine the effect of financial frictions on entrepreneurs’ production decisions, it is useful to focus on the static problem presented towards the end of Appendix A, which characterizes the optimal production decisions as a function of net worth $a$, export status $e$, productivity $z$, and capital-intensity $\alpha$.

Financial frictions distort entrepreneurs’ production decisions by reducing the scale at which they can choose to operate the firm. If $\theta < 1 + r$, the entrepreneur can operate the firm with a capital stock
that is, at most, as high as \( \frac{1+r}{1+r-\theta}a \). Therefore, if \( \theta \) is low enough, the magnitude of an entrepreneurs’ net worth \( a \) determines his production possibility frontier. In contrast, if \( \theta \geq 1+r \), the firm can operate with a capital stock that is as high as desired as long as \( a > 0 \). This is sensible, since, with \( \theta \geq 1+r \), agents can fully collateralize the amount borrowed as long as it is used to purchase an increase in the capital stock. Therefore, in this case, they have access to any desired amount of funds, insofar they lead to a more than equivalent increase in the size of the collateral posted.

Formally, these distortions to firms’ capital accumulation decisions leads them to hold sub-optimal levels of capital, and is reflected in variation in the marginal product of capital across firms:

\[
MPK(a, e; z, \alpha) = r + \delta + \mu_{\theta}
\]

where \( \mu_{\theta} \) is the Lagrange multiplier on the borrowing constraint. Therefore, to the extent that financial constraints bind, we have that \( \mu_{\theta} > 0 \), which increases the marginal product of capital above what it would be if the firm faced no financial constraints — thereby implying that firms hold less capital than otherwise.

The extent to which financial constraints distort firms’ production decisions depends not only on their production possibility frontier, but also on their desired scale of operation. In this model, an entrepreneur’s desired scale of operation is a function of his productivity \( z \), and the effective demand faced in the markets served. To the extent that a firm has higher productivity and faces a larger number of markets, it has a higher desired optimal scale. Therefore, conditional on a given level of net worth \( a \) and capital intensity \( \alpha \), firms that are relatively more productive and which sell internationally have more binding financial constraints — that is, \( \mu_{\theta} \) is larger for these firms. Thus, their decisions are likely to be relatively more distorted than those of the rest of the firms: their scale of operation relative to their frictionless scale is lower than for less productive firms that only sell domestically.

With a suboptimal level of capital, firms are unable to produce as much as they would otherwise want to. The left panel in Figure 2 indeed illustrates the relationship between net worth \( a \) and the total amount of output produced by exporters and non-exporters, conditional on a given level of productivity \( z \).\(^{17}\) As the figure clearly shows, for relatively low levels of net worth \( a \), the total output of exporters and non-exporters is increasing in the amount of net worth available: as the financial constraint is relaxed, firms can accumulate relatively more capital per unit of net worth available. Now, when their net worth becomes sufficiently large, firms reach their optimal scale, and do not increase their total output any further in response to further increases in net worth. However, exporters and non-exporters differ in their optimal scale and the amount of net worth required to reach it. In particular, exporters have a higher optimal scale than non-exporters, and require relatively more net worth to reach it. In this sense it is that, as argued above, conditional on a low level of net worth \( a \), exporters’ production decisions are relatively more distorted than those of non-exporters: the gap between their constrained scale, and their optimal scale, is larger for the former than the latter. The right panel in Figure 2

\(^{17}\)The model implies an analogous relationship between total output and net worth when we keep export status \( e \) fixed, and vary the level of productivity \( z \). If we were comparing two levels of productivity, \( z_l \) and \( z_h \) where \( z_h > z_l \), we could simply replace the “exporter” label by “\( z_h \)”, and the “non-exporter” label by “\( z_l \)” to get a sense of what the analogous figure would look like.
Figure 2: Output and Lagrange multipliers by export status, conditional on $z$ and $\alpha$

illustrates this by plotting the Lagrange multiplier on the collateral constraint for exporters and non-exporters as a function of net worth: a measure of the intensity at which the financial constraint binds. We can see that, conditional on a level of net worth, exporters have higher Lagrange multipliers than non-exporters, since their marginal product of capital is relatively more distorted given that they have a higher optimal scale.

I have, thus, just shown that financial frictions distort entrepreneurs’ production decisions. Moreover, I have argued that, exporters are relatively more distorted than non-exporters. Yet, it is important to note that, in doing so, I have compared exporters with non-exporters while keeping the level of net worth constant between them. But, as we have seen earlier, exporters are more likely to have higher levels of net worth, which may offset the strength of the channel discussed in this section. While the overall strength of the mechanism presented in this section is ultimately a quantitative matter, to the extent that the scale of exporters is relatively more distorted than the scale of non-exporters, financial frictions lead to an increase in the trade wedge $\hat{\tau}$ and, thus, to a decrease in the aggregate trade share.

3.4 Financial frictions distort capital-intensive firms relatively more

Up to here, I have studied the mechanisms through which financial frictions affect the aggregate trade share in this economy. I now study the extent to which financial frictions have a differential impact on the trade share of the set of capital-intensive firms (the capital-intensive industry) relative to trade share of the set of non-capital intensive firms (the non-capital-intensive industry). I show that the production decisions of non-capital-intensive firms are relatively less distorted than those of capital-intensive firms, given that they require lower levels of external financing. Therefore, I argue that the strength of the two key channels through which financial frictions distort the trade share in this
economy is diminished for these firms.

Consider two entrepreneurs with identical export status and productivity, but with differing levels of capital-intensity. The optimal unconstrained level of capital of the firm with higher capital-intensity relative to that with the lower capital-intensity is given by:

\[
\frac{k_h}{k_l} = \frac{1}{(r + \delta)(\sigma - 1)(\alpha_h - \alpha_l)} > 1
\]

where \(k_h\) and \(k_l\) denote the optimal unconstrained level of capital of high-capital-intensity and low-capital-intensity firms, respectively. Given that \(\sigma > 1\) and \(r + \delta < 1\), we have that \(\frac{k_h}{k_l} > 1\): that is, capital-intensive firms have a relatively higher level optimal level of capital than non-capital-intensive firms. Therefore, non-capital-intensive firms make less use of physical capital in production and, thus, have less investments that potentially require external financing. To the extent that these entrepreneurs also have low and identical levels of net worth \(a\), it is straightforward to see that the capital-intensive firm has a more binding financial constraint.

Given that firms in the less capital-intensive industry are more likely to operate close to their optimal scale and face lower investment needs that may potentially require external financing, they are likely to have a higher flow of internal funds to finance the investment to begin exporting, were they to find this endeavor profitable. Therefore, their export entry decisions are also likely to be less distorted due to their lower capital-intensity.

Now, what is the impact of these effects on the sectoral trade shares? The sectoral trade shares are given by the same expressions from Section 3.1, with the only difference that all integrals are taken across firms conditional on a given level of capital-intensity. Then, the previous discussion suggests that the two channels through which financial frictions reduce the trade share are weaker among firms with lower capital-intensity. Export entry decisions are likely to be less distorted in this sector. In addition, the production decisions of all firms are also likely to be less distorted (if at all), thereby implying that the relative impact of the frictions on the scale of exporters is likely to be diminished.

As mentioned earlier, note that most of these arguments are true conditional on a given level of net worth \(a\). To the extent that entrepreneurs with different capital-intensities do not completely offset the relative impact of the frictions on their production and export-entry decisions by adjusting the endogenous dynamics of net worth, the above arguments continue to hold. In the next section, we study the quantitative impact of financial frictions on the aggregate trade share by taking into account for the endogenous dynamics of net worth.

4 Quantitative analysis

In the previous section, I studied the mechanisms through which financial frictions distort aggregate- and industry-level trade flows in the model introduced in Section 2. While I have shown that that the aggregate trade share is reduced by financial frictions insofar these distort the decisions of firms engaged in international trade sufficiently more, the extent to which this is the case is ultimately a quantitative matter.
In this section, I study quantitatively the aggregate implications of financial frictions on international trade. To do so, I begin by calibrating the model to match key features of the data. The goal of the calibration procedure is to make the model economy as similar as possible to an actual economy, in order to run a set of experiments that may allow me to learn about the effects that changes in the development of financial markets in actual economies may have on international trade. Thus, I calibrate the model to match moments from data on Chilean plants that have been previously used in the literature to discipline similar economic environments. Given that the questions I ask in this paper extend well beyond the Chilean economy, and given the lack of accessible and comparable cross-country plant-level datasets, I interpret the results from my experiments to apply across countries, under the assumption that all parameters of the model are identical across countries except for those that I experiment with. I argue that, given that Chilean plants operate in an environment with an intermediate level of financial and economic development, the calibration approach is more likely to identify technological parameters that apply across countries with different levels of development, rather than ones specific to economies at the extremes of economic and financial development.

With a calibration of the model economy that resembles an actual economy, I then proceed to conduct a series of experiments to study the effect of financial frictions on international trade at both the industry- and aggregate-level. The main experiment consists of contrasting the stationary equilibrium of the baseline calibration, with the stationary equilibria of two economies featuring levels of financial development at each end of the spectrum. On one end, I contrast it with an economy in which financial frictions are the tightest and entrepreneurs cannot borrow at all — that is, where $\theta = 0$. On the other end, I contrast the stationary equilibrium of the baseline calibration with an economy in which there are no financial frictions and firms can borrow without posting collateral — that is, where $\theta = \infty$. I interpret the differences in the outcomes across these economies with differing degrees of financial development as informative about the effects of financial development.

I begin by using the experiment to study the effect of financial development on international trade across industries with different degrees of dependence on external finance. In the model, entrepreneurs with higher capital shares in their production technology have higher financing needs, since they have higher optimal levels of capital to accumulate — they are, thus, more likely to depend on external finance to operate. As mentioned earlier in the paper, I refer to the set of all entrepreneurs that operate with the technology featuring a high capital share $\alpha_h$ as the capital-intensive industry, or sector. Similarly, I refer to the set of all entrepreneurs that operate with the low-capital-share technology $\alpha_l$ as the non-capital-intensive industry, or sector. Note that there is no role played in the model by this concept of an industry or sector, beyond the decisions made by the entrepreneurs of each type.

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18 Analogous assumptions are made by other cross-country quantitative studies in the literature; see, for instance, Collard-Wexler, Asker, and Loecker (2011).

19 I remain agnostic, however, about the specific policies that may drive these differences in financial development. Specifically, I restrict the analysis to examining the impact that changes in the technology available for transforming savings into loans, namely $\theta$. An analysis of the actual policies that may drive these changes in the financial market is beyond the scope of the paper, and is an interesting avenue for further research.

20 The goal here is to create a theoretical counterpart to the concept of an industry studied in work based on Rajan and Zingales (1998) to identify the effect of differences in the extent of external finance dependence on economic outcomes — I therefore abstract from other dimensions along which industries may differ.
I first study the effect of financial development on industry-level trade shares. Not only am I interested in the effect that differences in financial development may have on these, but am also interested in the potential differences that these effects may exhibit across industries. I contrast these results with estimates based on a cross-country dataset at the industry-level that has been previously studied in the literature. Specifically, I use this dataset to estimate an empirical specification which explains the trade share of an industry in a given country as a function of a measure of the country’s level of financial development, and an interaction between this measure and a proxy for the industry’s dependence on external finance. Not only does this comparison serve as an exercise to potentially validate the implications of the model, but it also serves to provide a structural general equilibrium interpretation to related empirical estimates that have been previously documented in the literature.

After studying the effect of financial development on international trade at the industry-level, I proceed to study its effects at the aggregate-level. I begin by documenting the effects of financial frictions on the aggregate trade share, and contrasting them with the effects observed at the industry-level. I then study the channels that account for my findings. I show that the magnitude of the sunk export entry cost plays a key role determining the extent to which financial frictions distort aggregate trade flows. I conclude the section by contrasting my estimates of the sunk export entry cost with previous estimates from the literature.

4.1 Calibration

I now present the approach I follow to calibrate the model. I first introduce the Chilean plant-level dataset that I use throughout. Then, I present the details of the strategy I pursue for choosing each of the parameters of the model.

4.1.1 Data

I use Chilean plant-level data from the Chilean Annual Manufacturing Survey (ENIA), collected by the Chilean National Institute of Statistics (INE) for the years 1995 to 2007. The survey collects longitudinal data on all plants with more than 10 workers, and provides information on foreign and domestic sales, as well as on the use of factor inputs, which constitute the main variables I make use of to calibrate the model.

I exclude observations with negative or missing sales in the domestic or foreign markets, as well as those with zero or missing total sales. I also exclude observations from the following International Standard Industrial Classification (ISIC) Revision 3 categories, given their large price fluctuations and sharp increase in the share of the industries’ output traded over this period: 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 categories.
To start with, I partition the parameter space into two groups. The first group of parameters is predetermined to standard values from the literature, as well as to values estimated directly using analytical expressions from the model and plant-level data. The second group of parameters is chosen simultaneously, using the method of simulated moments, to match a set of key moments from the plant-level data.

The set of predetermined parameters consists of the preference parameters $\gamma$, $\sigma$, and $\beta$, and the technological parameters $\alpha_h$, $\alpha_l$, and $\delta$. The coefficient of relative risk aversion $\gamma$ is set to 2, the discount factor $\beta$ is set to 0.96, and the elasticity of substitution across varieties $\sigma$ is set to 4. The rate of capital depreciation $\delta$ is set to 0.06. These values fall well within the range of values that have been used in the literature to calibrate similar economic environments.\(^{21}\)

The capital shares $\alpha_h$ and $\alpha_l$ corresponding to the two types of entrepreneurs in the economy are estimated directly using plant-level data and an analytical expression for these shares obtained from the solution to the entrepreneurs’ problem. First, note that for every type of entrepreneur $i \in \{h, l\}$, the optimality conditions that characterize the solution to this problem can be rearranged to imply:

$$\alpha_i = 1 - \left( \frac{\sigma}{\sigma - 1} \right) \left( \frac{wn}{p_h y_h + p_f y_h} \right)$$

Following Midrigan and Xu (forthcoming), I calculate the capital share for every plant in the sample using the total wage bill to compute $wn$, and a measure of value-added\(^{22}\) to compute $p_h y_h + p_f y_h$. For the purposes of these calculations, I drop plants with negative values of value added, as well as plants with estimated capital shares below zero or above one. I compute the median capital share for each 3-digit ISIC rev. 3 industry category, and then set $\alpha_h$ and $\alpha_l$ as the capital shares corresponding to the industries with the highest (0.69) and lowest median capital shares (0.13), respectively. Capital shares are set at these values to capture the range of technologies operated across industries.\(^{23}\)

While they may not be representative of the typical technology operated in the economy, below I choose the share of entrepreneurs of each type to ensure that they have reasonable implications at the aggregate level by matching the aggregate capital-labor ratio.

The group of calibrated parameters consists of $F$, $\nu$, $\tau$, $\sigma_z$, $\eta$, the initial level of net worth $a$, and $\theta$. I choose them simultaneously following the method of simulated moments, to match the following moments from Chilean plant-level data: (1) the share of firms that export; (2) the exit rate (defined as the share of firms that don’t survive to the following period); (3) the ratio of aggregate exports to aggregate total sales; (4) the ratio of the average sales of exporters to the average sales of non-exporters; (5) the ratio of average sales at age five relative to the average sales upon birth among new firms that survive for at least five years; (6) the ratio of aggregate credit to aggregate value added; and

\(^{21}\)See Buera, Kaboski, and Shin (2011) and Midrigan and Xu (forthcoming) for the coefficient of relative risk aversion, discount factor, and rate of capital depreciation. See Broda and Weinstein (2006) and Simonovska and Waugh (forthcoming) for the elasticity of substitution.

\(^{22}\)I define value added as total revenue net of spending on intermediate inputs.

\(^{23}\)The average and median capital share across industries are 0.39 and 0.37, respectively. Their standard deviation is 0.13.
the ratio of aggregate capital stock to the aggregate wage bill. All target moments (1) – (7) are computed using the Chilean plant-level data described above. To compute (6), I also use the value of total credit to the manufacturing sector from Superintendencia de Bancos e Instituciones Financieras de Chile.

While all the calibrated parameters affect all of these target moments, I now provide a heuristic argument for mapping the former with the latter. The dispersion of idiosyncratic productivity $\sigma_z$ is informative about the size of exporters relative to non-exporters, since it affects the dispersion between high- and low-productivity firms and, hence, the gap between firms that choose to export and those which don’t do so. The sunk export entry cost $F$ affects the export entry threshold described in the previous section and, thus, the share of firms that export. The collateral constraint parameter $\theta$ is informative about the amount of credit taken in the economy, as reflected by the aggregate ratio of credit to value added, since firms with higher values of $\theta$ can choose to borrow relatively more. The initial net worth of newborn firms $a$ affects the extent to which these firms are constrained at birth and, thus, the gap between their optimal scale and their scale at birth. Thus, I choose it to target the ratio of average sales later in life (at age five), relative to their sales at birth — this ratio is decreasing in $a$. The iceberg trade cost parameter $\tau$ is informative about the aggregate ratio of exports to total sales in the economy since it controls the extent to which sales abroad are costlier than domestic sales, conditional on exporting. I interpret $\tau$ as a residual that accounts for the gap between the amount of international trade predicted by the other forces of the model (e.g., sunk export entry costs), and the amount of trade observed in the data — in this sense, it can capture technological costs to trade internationally, as well as policy distortions or demand-side factors that may affect trade and which are not modeled explicitly in this framework. As previewed earlier, the share of entrepreneurs of each type is chosen to match the aggregate capital-labor ratio in the economy, since this ratio is increasing in the share of entrepreneurs that operate the capital-intensive technology. Finally, the death rate $\nu$ is chosen to match the exit rate of firms.

The price of imported goods $p_m$ is set as the numeraire, and the quantity $\bar{y}^*$ and price $\bar{p}^*$ of the final good in the rest of the world are normalized to 10 and 1, respectively.$^{24}$ Finally, the average level of productivity $\mu_z$ is normalized to 1.

The calibrated parameters are presented in Table 1, while the moments targeted and their model counterparts are presented in Table 2. The model is solved using an adaptation of the endogenous grid method$^{25}$ to account for the discrete nature of the export entry decision. The statistics of the model are calculated from the stationary distribution of entrepreneurs, following the discretization approach in Heer and Maussner (2005).

---

$^{24}$In this model, and given the calibration approach described above, the size of the rest of the world can be normalized, since all that matters for firms’ export decisions is the product $\bar{y}^* \tau^{1-\sigma}$ — that is, the effective demand faced by exporters, after controlling for variable trade costs. To the extent that the size of the rest of the world is normalized to some value, our calibration procedure adjust $\tau$ such that the model predicts the target level of trade in the economy.

$^{25}$Carroll (2006).
Table 1: Parameter values

<table>
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<th>Predetermined parameters</th>
<th>Calibrated parameters</th>
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<tbody>
<tr>
<td>Discount factor</td>
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<tr>
<td>Risk aversion</td>
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<td>Elasticity of substitution</td>
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<td>Depreciation rate</td>
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<td>Capital share: Capital-intensive</td>
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<tr>
<td>Capital share: Non-capital-intensive</td>
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<td>Iceberg trade cost</td>
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<td>Death rate</td>
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<td>Productivity dispersion</td>
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<td>Initial net worth</td>
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<td>Share of capital-intensive firms</td>
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Table 2: Calibration moments

<table>
<thead>
<tr>
<th>Moment</th>
<th>Data</th>
<th>Model</th>
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</thead>
<tbody>
<tr>
<td>Share of firms that export</td>
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<td>0.21</td>
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<tr>
<td>Avg. sales (exporters/non-exporters)</td>
<td>7.20</td>
<td>7.20</td>
</tr>
<tr>
<td>Avg. sales (age 5/age 1)</td>
<td>1.52</td>
<td>1.52</td>
</tr>
<tr>
<td>Exit rate</td>
<td>0.10</td>
<td>0.10</td>
</tr>
<tr>
<td>Aggregate exports / Sales</td>
<td>0.25</td>
<td>0.25</td>
</tr>
<tr>
<td>Aggregate credit / Value added</td>
<td>0.50</td>
<td>0.50</td>
</tr>
<tr>
<td>Aggregate capital stock / Wage bill</td>
<td>4.67</td>
<td>4.67</td>
</tr>
</tbody>
</table>

4.2 Financial development and international trade across industries

I now use the calibrated model, which can account for key features of the data at both the plant- and aggregate-level, to study the effect of financial development on international trade across industries.

To do so, I run a counter-factual experiment through which I contrast the economic outcomes featured by the baseline calibration of the model with the outcomes featured by the stationary equilibria of two economies with financial frictions at each end of the spectrum: an economy in which these frictions are so tight that firms cannot borrow at all (that is, where $\theta = 0$), and an economy without frictions so that firms are not required to post collateral in order to borrow (that is, where $\theta = \infty$). All other parameters are kept fixed.

I use this experiment to answer the following question: To what extent do financial frictions reduce the share of output that is traded internationally across industries? After reporting my findings from
the experiment, I study the mechanisms of the model that account for the results I find. Finally, I contrast the outcomes of the experiment with estimates based on a cross-country dataset that has been previously used in the literature to study the relationship between financial development and international trade across industries.

4.2.1 What is the effect of financial development on the trade share across industries?

I report the outcomes of the counter-factual experiment in Table 3. Each column of the table reports equilibrium outcomes corresponding to the stationary equilibrium of a different economy, where I label the economy with $\theta = 0$ as “No credit”, the baseline calibration with $\theta = 0.29$ as “Baseline”, and the economy with $\theta = \infty$ as “Frictionless”. Except for the last panel, which reports the equilibrium prices, each row of the table reports separately the equilibrium outcomes corresponding to each of the two types of entrepreneurs in the economy. I label the entrepreneurs that operate the technology with capital share $\alpha_h$ as “Capital-intensive”, and those that operate the technology with capital share $\alpha_l$ as “Non-capital-intensive” — I refer to each of these sets of entrepreneurs as industries or sectors.

On the one hand, I find that, as the financial constraint is relaxed, the capital-intensive industry increases the share of output exported — from 0.34 in an environment with no credit, to 0.38 in a frictionless environment. While the increase is modest, it suggests that financial frictions distort firms’ export decisions relatively more than domestic ones, as discussed earlier. Therefore, as these frictions are relaxed, industry-level exports feature a relatively larger increase than domestic sales and, thus, we observe an increase in the trade share.

On the other hand, and in sharp contrast, I find that the non-capital-intensive industry exhibits a large decrease in the trade share as the financial frictions are relaxed — from 0.32 in an economy with no credit, to 0.12 in an economy with frictionless financial markets. While apparently at odds with the earlier discussion in Section 3, the response of the trade share is driven the effect of financial development on general equilibrium prices, which offset the mechanisms presented in the previous section. I discuss these forces in more detail below.

Therefore, I find that financial development leads to a sharply different response of industry-level trade shares across industries with different capital intensities and, thus, degrees of dependence on external finance. While the trade share increases by 0.10 log-points in the capital-intensive industry, it decreases by -0.96 log-points in the non-capital-intensive one. Therefore, we find that, as the economy’s financial markets develop, there is a large reallocation in the extent to which industries trade: from industries that have little dependence on external finance, to those that rely relatively more on well-functioning financial markets. That is, while capital-intensive industries increase the relative extent to which they trade, non-capital-intensive industries actually decrease the extent to which they do so.

4.2.2 What drives the differential response of the trade share across industries?

I now study the forces that account for the differential response of industry-level trade shares to changes in the development of financial markets. To do so, I present a series of equilibrium outcomes in Table 3 that are informative about the distortive effect of financial frictions on export entry and production.
Table 3: Financial development and international trade across industries

<table>
<thead>
<tr>
<th></th>
<th>No credit</th>
<th>Baseline</th>
<th>Frictionless</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exports / Domestic sales</td>
<td>Capital-intensive</td>
<td>0.34</td>
<td>0.34</td>
</tr>
<tr>
<td></td>
<td>Non-capital-intensive</td>
<td>0.32</td>
<td>0.32</td>
</tr>
<tr>
<td>Share of exporters</td>
<td>Capital-intensive</td>
<td>0.26</td>
<td>0.32</td>
</tr>
<tr>
<td></td>
<td>Non-capital-intensive</td>
<td>0.14</td>
<td>0.14</td>
</tr>
<tr>
<td>Effective interest rate</td>
<td>Capital-intensive</td>
<td>0.20</td>
<td>0.22</td>
</tr>
<tr>
<td></td>
<td>Non-capital-intensive</td>
<td>0.03</td>
<td>0.07</td>
</tr>
<tr>
<td>Prices</td>
<td>Wage</td>
<td>0.61</td>
<td>0.65</td>
</tr>
<tr>
<td></td>
<td>Interest rate</td>
<td>-0.05</td>
<td>0.06</td>
</tr>
</tbody>
</table>

decisions across industries. In addition, in the bottom panel, I present the factor prices that support an equilibrium in each of the environments that I study in this experiment.

I argue that the response of an industry’s trade share 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 per unit of collateral posted, allowing them to operate at a higher scale, as well as making it feasible, or more attractive, to undertake the export entry investment. Given the discussion in Section 3, these effects lead to an increase in the trade share. On the other hand, however, the increased scale of operation induced by financial development, as well as the increase in export entry investments, leads to an increase in the demand for labor and capital by entrepreneurs. The increased demand for labor leads to an increase in the wage to ensure that the labor market clears. Similarly, the increased demand for capital leads to an increased demand for loans, bidding up the interest rate to guarantee the clearing of financial markets. Now, this increase in factor prices, which can be observed in the bottom panel of Table 3, reduces the entrepreneurs’ profits in each of the markets — in particular, it reduces the profits from exporting, leading to a reduction in the returns to undertaking the export entry investment. Therefore, this response of general equilibrium prices reduces the share of firms that choose to export and, thus, acts as a force to reduce the trade share. The overall effect on the trade share, however, depends on the relative magnitude of these two opposing forces: to the extent that the former dominates the latter, the trade share increases — and vice-versa.

Given the role of these two opposing forces in determining an industry’s trade share, what accounts for the differential response of this statistic to changes in $\theta$ across industries with different capital
intensities? Table 3 presents a series of equilibrium outcomes which show that, in the capital-intensive industry, the increased incentives to trade internationally dominate the negative impact of the increase in factor prices. In contrast, the latter force dominates the former in the non-capital-intensive one.

On the one hand, I first show that production decisions are relatively more distorted in the capital-intensive industry, thus experiencing a relatively larger increase in the incentives to trade when financial markets develop. A useful measure of the extent to which financial frictions distort production decisions in each of the industries is the gap between the average effective interest rate faced by firms, and the underlying interest rate paid by the risk-free bond. In this economy, the effective interest rate is given by \( \tilde{r} := (1 + r)(1 + \mu_\theta) - 1 \), where \( \mu_\theta \) is the Lagrange multiplier on the borrowing constraint. Thus, the extent to which financial frictions distort firms’ production decisions is increasing in \( \frac{1 + \tilde{r}}{1 + r} \).

Table 3 indeed shows that production decisions are relatively more distorted in the capital-intensive industry for the economies with \( \theta < \infty \), since it features a relatively larger gap between its effective rate, and the rate paid by the bond. This is intuitive and in line with the discussion from Section 3, where I argued that production decisions in this sector are relatively more distorted since it has a higher optimal capital stock and, thus, faces a higher need for external finance.

On the other hand, Table 3 shows that factor prices are increasing in the development of financial markets. As discussed earlier, this increase in factor prices reduces the returns to undertaking the export entry investments. Now, given that this effect affects both industries to a similar extent, we conclude that the capital-intensive one experiences a larger net increase in the incentives to trade, given that its production decisions are initially relatively more distorted. Indeed this is what we observe, since the trade share increases in the capital-intensive industry, while this share decreases in the non-capital-intensive one. The share of firms that export mirrors the response of the industry-level trade shares, and clearly illustrates the tension between the two forces described above: while it increases in the capital-intensive industry in response to financial development, it decreases in the non-capital-intensive one.

4.2.3 How do these effects contrast with empirical estimates?

I now ask: To what extent are these findings consistent with the relationship between financial development and international trade observed in the data at the industry-level? To answer this question, I use cross-country measures of international trade and financial development at the industry-level to estimate a specification which explains the trade share of an industry in a given country as a function of the country’s level of financial development, and the interaction between this level and the degree of the industry’s dependence on external finance. I then use the estimated specification to compute an estimate of the change of industry-level trade shares in response to financial development across industries with different degrees of finance-intensity. Finally, I contrast these empirical estimates with

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26The effective interest rate is the interest rate that would make the entrepreneur indifferent between saving an extra unit of the final good by buying the risk-free bond, and the returns that accrue from capital accumulation — when the firm operates below its optimal scale, these returns are larger than the interest rate that clears the bond market.

27I derive the effective interest rate \( \tilde{r} \) from the entrepreneurs’ Euler equation: \( c^{-\gamma} = \beta c^{-\gamma}(1 + r)(1 + \mu_\theta) \). Thus, \( \tilde{r} \) is the rate that makes the agent indifferent between consuming an extra unit of the final good today, and investing an extra unit of it by accumulating capital.
the implications of the model presented in the previous subsections.

**Empirical specification**  In the model presented in the previous sections, the trade share of an industry \( i \) which operates a production technology with capital-intensity \( \alpha_j \in \{\alpha_l, \alpha_h\} \) is given, in logs, by:

\[
\ln \frac{\text{Exports}_j}{\text{Domestic sales}_j} = \ln \left[ \frac{p^s y^s}{p^y y} \right] + (1 - \sigma) \ln \tau + \ln E_j + \ln \left[ \frac{1}{E_j} \int_{X_j} \left[ z \left( \frac{r + \delta}{r + \delta + \mu(s)} \right)^{\alpha_j} \right]^{\sigma-1} \phi(s) ds \right] + \int_{S_j} \left[ z \left( \frac{r + \delta}{r + \delta + \mu(s)} \right)^{\alpha_j} \right]^{\sigma-1} \phi(s) ds
\]

where \( S_j \) denotes the set of all entrepreneurs that operate a technology with capital-intensity \( \alpha_j \), and \( X_j \) the set of all of these which export. The first two terms are identical for all industries in the economy. The third and fourth ones, however, are a function of country-specific characteristics (such as the level of development of financial markets and the distribution of productivity across plants) as well as a function of industry-specific features, such as the extent to which the industry depends on external finance.

I follow Manova (2013) and Beck (2003) in estimating this relationship using a cross-country panel of industry-level data using the following empirical specification:

\[
\ln \frac{\text{Exports}_{ijt}}{\text{Domestic sales}_{ijt}} = \alpha_i + \beta_j + \gamma_t + \frac{\text{Credit}_{it}}{\text{GDP}_{it}} \left[ \omega_1 + \omega_2 \times \text{Finance-intensity}_j \right] + \sum_{k=1}^{K} \eta_k x_{k,ijt} + \varepsilon_{ijt}
\]

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 the rest of the world to total domestic sales corresponding to industry \( j \) in country \( i \), in year \( t \). \( \frac{\text{Credit}_{it}}{\text{GDP}_{it}} \) denotes the country-level ratio of credit to GDP, which is a widely-used outcome-based measure of financial development. Finance-intensity\(_j\) denotes an industry-level index of the degree to which an industry has an intensive need for external finance — in the model, this is associated with the industries’ capital share. Finally, \( x_{k,ijt} \) denotes other covariates that are used as controls. In the next subsection I describe in more detail each of the variables that I use to estimate this specification.

While, throughout the next subsections, I may sometimes use language that can suggest that \( \omega_1 \) and \( \omega_2 \) actually estimate the causal impact of financial development on industry-level trade shares, I remain agnostic about the extent to which these parameters capture a relationship that is causal in nature. For my purposes, these parameters capture the empirical relationship among industry-level trade shares and the interaction between the country-level extent of financial development and the industries’ need for external finance — regardless of causality. I interpret this empirical relationship as a moment of the data with which to contrast the implications of the model. For a causal interpretation of these parameters, see Manova (2013).
Data

The data that I use in this section is based on the dataset constructed by Manova (2013), which I downloaded from the publisher’s website. The dataset consists of a panel of 107 countries and 27 sectors at the 3-digit ISIC rev. 2 level for the period 1985-1995. I aggregate the data to obtain observations at the country $i$, industry $j$, and year $t$ level.

To construct industry-level trade shares, I compute the ratio between a measure of exports and a measure of 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 a measure of total output constructed by the United Nations Industrial Development Organization (UNIDO) at the 3-digit ISIC rev. 2 level. Observations with industry-level trade shares below zero or above one are dropped.

The measure of credit-to-GDP at the country-level is obtained from Beck, Demirguc-Kunt, and Levine (2010), and covers the total amount of credit issued by banks and other financial intermediaries to the private sector. This variable ranges from 0.4% in Guinea-Bissau in 1989, to 179% in Japan in 1995 — the mean value is 39.7% and its standard deviation is 34.9%.

The industry-level measure of finance-intensity that I use is external finance dependence, and is defined as the share of capital expenditures not financed with cash flows from operations. I use the measure constructed by Braun (2003) based on data for all publicly listed US-based companies from Compustat’s annual industrial files. For further discussion on the motivation of this variable as a measure of external finance dependence, see Rajan and Zingales (1998) and Braun (2003). This variable ranges from -0.45 in the tobacco industry to 1.14 in the plastic products industry, with a mean value of 0.25 and a standard deviation of 0.33.

Finally, I control for the level of aggregate GDP, GDP per capita, and the average distance between the country and its export destinations. For further details on the construction of the data see Manova (2013).

Regression estimates

Table 4 reports the results from estimating the empirical specification above by ordinary least squares (OLS). Only the coefficients on the aggregate ratio of credit to GDP and its interaction with the finance-intensity measure are reported, since these are the main objects of interest. Note, however, that fixed effects for each country, industry, and year are included in the estimated regression, as well as the three control variables described in the previous subsection.

To interpret the estimated relationship between financial development and international trade across industries, it is instructive to compute the partial derivative of the trade share (in logs) with respect to the credit-to-GDP ratio, which is given by $\omega_1 + \omega_2 \times \text{Finance-intensity}_j$. The coefficient estimates of $\omega_1$ and $\omega_2$, both of which are statistically significant, imply that, in countries with higher credit-to-GDP ratios, industries with low enough levels of finance-intensity have relatively lower trade shares. In contrast, industries in which finance-intensity is sufficiently high have relatively higher trade shares in these countries. This relationship between the extent of financial development and trade shares across industries with different degrees of dependence on external finance is qualitatively consistent with the implications of the model presented earlier.
Financial development and industry-level trade shares: Model vs. data  I now study the extent to which the relationship between financial development and industry-level trade shares implied by the model is quantitatively consistent with the empirical estimates reported in the previous subsection. I do so by using the regression estimates to compute the change of industry-level trade shares associated with a change in the aggregate credit-to-GDP ratio of the magnitude implied by the model between the no credit and frictionless economies — as reported in Table 6, this ratio increases from 0.00 to 1.63 when $\theta$ is increased from 0 to $\infty$.

To contrast the response of industry-level trade shares across industries with different capital-intensities implied by the model, with the data, requires me to take a stand on the level of the finance-intensity measure corresponding to each of the industries in the model. Recall that I calibrated the capital shares at which each industry operates by choosing those of the industries with the highest and lowest values estimated from the Chilean plant-level data. Now, given that the model implies a monotonic relationship between the measure of finance-intensity that I use, external finance dependence, and each industry’s capital share, I compute the empirical counterpart to the change in the capital-intensive-industry’s trade share by evaluating the estimated regression at the highest level of finance-intensity observed in the data, among the industries that are observed in both datasets.28 Similarly, I compute the empirical counterpart to the change in the non-capital-intensive-industry’s trade share by evaluating the estimated regression at the lowest level of finance-intensity observed in the data, among the industries that are observed in both datasets. The results are reported in Table 5.

I find that the quantitative change of industry-level trade shares in response to the development

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Note: Fixed effects for each country, industry, and year are included. I also control for the log of aggregate GDP, GDP per capita, and the average distance between the country and its export destinations.

<table>
<thead>
<tr>
<th></th>
<th>$\ln(Exports/Domestic sales)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Credit/GDP</td>
<td>-0.69***</td>
</tr>
<tr>
<td></td>
<td>(0.15)</td>
</tr>
<tr>
<td>Credit/GDP × Finance-intensity</td>
<td>0.68***</td>
</tr>
<tr>
<td></td>
<td>(0.11)</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.50</td>
</tr>
<tr>
<td># of observations</td>
<td>15280</td>
</tr>
</tbody>
</table>

---

28This leads me to exclude ISIC rev. 2 code 314 (tobacco) since it is not observed in the plant-level dataset.
### Table 5: Financial development and trade across industries: Model vs data

<table>
<thead>
<tr>
<th></th>
<th>Model</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>High external finance dependence</td>
<td>0.10</td>
<td>0.14</td>
</tr>
<tr>
<td>Low external finance dependence</td>
<td>-0.96</td>
<td>-1.27</td>
</tr>
</tbody>
</table>

Note: “High external finance dependence” corresponds to the capital-intensive industry in the model, and to the industry with highest finance-intensity in the data. Similarly, “Low external finance dependence” corresponds to the non-capital-intensive industry in the model, and to the industry with lowest finance-intensity in the data.

The model captures a large extent of financial markets implied by the model is, to a large extent, consistent with the quantitative implications computed based on the empirical specification estimated above. Not only do I find that the trade share of the industry with high dependence on external finance increases in both the model and the data, but I find that they increase by modest amounts: by 0.10 and 0.14 log-points, respectively. In contrast, I find that the trade share of the industry with low dependence on external finance actually decrease very sharply in both the model and the data: by 0.96 and 1.27 log-points, respectively. Thus, the model can account for 71% and 76% of the change in the trade shares of the capital- and non-capital-intensive industries, respectively, implied by the empirical specification estimated above.

Therefore, I conclude that the model can not only capture the qualitative relationship between industry-level trade shares and financial development across industries with heterogeneous dependence on external finance, but can also do so, to a large extent, quantitatively. As described earlier, both the model and the data suggest that financial development is associated with a large reallocation of the extent to which the different industries trade, from ones with low dependence on external finance, to ones with high degrees of external finance dependence. Yet, while financial frictions clearly have a large impact on the economy’s allocations and its portfolio of exports, the previous results are silent with regards to the aggregate implications of financial frictions on the extent to which the economy trades at the aggregate level — I study these implications in the next section.

#### 4.3 Financial development and international trade at the aggregate-level

I now study the aggregate implications of this strong industry-level relationship between trade and finance. Specifically, I ask: To what extent do financial frictions reduce the share of output that is traded internationally at the aggregate-level? To answer this question, I compute the aggregate trade share corresponding to each of the economies studied in the experiment conducted in the previous section: an economy with $\theta = 0$ (“No credit”), the baseline calibration where $\theta = 0.29$ (“Baseline”), and an economy without financial frictions in which $\theta = \infty$ (“Frictionless”). After reporting my findings from the experiment, I study the mechanisms of the model and the features of the calibration
that account for the results that I find. I conclude by contrasting some of the features of the calibration
that I find to be important for my results with a previous study from the literature.

4.3.1 What is the effect on the trade share at the aggregate-level? Why?

I report the outcomes of the counter-factual experiment in Table 6. As before, each column of the table
reports the equilibrium outcomes corresponding to the stationary equilibria of the different economies
that I study.

As the financial constraint is relaxed, I find that the aggregate ratio of credit to value-added
increases sharply, from 0.00 to 1.63. This is intuitive: as firms’ borrowing constraints are relaxed, they
increase the amount that they borrow, both in levels and relative to a measure of the economy’s total
output. Possibly less intuitively, however, I find that, even though financial constraints are relaxed
and the aggregate amount of credit increases as sharply as it does, the aggregate trade share remains
virtually unchanged — it increases from 0.33 to 0.34, or by 3%, as we move from an economy without
credit to an economy without financial frictions. That is, even though I previously found that financial
frictions have a strong effect of the extent to which industries with differing degrees of dependence
on external financial trade internationally, these effects do not translate to a strong effect of financial
frictions on the extent of international trade at the aggregate-level.

To understand the forces that drive this result, it is instructive to express the aggregate trade share
as a weighted sum of the industry-level trade shares:

\[
\frac{X}{D} = \frac{D_l}{D_l + D_h} \times \frac{X_l}{D_l} + \frac{D_h}{D_l + D_h} \times \frac{X_h}{D_h}
\]

where, to simplify the notation, \(X\) and \(D\) denote aggregate exports and domestic sales, respectively,
while \(X_i\) and \(D_i\) denote industry \(i\)’s exports and domestic sales, respectively. Thus, the aggregate trade
share is a weighted sum of industry-level trade shares, where the weights are given by the relative size
of each industry in the domestic market.

From the results presented in the previous section, we already know how industry-level trade shares
respond to a relaxation of the financial constraint. Now, Table 6 reports the share of domestic output
accounted by the capital-intensive industry. I find that, as the financial constraint is relaxed, the share
of domestic output accounted by the capital-intensive industry increases, from 0.59 in the environment
without credit, to 0.84 in the economy without financial frictions. Therefore, as financial frictions are
relaxed, the capital-intensive industry not only increases its trade share, but also increases its share
of domestic output relative to the non-capital-intensive industry. These increases offset the sharp
decrease in the trade share experienced by the non-capital-intensive industry, leaving the aggregate
trade share virtually unchanged.

The forces at play behind the reallocation of domestic output toward the capital-intensive industry
in response to a relaxation of the financial constraints are the same that account for the differential
response of the trade shares across these industries. Given that firms in the capital-intensive industry
have a higher optimal capital stock, their scale is relatively more distorted by financial frictions than
Table 6: Financial development and international trade at the aggregate-level

<table>
<thead>
<tr>
<th></th>
<th>No credit</th>
<th>Baseline</th>
<th>Frictionless</th>
</tr>
</thead>
<tbody>
<tr>
<td>Credit / Value added</td>
<td>0.00</td>
<td>0.50</td>
<td>1.63</td>
</tr>
<tr>
<td>Exports / Domestic Sales</td>
<td>0.33</td>
<td>0.34</td>
<td>0.34</td>
</tr>
<tr>
<td>Capital-intensive share of domestic output</td>
<td>0.59</td>
<td>0.68</td>
<td>0.84</td>
</tr>
</tbody>
</table>

firms in the non-capital-intensive industry. Therefore, as these are relaxed, firms in the former industry increase their scale relatively more than firms which operate in the latter. Now, while factor prices also increase in response to a relaxation of the financial frictions, driving down profits and sales in each market, their impact hits firms in both industries in a similar fashion. Thus, we observe an increase in the relative contribution of the capital-intensive industry to the total output sold domestically.

4.3.2 Are these effects specific to the parameterization or a generic feature of the model?

I now study the sources behind the unresponsiveness of the aggregate trade share to the relaxation of the financial constraints. A potential concern is that, in the economic environment that I study, financial frictions may not be able to distort the share of aggregate output exported for any possible parameterization of the model. If that were to be the case, the quantitative analysis would be flawed (or irrelevant) from the start, since I would not be studying the extent to which financial frictions distort aggregate trade flows in an environment that gives the former the chance to affect the latter — even if the theoretical result could be of great academic and economic interest. In addition, a better understanding of the features of the calibration that could actually lead to large distortions at the aggregate-level would shed light on the forces of the model that are crucial for the result that I find.

Thus, I ask: To what extent are my previous findings a feature of the parameterization that I study, or a generic feature of the economic environment? To answer this question, I revisit the aggregate implications of financial development on international trade in the context of an alternative parameterization of the model that makes international trade be more intensive in finance. I do so by increasing the magnitude of the export entry costs that firms are required to pay to start exporting. As discussed earlier in the paper, financial frictions distort export entry decisions by preventing firms to borrow sufficient external funds to undertake such export entry investment. Thus, an increase in these costs increases the amount of external finance that firms would need to borrow to begin exporting, thereby making international trade a more finance-intensive activity.

I increase the export entry costs while simultaneously reducing the iceberg trade cost in half,\(^\text{29}\)

\(^\text{29}\)I reduce the iceberg trade cost in half to illustrate numerically with a large reduction of this cost.
in order to match the aggregate trade share observed in the data, while keeping all other parameters fixed at their baseline calibration values — the export entry cost required to do so is six times as large as in the baseline calibration. By the nature of the exercise, firm-level moments such as the share of exporters and their relative scale are inevitably off from the values observed in the data. However, from the lens of the aggregate moments targeted in the calibration, this alternative parameterization in fact looks very similar to the economy under the baseline parameterization — the aggregate ratio of credit to value-added is 0.48, and the aggregate ratio of the capital stock to the wage bill is 4.64.

I contrast the equilibrium outcomes of this alternative parameterization with their no credit and frictionless counterparts — that is, with the equilibrium outcomes from the economies with \( \theta = 0 \) and \( \theta = \infty \), respectively, in which all other parameters are kept fixed. I report the outcomes of this counter-factual experiment in Table 7. As in the counter-factual experiments based on the baseline calibration, as the financial constraint is relaxed, I find that the aggregate ratio of credit to value-added increases sharply, from 0.00 to 1.72 in this case. Now, in contrast to the experiments based on the baseline calibration, I find that the aggregate trade share indeed increases from 0.31 to 0.50, by 61% — compared with the 3% increase implied by the baseline calibration. This alternative parameterization, however, misses key features of the data that the baseline calibration can account for, such as the share of exporters, which is only 0.05, or the ratio between the average sales of exporters and the average sales of non-exporters, which is equal to 10.21. Therefore, I conclude that the findings reported in the previous section are not the result of a generic feature of the economic environment that I study, but a result specific to the calibration.

### 4.3.3 Is the size of export entry costs larger than previous estimates from the literature?

The previous subsection shows that the magnitude of the export entry cost plays a key role in driving the quantitative results reported earlier in this section. A potential concern, then, is that the calibration approach that I pursue in this paper leads to estimates of the export entry cost that are too low. Now, to evaluate this concern formally, I contrast my estimates of the export entry cost with previous estimates of these costs from the literature. That is, I ask: To what extent are my estimates of the export entry cost lower than previous estimates from the literature? To execute this comparison, I measure the magnitude of these costs using a statistic that has been previously reported in the literature: the ratio
Table 8: Size of export entry costs: Baseline calibration vs literature

<table>
<thead>
<tr>
<th></th>
<th>Avg. Export entry costs</th>
<th>Avg. Export profits of new exporters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline calibration</td>
<td>2.44</td>
<td></td>
</tr>
<tr>
<td>Parameterization with large export entry costs</td>
<td>16.85</td>
<td></td>
</tr>
<tr>
<td>Alessandria and Choi (2013)</td>
<td>0.99</td>
<td></td>
</tr>
</tbody>
</table>

between the average export entry cost and the average export profits of new exporters.

Table 8 reports the value of this statistic corresponding to both the baseline calibration and the alternative parameterization with large export entry costs discussed earlier, and contrasts them with the value reported in an influential paper from the literature which studies the implications of sunk export entry costs for international trade. Alessandria and Choi (2013) find that the average value of export entry costs is 0.99 times the value of average annual export profits of new exporters. In contrast, in the baseline calibration, the average value of export entry costs relative to average annual profits from selling abroad for the first time\textsuperscript{30} is significantly higher, at 2.44. This suggests that, if anything, my estimates of the export entry costs are significantly larger than previous estimates reported in the literature, which would in fact be overstating the impact of financial frictions on international trade at the aggregate-level. Finally, note that the ratio between the average export entry cost and the average export profits of new exporters in the alternative parameterization with large export entry costs, in which financial frictions do have a significant impact on the aggregate trade share, is almost seven times as large as in the baseline calibration, and almost seventeen times as large as in Alessandria and Choi (2013). This shows that export entry costs need to be significantly larger than estimated in the literature and this paper to have an aggregate impact on the share of output traded internationally.

5 Conclusion

In this paper, I have studied the aggregate implications of financial frictions on international trade. I introduced financial frictions to a standard model of international trade with heterogeneous firms subject to export entry costs, and estimated it using plant-level data from Chile. I found that financial frictions have a large effect on the extent of international trade across industries with different degrees

\textsuperscript{30}In the model, total profits cannot be naturally decomposed into the profits earned from selling to each of the markets, given that the financial constraint links the production decision across markets by limiting the capital stock with which firms can operate. Thus, I compute profits in the export market as the product between the share of total sales that are exported, and the firms’ total profits.
of dependence on external finance, and have shown that these effects are consistent with estimates based on cross-country industry-level data. Yet, I found that the model implies that financial frictions have a negligible effect on the extent of international trade at the aggregate-level.

These findings show that the strong relationship between the extent of international trade and measures of access to (or need of) external finance at the firm- or industry-level that has been widely documented in the literature need not imply a relationship between them at the aggregate-level. While financial frictions do affect the pattern of an economy’s specialization across sectors with differential degrees of dependence on external finance, they do not necessarily affect the share of output that economies sell to foreign markets.

More generally, these findings point to the importance of taking into account of general equilibrium effects when interpreting firm- or industry-level evidence. As in several other papers in the literature, while some distortions may appear to play an important role when studying firms or small industries in isolation, their importance at the aggregate level is often offset by changes in equilibrium prices.
References


Appendix A: Reformulation of the entrepreneur’s problem

I now reformulate the entrepreneurs’ problem to get rid of one endogenous state variable. This reformulation simplifies the analysis of the model as well as its numerical solution. I then adjust and restate the equilibrium conditions that are affected. Let \( a := k - \frac{d}{1+r} \) denote the entrepreneurs’ net worth at the beginning of the period, before interests are paid. I now show that the entrepreneurs’ problem can be reformulated with \( a \) as a state variable, instead of \( k \) and \( d \).

Starting from the recursive formulation of the entrepreneurs’ problem, plug the law of motion for capital into the budget constraint and use the definition of \( a' \) to obtain:

\[
pc + (1 - \nu)pa' + pd + wn + pF \mathbb{1}_{\{e=0, e'=1\}} = w + ph_0 + pf_y f + (1 - \delta)pk - T
\]

Then, the entrepreneur’s problem can be rewritten as:

\[
v(k, d, e; z, \alpha) = \max \frac{e^{1-\gamma}}{1 - \gamma} + \beta(1 - \nu)g(a', e'; z, \alpha)
\]

subject to

\[
pc + (1 - \nu)pa' + pd + wn + pF \mathbb{1}_{\{e=0, e'=1\}} = w + ph_0 + pf_y f + (1 - \delta)pk - T
\]

\[
y_h + \tau y_f = zk^\alpha n^{1-\alpha}
\]

\[
y_h = \left( \frac{ph_0}{p} \right)^{-\sigma} y
\]

\[
y_f = \left( \frac{pf_y f}{p*} \right)^{-\sigma} \tilde{y}^*
\]

where \( g(a, e; z, \alpha) \) is given by

\[
g(a, e; z, \alpha) = \max v(k, d, e; z, \alpha)
\]

subject to

\[
a = k - \frac{d}{1+r}
\]

\[
pd \leq \theta pk
\]

Now, plugging \( v(k, d, e; z, \alpha) \) into \( g(a, e; z, \alpha) \), and \( d = (1 + r)(k - a) \) into the budget and financial constraints, we obtain:

\[
g(a, e; z, \alpha) = \max \frac{e^{1-\gamma}}{1 - \gamma} + \beta(1 - \nu)g(a', e'; z, \alpha)
\]

subject to

\[
pe + (1 - \nu)pa' + (r + \delta)pk + wn + pF \mathbb{1}_{\{e=0, e'=1\}} = w + ph_0 + pf_y f + (1 + r)pa - T
\]

\[
px(1 + r - \theta) \leq (1 + r)pa
\]
\[ y_h + \tau y_h = zk^\alpha n^{1-\alpha} \]
\[ y_h = \left( \frac{p_h}{p} \right)^{-\sigma} y \]
\[ y_f = \left( \frac{p_f}{p^*} \right)^{-\sigma} y^* \]

To solve this problem numerically, I find it convenient to rewrite it in such a way that export entry decisions, consumption-saving decisions, and the static decisions are all solved separately. Based on the observation that, conditional on \( a, e, z, \) and \( \alpha \), the entrepreneurs’ production decision is static (as can be verified by computing his optimality conditions), the above problem is equivalent to:

\[ g(a, e; z, \alpha) = \max_{e'} \left\{ \tilde{g}(a, e, 0; z, \alpha), \tilde{g}(a, e, 1; z, \alpha) \right\} \]

where

\[ \tilde{g}(a, e, e'; z, \alpha) = \max_{c, a'} \frac{c^{1-\gamma}}{1-\gamma} + \beta (1-\nu) g(a', e'; z, \alpha) \]
subject to

\[ c + (1-\nu)a' + F \mathbb{1}_{(e=0, e'=1)} = \frac{w}{p} + \frac{\pi(a, e, z)}{p} + (1+r)a - \frac{T}{p} \]

and their static intra-period problem is given by:

\[ \pi(a, e; z, \alpha) = \max_{p_h, y_h, p_f, y_f, n, k} p_h y_h + e p_f y_f - wn - (r+\delta) pk \]
subject to

\[ y_h + \tau y_f = zk^\alpha n^{1-\alpha} \]
\[ pk(1+r-\theta) \leq (1+r)pa \]
\[ y_h = \left( \frac{p_h}{p} \right)^{-\sigma} y \]
\[ y_f = \left( \frac{p_f}{p^*} \right)^{-\sigma} y^* \]

With a slight abuse of notation, redefine the state space of entrepreneurs \( S := A \times E \times Z \times I \), where \( A \) denotes the set of possible values of net worth. The only equilibrium condition affected by this reformulation, besides the entrepreneur’s problem, is the clearing of financial markets. This condition becomes:

\[ \int_S k(s) \phi(s) ds = \int_S a(s) \phi(s) ds. \]