ABSTRACT

This paper studies the aggregate implications of financial frictions on international trade. I setup a multi-industry general equilibrium model of international trade with heterogeneous firms subject to export entry costs and financial frictions, in which industries differ in their dependence on external finance. The model is parametrized to match key features of plant-level data from Chile. The model implies that while financial frictions have a large effect on the extent of international trade across industries, consistent with estimates from cross-country industry-level data, they have a negligible impact at the aggregate-level.

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1 Introduction

International trade costs are large, particularly in developing countries.\textsuperscript{2} While recent studies have estimated large gains from reducing these costs,\textsuperscript{3} identifying specific policies that may allow poor countries to reduce them remains an important challenge.

Recent papers suggest that the development of financial markets may be one such policy. For instance, Beck (2003) and Manova (2013) find that better financial markets lead industries with higher dependence on external finance to export relatively more.\textsuperscript{4} Strong links between measures of access to external finance and international trade have been also documented at the firm-level by Minetti and Zhu (2011) and Bellone, Musso, Nesta, and Schiavo (2010), among others, suggesting firms’ export decisions are significantly distorted by financial frictions.\textsuperscript{5}

The goal of this paper is to study the extent to which frictions in financial markets act as a significant barrier to international trade at the aggregate-level. To do so, I investigate a multi-industry general equilibrium model of international trade with frictions in financial markets. The model features firms heterogeneous in productivity and external finance dependence, where international trade is a finance-intensive activity due to the existence of entry and variable costs. I parametrize the model to match key features of plant-level data from Chile, and use it to quantify the impact of financial frictions on the share of aggregate output that is traded internationally.\textsuperscript{6}

I find that, while financial frictions can indeed account for the strong em-

\textsuperscript{2}Anderson and van Wincoop (2004).
\textsuperscript{3}Waugh (2010) estimates large welfare gains from reducing international trade costs to the level of rich countries.
\textsuperscript{4}Similar findings have been also documented by Hur, Raj, and Riyanto (2006), Svaleryd and Vlachos (2005), among others.
\textsuperscript{5}Suwantaradon (2012) and Berman and Hericourt (2010) report similar findings. For a more exhaustive review of the empirical evidence available on the relationship between international trade and access to finance, see Contessi and de Nicola (2013).
\textsuperscript{6}A large literature has recently studied the extent to which financial frictions distort allocations in a closed economy. The goal of this paper is to study the extent to which trade is relatively more distorted than production for the domestic market. I, therefore, focus on the impact of financial frictions on the trade share, rather than on the level of trade.
Empirical relationship between financial development and international trade at the industry-level, they have a negligible effect on the extent of trade at the aggregate-level. Relaxing the financial constraints increases the trade share in industries with high dependence on external finance, but decreases it in industries with low external finance dependence. This reallocation of industry-level trade shares is driven by the higher equilibrium prices that result from the increased demand for factors of production due to financial development. These effects, along with the change in the share of aggregate output accounted by each industry, offset each other almost exactly, leaving the aggregate trade share virtually unchanged.

The model consists of an economy populated by heterogeneous entrepreneurs who supply labor and operate a firm that produces differentiated goods. To produce, entrepreneurs hire labor and accumulate capital internally. Firms can sell internationally, but first need to undertake an export entry investment, and are also subject to an ad-valorem trade cost.\textsuperscript{7} While entrepreneurs can borrow to finance these capital accumulation and export entry investments, they are subject to a collateral constraint, which limits the amount they can borrow to a fraction of the value of the capital stock installed at the time that loans are due for repayment.\textsuperscript{8} International trade is more finance-intensive in this economy due to the interaction of the collateral constraint with the entry and variable trade costs.\textsuperscript{9} Finally, a number of entrepreneurs die every period, and are replaced by a new cohort of entrepreneurs endowed with an idiosyncratic productivity level, a low initial level of capital,\textsuperscript{8}

\textsuperscript{7}International trade is modeled following Melitz (2003) and Chaney (2008), with the dynamic features of Alessandria and Choi (2013).
\textsuperscript{8}For closely 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).
\textsuperscript{9}This approach follows Chaney (2013) and Manova (2013), who introduce financial constraints to a standard Melitz (2003) model, and show that firms with insufficient internal funds may not afford to pay the export entry investments required to start exporting. The model I study is, however, most closely related to dynamic extensions of their framework, as executed by Kohn, Leibovici, and Szkup (2014), Gross and Verani (2013), or Caggese and Cunat (2013). Financial frictions have been also shown to distort firms’ decisions through alternative channels not considered in my model, as in Feenstra, Li, and Yu (2014), among others.
and a firm-specific capital-intensity. I interpret industries in this model as given by the set of entrepreneurs that operate a production technology with the same capital-intensity.

Financial frictions reduce the aggregate trade share through two channels. First, financial frictions distort the production decisions of exporters relatively more than those of non-exporters, thereby reducing the share of output that is sold internationally. While financial frictions distort the scale of production of all firms by limiting the capital expenditures that can be financed externally, exporters are distorted relatively more since they have a higher optimal scale: they face a larger market, and are also typically more productive. Second, financial frictions distort export entry decisions, reducing the share of firms that export. This leads them to delay export entry until sufficient internal funds are accumulated to undertake the export entry investment. In addition, to the extent that firms operate at a sub-optimal scale upon entry to the export market, financial frictions reduce the returns to exporting, leading firms to further delay the export entry investment until internal funds are sufficiently high.

To study the quantitative impact of financial frictions on international trade, I choose the parameters of the model to match moments from Chilean plant-level data which have been previously used to parametrize 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 target moments that make the model economy look close to the data at the aggregate-level along dimensions relevant to the trade-finance nexus.

I use the calibrated economy as a laboratory to study the impact of financial frictions on international trade at the industry- and aggregate-level. The main experiment consists of contrasting its stationary equilibrium allocations, with the stationary equilibria of two economies featuring levels of financial development at either ends 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 it with an economy in which
financial frictions are relaxed to resemble a financially developed economy. I interpret the differences in the outcomes featured by these economies with differing degrees of frictions in financial markets 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. I find that financial frictions have a large effect on the extent of international trade at the industry-level. Financial development has a heterogeneous impact across industries, which is driven by differences in capital-intensity that affect the degree to which frictions in financial markets distort their production decisions. In industries with high capital-intensity, where external finance dependence is high, relaxing the financial constraints increases the trade share, 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 that arise due to the increased demand for factors of production.

I then 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 impact 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 by each industry, offset each other almost exactly, implying that the aggregate trade share remains virtually unchanged.\textsuperscript{10}

I evaluate the validity of my findings by contrasting the industry-level implications of the model with estimates from industry-level data. To do so, I

\textsuperscript{10}A number of related papers have now studied other dimensions of the relationship between financial frictions on international trade at the aggregate-level from the lens of general equilibrium models. For instance, Wynne (2005), Matsuyama (2005), and Antras and Caballero (2009) study their qualitative impact on the pattern of comparative advantage. Brooks and Dovis (2013) investigate their quantitative impact on the gains from reducing the barriers to international trade.
construct an empirical counterpart to the implications of the model. First, I use the model to derive an empirical specification that explains an industry’s trade share as a function of the country’s level of financial development, the industry’s degree of dependence on external finance, and the interaction between them. I estimate it using the cross-country industry-level dataset previously used by Manova (2013) in a related context, with financial development measured as the ratio of aggregate credit to GDP and external finance dependence measured following Rajan and Zingales (1998). I then use the estimation results to compute the change of industry-level trade shares associated with a change in financial development across industries with varying degrees of finance intensity, where the latter are chosen to make the exercise consistent with the model’s calibration and quantitative experiment.

I find that the empirical estimates are qualitatively and quantitatively consistent with the industry-level implications of the model. I document that, while higher financial development is associated with an increase of industry-level trade shares in industries with high dependence on external finance, it is associated with a decrease of trade shares in industries with low external finance dependence. Moreover, I find that, in each of the industries, the model can account for more than 86% of the changes in trade shares associated with the development of financial markets.

Previous studies have largely focused on the relationship between financial development and the level of international trade flows across industries, documenting that better financial markets are typically associated with larger trade flows in all industries, but relatively larger in finance-intensive industries. To the best of my knowledge this is the first paper to document that such finding hides a qualitatively different response of trade shares across industries: financial development is associated with higher trade shares in finance-intensive industries, but lower trade shares in non-finance-intensive ones.

Finally, I contrast the aggregate implications of the model with their empirical counterparts.\textsuperscript{11} I first aggregate the cross-country industry-level data

\textsuperscript{11}Evidence of an aggregate relationship between trade and finance has been elusive given the econometric challenge to identify such estimates in a causal fashion. Amiti and Weinstein
across industries to generate a country-level panel dataset. I then use it to examine the relationship between financial development and aggregate trade shares by estimating an empirical specification that is consistent with my quantitative model. I find that the relationship between financial development and aggregate trade shares is statistically insignificant, which is consistent with the economically small link implied between them by the model.

My findings show that, even though we may observe a strong relationship between measures of access to external finance and industry-level trade shares, they need not imply that financial frictions have a strong effect on aggregate trade flows, as suggested by previous empirical studies. I introduce financial frictions to a standard model of international trade, calibrate it to match salient features of plant-level data, and find that while the model implies an industry-level relationship between trade and finance that is consistent with empirical estimates, it implies a negligible effect of financial frictions on international trade at the aggregate-level.

The paper is organized as follows. The rest of this section reviews the related literature. 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 contrasts the quantitative findings with empirical evidence. Section 6 concludes.

2 Model

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.

(2011) and Paravisini, Rappoport, Schnabl, and Wolfenzon (2014) overcome these difficulties by exploiting rich firm-level data that allows them to estimate the average response of trade-related outcomes across firms with differential exposure to banks affected by an aggregate shock. While the former estimate a strong link between firm-level variables and the exposure to affected banks, the latter show that the impact is significantly decreased once one controls for potential sources of estimation bias.

While Beck (2002) documents a strong link between trade and finance at the aggregate-level, his measure of interest, the ratio of manufacturing exports (or imports) to total GDP, is not directly comparable to the one I study, since it confounds the impact of financial development on the magnitude of the manufacturing sector relative to total GDP with its impact on the sectoral level of trade relative to output. My findings suggest that his results are driven by the former rather than the latter.
There are three types of goods in the economy: final goods, domestic varieties, and foreign varieties. Final goods are produced by final good producers and used by entrepreneurs for consumption and investment. Domestic varieties are produced by entrepreneurs and sold to final good producers and the rest of the world. Finally, foreign varieties are produced by the rest of the world and sold to final good producers. Only domestic and foreign varieties can be traded internationally.

2.1 Economic environment

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 period utility function, $\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \frac{c_t^{1-\gamma}}{1-\gamma}$, where $\gamma$ denotes the coefficient of relative risk aversion, $\beta$ is the subjective discount factor, and $\mathbb{E}_0$ denotes the expectation operator taken over the realizations of a death shock that is described below, conditional on the information set in period zero.

Technology Entrepreneurs produce a differentiated variety by operating a constant returns to scale production technology $y_t = z k_t^\alpha n_t^{1-\alpha}$, where $z$ denotes an idiosyncratic level of productivity, $k_t$ is the capital stock, $n_t$ is the amount of labor hired, and $\alpha \in (0,1)$ is the capital share. Idiosyncratic productivity $z$ is distributed log-normal with mean $\mu_z$ and standard deviation $\sigma_z$, and is fixed over the lifetime of entrepreneurs.

There are two types of entrepreneurs which differ in the capital-intensity $\alpha$ of their production technology. An exogenous 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.

Every period entrepreneurs are endowed with a unit of labor that is supplied inelastically to other entrepreneurs through a competitive labor market.

\footnote{In the quantitative analysis of the model, I interpret these two types of entrepreneurs as two industries that operate different production technologies.}
Capital is accumulated internally by transforming final goods invested in period $t$, $x_t$, into physical capital in period $t + 1$. Capital depreciates at rate $\delta$ after being used for production, leading to a law of motion for capital that is given by $k_{t+1} = (1 - \delta)k_t + x_t$.

**International trade** Entrepreneurs can trade internationally conditional on the 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 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 labor. A firm that can export in the current period, can export in every subsequent period. Furthermore, exporters are subject to an ad-valorem trade cost $\tau > 1$, which requires firms to ship $\tau$ units for every unit that arrives and is sold at destination.

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

**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 and capital accumulation decisions are made, entrepreneurs purchase an annuity contract. The contract specifies that, upon death, their savings and capital are transferred to surviving entrepreneurs. Upon survival to the following period, the contract specifies that agents receive $\frac{\nu}{1-\nu}$ units of capital per unit of capital held. Similarly, their savings are

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14 This assumption is made for convenience, to prevent wealth from being destroyed upon the death of entrepreneurs, while abstracting from an explicit modeling of bequests.
increased by $\frac{\nu}{1 - \nu}$ units per unit of savings held.\textsuperscript{15} 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 $T$ levied by the government on all entrepreneurs, an idiosyncratic productivity level drawn from the stationary productivity distribution, a capital-intensity $\alpha \in \{\alpha_h, \alpha_l\}$, 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 given by the rest of the world. These demand schedules are described in detail below. 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 is as follows. Entrepreneurs begin the period by hiring labor, producing their differentiated domestic variety, and then selling it in 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. At the very beginning of the following period, dead entrepreneurs are replaced by newborn ones, who receive an initial endowment of capital from the taxes paid by entrepreneurs in the previous period.

\textsuperscript{15}If in debt, their stock of debt is increased by $\frac{\nu}{1 - \nu}$ units per unit owed.
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 their differentiated variety in each of the markets, in order to maximize lifetime expected utility. 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 $k_{t+1} = \frac{1}{1-\nu} [ (1-\delta)k_t + x_t ]$, and production technology $y_{h,t} + \tau y_{f,t} = z k_t^{\alpha} n_t^{1-\alpha}$. Their budget constraint in period $t$ is given by
$$
p_t c_t + p_t x_t + p_t d_t + w_t F^I_{\{e_t=0,e_{t+1}=1\}} = w_t + p_{h,t} y_{h,t} + p_{f,t} y_{f,t} - w_t n_t + p_t d_{t+1} \frac{1-\nu}{1+\tau_t} - T,
$$
where $p_t$ denotes the price of the final good, $w_t$ denotes the wage rate, $F^I$ is an indicator function that is equal to one if its argument is true and zero otherwise, and the interest rate is adjusted by the annuity return.

2.1.2 Final good producers

Final good producers purchase differentiated varieties 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 varieties, $\{y_{h,t}(i)\}_{i \in [0,1]}$ 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

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

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 variety demanded by final good producers is given by the demand functions 
\[
y_{h,t}(i) = \left( \frac{p_{h,t}(i)}{p_t} \right)^{-\sigma} y_t
\]
and 
\[
y_{m,t} = \left( \frac{p_{m,t}}{p_t} \right)^{-\sigma} y_t,
\]
which are faced by entrepreneurs and the rest of the world, respectively.

2.1.3 Rest of the world

The rest of the world demands domestic varieties from entrepreneurs (the domestic economy’s exports), and supplies foreign varieties to final good producers (the domestic economy’s imports). The demand for varieties produced by entrepreneurs 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 varieties 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.

Domestic entrepreneurs have access to international financial markets where they face a perfectly elastic supply of funds at interest rate \( r \).

2.2 Entrepreneur’s problem: Recursive formulation

Given the environment described above, the entrepreneur’s problem can be represented by the following dynamic programming problem:
\[
v(k, d, e; z, \alpha) = \max_{c, x, n, d', k', p_h, p_f, y_h, y_f, e' \in \{0, 1\}} \frac{c^{1-\gamma}}{1-\gamma} + \beta (1-\nu)v(k', d', e'; z, \alpha)
\]
subject to
\[
pc + px + pd + wn + w F^w_{\{e=0, e'=1\}} = w + p_h y_h + p_f y_f + pd' \frac{1-\nu}{1+r} - T
\]
\[
k' = \frac{1}{1-\nu} [(1-\delta)k + x], \quad d' \leq \theta k'
\]
\[
y_h + \tau y_f = z k^\alpha n^{1-\alpha}, \quad y_h = \left( \frac{p_h}{p} \right)^{-\sigma} y, \quad y_f = \left( \frac{p_f}{\bar{p}^*} \right)^{-\sigma} \bar{y}^*
2.3 Equilibrium

Let \( S := K \times D \times E \times Z \times I \) denote the state space of entrepreneurs, where \( K = \mathbb{R}^+ \), \( D = \mathbb{R} \), \( E = \{0, 1\} \), \( Z = \mathbb{R}^+ \), and \( I = \{\alpha_l, \alpha_h\} \) denote the set of possible values of capital, debt, export status, productivity, and capital-intensity, respectively. Finally, let \( s \in S \) denote an element of the state space.

Then, a recursive stationary competitive equilibrium of this economy consists of prices \( \{w, p\} \), policy functions \( \{d', k', e', c, n, y_{d}, y_{x}, p_{d}, p_{x}, y, y_{m}, T\} \), a value function \( v \), and a measure \( \phi : S \to [0, 1] \) such that:

1. Policy and value functions solve the entrepreneurs’ problem
2. Policy functions solve the final good producers’ problem
3. Government’s budget is balanced: \( p\nu k = T \)
4. Labor market clears: \( \int_{S} [n(s) + F\Pi_{\{e=0,e'(s)=1\}}] \phi(s)ds = 1 \)
5. Markets for domestic varieties clear: \( y_{h}(i) = y_{h}(s) \) if \( s_i = s \)
6. Final good clears: \( \int_{S} [c(s) + x(s)] \phi(s)ds + \nu k = y \)
7. Measure \( \phi \) is stationary

3 Mechanism

I now study the mechanism through which financial frictions distort aggregate trade flows in this economy. While there is a large literature that studies the distortionary impact of financial frictions on the equilibrium allocations of similar economic environments, the extent to which international trade flows are relatively more distorted than production for the domestic market is much less understood. Therefore, I restrict attention to the effect of financial frictions on the aggregate trade share,\(^{16}\) that is, the ratio of exports to domestic trade flows.

\(^{16}\)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 distortions of international trade flows due to financial frictions, policies that relax these frictions can act as a reduction in the barriers to trade faced by poor countries, with potentially a very large impact on welfare via changes in the aggregate trade share (Waugh 2010).
sales,\(^\text{17}\) rather than on the level of trade. This allows me to focus on the relative impact of financial frictions across markets while abstracting from their overall impact on allocations.

The ratio of aggregate export sales to domestic sales is given by:

\[
\frac{\text{Exports}}{\text{Domestic sales}} = \frac{\tilde{y}^* y^*}{p^* y} \times \tau^{1-\sigma},
\]

where I refer to \(\tau\) as the trade wedge, which reduces the trade share to account for the impact of trade costs on firms' decisions. Absent any trade costs, the trade wedge equals one, and the aggregate trade share is given by the first term: the aggregate demand of the rest of the world relative to the aggregate demand in the domestic economy. In contrast, with trade costs, the trade wedge becomes larger than one, lowering the trade share given that \(\sigma > 1\).

Financial frictions affect the trade share through two channels. First, tighter financial frictions increase the relative effective foreign demand since domestic activity decreases while the rest of the world remains unchanged.\(^\text{18}\) This effect is captured by the first term in Equation (1). While it increases the trade share, it does so by shrinking the domestic economy and making it a less attractive destination. The second channel through which financial frictions distort the ratio of exports to domestic sales is by increasing the trade wedge, as captured by the second term in Equation (1). It is through this channel that economies with tighter financial frictions may look like economies subject to higher trade costs. To the extent that the latter effect is larger than the former, financial frictions reduce the aggregate ratio of exports to domestic sales in this economy.

While the forces behind the first channel are well understood from previous studies of similar economies, it is useful to examine the second one in more

\(^{17}\)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.

\(^{18}\)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.
detail, as it is the channel through which financial frictions may distort international trade flows relatively more than production for the domestic market. Therefore, I now study the forces that determine the trade wedge, which is given by:

\[
\hat{\tau} = \left[ \frac{\int_{\mathcal{S}} \left[ z \left( \frac{r+\delta}{r+\delta+\mu_0(s)} \right)^{\alpha} \phi(s) ds \right]^{\frac{1}{\sigma-1}} \times \left( \frac{1}{E} \right)^{\frac{1}{\sigma-1}}}{\frac{1}{E} \int_{\mathcal{X}} \left[ z \left( \frac{r+\delta}{r+\delta+\mu_0(s)} \right)^{\alpha} \phi(s) ds \right]^{\frac{1}{\sigma-1}} \phi(s) ds} \right] \times \tau, \tag{2}
\]

where \(\mu_0\) 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.\(^{19}\)

The first term captures the size of the firms that operate in the domestic market relative to the size of exporters. These measures of size consist of the average productivity across firms, where productivities are adjusted according to the extent to which the financial frictions bind. That is, while their optimal scale is increasing in productivity, their sales are reduced when financial constraints bind. To the extent that financial frictions reduce the measure of average scale of exporters (the denominator) relative to that of all firms that sell in the domestic market (the numerator), they imply a higher trade wedge \(\hat{\tau}\) and, thus, a lower aggregate trade share.

The second term is a function of the share of firms that export. To the extent that financial frictions reduce the share of firms that export, they imply a higher trade wedge \(\hat{\tau}\) and, thus, a lower aggregate trade share.

Finally, the last term is given by the variable trade cost \(\tau\) and is, thus, unaffected by the extent of financial development.\(^{20}\)

3.1 Financial frictions reduce relative scale of exporters

I now argue that financial frictions indeed reduce the scale of exporters relative to firms that only operate in the domestic market, leading to an increase

\(^{19}\)\(\mathcal{X}\) and \(E\) are given by \(\mathcal{X} := \{ s \in \mathcal{S} | e = 1 \}\) and \(E := \int_{\mathcal{S}} 1_{(e=1)} \phi(s) ds\), respectively.

\(^{20}\)The impact of variable trade costs on equilibrium allocations, however, is affected by the extent of financial development. Specifically, higher variable trade costs reduce the profit flows from exporting, reducing the speed at which firms can export to accumulate internal funds and relax their financial constraint.
in the first term of Equation (2). To see this formally, it is useful to focus on the reformulation of the entrepreneurs’ problem derived in Appendix A, which gets rid of an endogenous state variable and separates the dynamic decisions from the static ones. In this formulation of the entrepreneurs’ problem, net worth \( a := k - \frac{d}{1+r} \) becomes an endogenous state variable, instead of \( k \) and \( d \).

Financial frictions distort entrepreneurs’ production decisions by reducing the scale at which they operate the firm. If \( \theta \) is low enough (\( \theta < 1 + r \), specifically), the entrepreneur can operate the firm with a capital stock that is, at most, as high as \( \frac{1+r}{1+r-\theta}a \). In such case, the firm’s production possibility frontier is determined by its net worth. As a result of these distortions, firms hold sub-optimal levels of capital, which leads to variation in the marginal product of capital across firms: \( MPK(a, e; z, \alpha) = r + \delta + \mu_\theta \). In contrast, for high enough values of \( \theta \), the firm can operate with a capital stock that is as high as desired. In this case, the marginal product of capital is constant across firms since \( \mu_\theta = 0 \). The left panel of Figure 1 illustrates the relationship between net worth \( a \) and the total amount of output produced by exporters and non-exporters, conditional on states \( (z, \alpha) \).

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, which is a function of the productivity level \( z \) and the effective demand faced in the markets served. In particular, productive firms which sell to multiple markets have a relatively higher optimal scale than unproductive ones which only sell in the domestic market. Therefore, conditional on a given level of net worth \( a \) and capital intensity \( \alpha \), the financial constraints of the former firms will be relatively more binding, as the gap between their effective scale of operation and their optimal scale is relatively larger. The right panel of Figure 1 indeed shows that conditional on a level of net worth, exporters have larger Lagrange multipliers than non-exporters conditional on states \( (z, \alpha) \) since they have a higher optimal scale.
3.2 Financial frictions reduce the share of exporters

I now show that financial frictions indeed reduce the share of firms that export, leading to an increase in the second term of Equation (2).

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. Financial frictions affect firms’ export entry decisions by distorting these relative values at different levels of net worth and productivity.

Financial frictions lower the value of exporting through three channels. First, firms with sufficiently low net worth may not afford to finance the sunk export entry cost using the external and internal funds available. Second, firms with higher levels of net worth that can actually afford this investment may nevertheless also have their decisions distorted. For these firms, financial frictions reduce the potential to smooth out the payment of the sunk cost, forcing them to rely relatively more on internal funds and leading to a large drop in consumption upon entry. Therefore, such entrepreneurs choose to delay their export entry decision until they accumulate higher levels of net worth in order to reduce the impact on consumption. The third channel is driven by the distortions to the firms’ scale described above, which lower the expected returns from making the export entry investment. Firms without
sufficient net worth, then, choose to delay their decision to enter the foreign market until they can operate at a scale that ensures that the returns to the export entry investment are high enough.

To illustrate the impact of these channels on firms’ export entry decisions, Figure 2 contrasts their policy functions with and without financial frictions. To make the comparison as sharp as possible, I contrast an environment in which financial frictions are tightest and firms cannot borrow at all ($\theta = 0$) to a frictionless economy ($\theta = \infty$), while keeping all aggregate prices and quantities fixed.

The left panel plots the export entry policy for the model without financial constraints. As in standard models, there is a threshold level of productivity such that only firms above it choose to export. 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 right panel plots the export entry policy for the model with financial constraints. As in the frictionless model, 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. 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, thus finding it more profitable to pay the sunk cost, conditional on being able to afford it.

4 Quantitative analysis

In this section, I quantify the extent to which financial frictions distort international trade flows in this economy. To do so, I begin by calibrating the model to match key features of plant-level data. I then use this calibrated
economy as a laboratory 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 allocations of the baseline calibration with those of economies at different levels of financial development. I interpret differences in the outcomes implied by these economies as informative about the effects of financial development.\footnote{I remain agnostic, however, about the specific policies that may drive these differences in financial development. Such analysis is beyond the scope of the paper and constitutes an interesting avenue for further research.}

I first use the experiment to study the effect of financial development on international trade across industries with different degrees of dependence on external finance, and then study its effect at the aggregate-level. In the next section, I contrast my findings with estimates from the data.

4.1 Calibration

4.1.1 Data

I choose the parameters of the model to match key features of data from Chilean manufacturing plants for the period 1995 to 2007. The data was collected by the Chilean National Institute of Statistics (INE) as part of its Annual Survey of Manufactures (ENIA). 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 that I use to discipline the implications of the model.\footnote{I exclude plants 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 dependence on natural resource extraction: category 2720 (manufactures of basic precious and non-ferrous metals), and category 2411 (manufactures of basic chemicals except for fertilizers and nitrogen compounds). The quantitative results are robust to the inclusion of these categories.}

4.1.2 Parametrization

To choose the parameter values of the model, I begin by partitioning the parameter space into two groups. The first group of parameters is set to standard values from the literature, as well as to values estimated directly using plant-level data along with some of the analytical implications of the model. The second group of parameters is chosen simultaneously through the method of simulated moments to match a set of moments from the plant-level data. The parameter values used are presented in Table 1, while the moments targeted and their model counterparts are presented in Table 2.\footnote{The model is solved using an extension of the endogenous grid method from Carroll (2006) to account for the discrete nature of the export entry decision. The statistics of the model are calculated off the stationary distribution of entrepreneurs following the discretization approach in Heer and Maussner (2005).}

The set of predetermined parameters consists of the preference parameters ($\gamma$, $\sigma$, and $\beta$), the technological parameters ($\alpha_h$, $\alpha_l$, and $\delta$), and the interest rate $r$. The coefficient of relative risk aversion $\gamma$ is set to 2, which implies an intertemporal elasticity of substitution $1/\gamma$ equal to 0.5. The discount factor $\beta$ is set to 0.96, the elasticity of substitution across varieties $\sigma$ is set to 4, and the rate of capital depreciation $\delta$ is set to 0.06. These values fall well within the range of values that have been previously used in the literature to calibrate similar economic environments.\footnote{See Buera, Kaboski, and Shin (2011) and Midrigan and Xu (forthcoming) for economic environments that use similar values of the coefficient of relative risk aversion, discount factor, and rate of capital depreciation. See Guvenen (2006) and Blundell, Meghir, and Neves (1993) for estimates of the intertemporal elasticity of substitution, and Broda and Weinstein (2006) and Simonovska and Waugh (forthcoming) for estimates of the elasticity of substitution across varieties.} Given that the interest rate is assumed to be exogenous, I set it to match an average real interest rate equal to 6% in...
Chile over the period 1995-2007, as estimated by the International Monetary Fund for its International Financial Statistics.

The capital shares $\alpha_h$ and $\alpha_l$ that correspond to the two types of entrepreneurs in the economy are estimated directly by using plant-level data along with some of the analytical implications of the model. For every entrepreneur of type $i \in \{h, l\}$, the optimality conditions that characterize the solution to their problem can be shown to imply

$$\alpha_i = 1 - \left(\frac{\sigma}{\sigma - 1}\right) \left(\frac{\mu n}{p_h y_h + p_f y_f}\right),$$

I use plant-level data on the total wage bill and a measure of value added, along with the predetermined value chosen for $\sigma$, to compute the capital share of every plant in the sample. For each 3-digit ISIC rev. 3 industry category, I compute their median capital share, and then set $\alpha_h$ and $\alpha_l$ at the highest (0.69) and lowest median capital shares (0.13) across industries, respectively. Capital shares are set at these values to capture the range of technologies operated across industries. To ensure that the aggregate technology implied by these shares is reasonable, I choose the fraction of entrepreneurs of each type to match the aggregate capital-labor ratio.

The group of calibrated parameters consists of $F$, $\nu$, $\tau$, $\sigma_z$, $\eta$, $\theta$, and the initial level of net worth $a$. 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 operate in period $t$ which do not do so in period $t + 1$); (3) the ratio of aggregate exports to aggregate total sales; (4) the ratio between the average sales of exporters and 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

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25 Value added is computed as total revenue net of spending on intermediate inputs.

26 For the purposes of these calculations, I drop plants with negative value added, as well as plants with estimated capital shares below zero or above one.

27 The average and median industry-level capital share are 0.39 and 0.38, respectively. Their respective standard deviations are 0.10 and 0.07.

28 In Appendix A, I define net worth $a$ as $k - \frac{d}{1+r}$, and show that it is a sufficient state variable for the entrepreneur that can substitute for $k$ and $d$. I solve the model using this reformulation of the entrepreneur’s problem, and initialize newborn entrepreneurs with net worth $a$. Then, given net worth $a$ upon birth, entrepreneurs are free to choose their level of $k$ in the first period.
to aggregate value added; and (7) the ratio between aggregate capital stock\textsuperscript{29} and the aggregate wage bill. All target moments (1) – (7) are computed using the Chilean plant-level dataset described above. To compute (6), I also use the total value of outstanding credit in the manufacturing sector, as reported by the Superintendencia de Bancos e Instituciones Financieras de Chile.

While all the calibrated parameters simultaneously affect all of these target moments, I now provide a heuristic argument to map the former with the latter. The dispersion of idiosyncratic productivity $\sigma_z$ impacts 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. The sunk export entry cost $F$ affects the export entry threshold and, thus, the share of firms that export. The collateral constraint parameter $\theta$ determines the amount of credit taken in the economy as reflected, for instance, by the aggregate ratio of credit to value added, since higher values of $\theta$ allow firms to borrow relatively more. The level of initial net worth of newborn firms $a$ affects the extent to which these firms are constrained at birth and, thus, the gap between their scale in subsequent years and their scale at birth. The iceberg trade cost parameter $\tau$ plays a key role in determining the aggregate ratio of exports to total sales in the economy since it controls the extent to which sales abroad are more costly than domestic sales, conditional on being an exporter.\textsuperscript{30} As mentioned above, 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.

\textsuperscript{29}The capital stock at the plant-level is computed by applying the perpetual inventory method, using the value of $\delta$ chosen above and initializing each series with the book value of capital. For further details see, for example, Caballero, Engel, and Haltiwanger (1995).

\textsuperscript{30}I interpret $\tau$ broadly as a residual that captures features not modeled explicitly in this framework that are required to reconcile the implications of the model with the amount of trade observed in the data. That is, this parameter may capture more than technological costs to trade internationally, as a literal interpretation of the model may suggest. For instance, it may also reflect unmodeled policy distortions or demand-side factors that affect international trade.
Table 1: Parametrization

<table>
<thead>
<tr>
<th>Predetermined parameters</th>
<th>Calibrated parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discount factor $\beta$</td>
<td>Iceberg trade cost $\tau$</td>
</tr>
<tr>
<td>Risk aversion $\gamma$</td>
<td>Death rate $\nu$</td>
</tr>
<tr>
<td>Substitution elasticity $\sigma$</td>
<td>Productivity dispersion $\sigma_z$</td>
</tr>
<tr>
<td>Depreciation rate $\delta$</td>
<td>Sunk export entry cost $F$</td>
</tr>
<tr>
<td>High capital share $\alpha_h$</td>
<td>Collateral constraint $\theta$</td>
</tr>
<tr>
<td>Low capital share $\alpha_l$</td>
<td>Initial net worth $a$</td>
</tr>
<tr>
<td>Interest rate $r$</td>
<td>Fraction of $\alpha_h$ firms $\eta$</td>
</tr>
</tbody>
</table>

Finally, the price of imported goods $p_m$ is set as the numeraire, the average level of productivity $\mu_z$ is normalized to 1, 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.\footnote{In this model, given the calibration approach described above, we are free to normalize the size of the rest of the world. Specifically, conditional on a value of $\bar{y}$, the calibration approach adjusts $\tau$ to match the targeted level of trade without distorting other outcomes in the economy.}

4.1.3 Additional moments

In the bottom panel of Table 2, I report additional moments implied by the stationary equilibrium of the model along with their empirical counterparts, which are not targeted directly in the calibration procedure.

I first find that the degree of heterogeneity across firms featured by the model is close to its empirical counterpart. Specifically, the degree of dispersion in total sales, wage bill, and capital implied by the model is within the same order of magnitude as implied by the data, yet somewhat smaller. Moreover, the model implies the same quantitative relationship between them as observed in the data: dispersion of capital across firms is the largest, followed by sales dispersion at roughly 80% of capital dispersion, with wage bill dispersion around 66% lower than capital dispersion.

I also find that the contribution of young firms (less than 5 years old), to aggregate sales, the wage bill, and capital in the model is close to that observed in the data. Given that young firms are those that are distorted the most in the model, this finding serves as an additional check on the key friction
Table 2: Moments

<table>
<thead>
<tr>
<th>Moment</th>
<th>Data</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A. Used to calibrate model</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Share of firms that export</td>
<td>0.21</td>
<td>0.21</td>
</tr>
<tr>
<td>Average sales (exporters/non-exporters)</td>
<td>7.18</td>
<td>7.18</td>
</tr>
<tr>
<td>Average 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>0.33</td>
<td>0.33</td>
</tr>
<tr>
<td>Aggregate capital stock / Wage bill</td>
<td>5.40</td>
<td>5.40</td>
</tr>
<tr>
<td><strong>B. Additional moments</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Std. dev. total sales</td>
<td>1.75</td>
<td>1.27</td>
</tr>
<tr>
<td>Std. dev. wage bill</td>
<td>1.47</td>
<td>1.05</td>
</tr>
<tr>
<td>Std. dev. capital</td>
<td>2.17</td>
<td>1.61</td>
</tr>
<tr>
<td>Avg. total sales growth</td>
<td>0.02</td>
<td>0.04</td>
</tr>
<tr>
<td>Avg. wage bill growth</td>
<td>0.05</td>
<td>0.04</td>
</tr>
<tr>
<td>Avg. capital growth</td>
<td>0.09</td>
<td>0.06</td>
</tr>
<tr>
<td>Share of total sales, ages 1-5</td>
<td>0.22</td>
<td>0.21</td>
</tr>
<tr>
<td>Share of wage bill, ages 1-5</td>
<td>0.21</td>
<td>0.26</td>
</tr>
<tr>
<td>Share of capital, ages 1-5</td>
<td>0.18</td>
<td>0.13</td>
</tr>
</tbody>
</table>

Finally, I find mixed evidence on the extent to which the average growth featured by firms in the model is consistent with the data. While the average growth of the wage bill is close to the data, the model implies total sales which grow faster on average, while implying that capital grows considerably slower on average.

Given its stylized nature, the model does not necessarily account for all of these moments exactly, but can capture key features of the actual data in a reasonable manner. These findings lend further support for thinking about the calibrated model economy as a good approximation of the Chilean economy.

4.2 The experiment

To study the impact of financial development on international trade flows I use the model to conduct the following experiment. I compute the stationary
equilibrium of the calibrated economy and then contrast its allocations with those of two economies at different levels of financial development. In the first economy I set $\theta$ to zero, while keeping all other parameters fixed, to examine the allocations implied by the model in an environment in which firms have no access to external finance — that is, an economy in which financial frictions are at their tightest. In the second economy I set $\theta$ to match the highest ratio of credit to value added observed in the data, which I interpret as an economy with highly developed financial markets.\footnote{While the frictionless economy is given by setting $\theta = \infty$, I restrict attention to degrees of financial development currently feasible to the most advanced economies of the world. In this sense, I study the impact of improving financial markets to the level of developed economies, rather than to some abstract frictionless counterpart.} Specifically, I choose $\theta$ to target Japan’s average ratio of private credit to value added which is equal to 1.63, as reported by Manova (2013) using data for the period 1980-1997.\footnote{While more recent data could alternative be used to capture the further development of financial markets in recent decades, I restrict attention to this particular source of data since I later contrast the implications of the model with those estimated by Manova (2013) over such time period.} The value of $\theta$ required to match this value is 0.61. In doing so, I also keep all other parameters fixed.

4.3 Industry-level implications

I first ask: To what extent do financial frictions reduce the share of output that is traded internationally in different industries?

I report the outcomes of the counter-factual experiment in Table 3. Each column of the table reports the equilibrium outcomes corresponding to the stationary equilibria of the different economies, where I label the economy with $\theta = 0$ as “No credit”, the baseline calibration with $\theta = 0.18$ as “Baseline”, and the economy with $\theta = 0.61$ as “High credit”. Except for the bottom panel, which reports the equilibrium prices, the rows of the table separately report 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 “High capital share”, and those that operate the technology with capital share $\alpha_l$ as “Low capital share.”

I find that, as the financial constraint is relaxed, the capital-intensive in-
dustry increases the share of output exported — from 0.36 in an environment with no credit, to 0.39 in the high credit benchmark. While the increase is modest, it suggests that financial frictions distort firms’ export decisions relatively more than those aimed at the domestic market. 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.

In contrast, I find that the non-capital-intensive industry exhibits a sharp decrease in the trade share when financial frictions are relaxed — from 0.28 in the economy with no credit, to 0.09 in an economy with developed financial markets. While apparently at odds with the earlier discussion from Section 3, the response of the trade share is driven by the impact of financial development on general equilibrium prices, which offset the mechanisms examined in the previous section. I discuss these forces in more detail below.

The response of industry-level trade shares to an increase in $\theta$ depends on the relative magnitude of two opposing forces. On the one hand, financial development allows firms to borrow more, leading them to increase their scale as well as to begin exporting which, as discussed in Section 3, increase the trade share. On the other hand, this increase in the scale of firms leads to an increased demand for labor that bids up the wage, thereby increasing firms’ costs as well as reducing their profits and the returns to exporting. The overall effect on the trade share, then, 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.

The differential response of the trade share across industries is driven by differences in the relative importance of these forces. Production decisions are relatively more distorted by financial frictions in the capital-intensive industry, given that such firms have a higher optimal level of capital. These distortions reduce the flow of internal funds available to finance the export entry investment, and also the returns from doing so. Thus, capital-intensive firms experience a relatively larger increase in the incentives to trade when financial markets develop.

In contrast, labor costs increase with the development of financial markets,
Table 3: Industry-level implications, model

<table>
<thead>
<tr>
<th>Exports</th>
<th>No credit</th>
<th>Baseline</th>
<th>High credit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic sales</td>
<td>High capital share</td>
<td>0.36</td>
<td>0.37</td>
</tr>
<tr>
<td></td>
<td>Low capital share</td>
<td>0.28</td>
<td>0.24</td>
</tr>
<tr>
<td>Share of exporters</td>
<td>High capital share</td>
<td>0.30</td>
<td>0.33</td>
</tr>
<tr>
<td></td>
<td>Low capital share</td>
<td>0.17</td>
<td>0.13</td>
</tr>
<tr>
<td>Prices</td>
<td>$w$</td>
<td>0.62</td>
<td>0.65</td>
</tr>
<tr>
<td></td>
<td>$p$</td>
<td>0.64</td>
<td>0.63</td>
</tr>
</tbody>
</table>

impacting the non-capital-intensive industry relatively more given their higher use of labor in production. Therefore, we conclude that firms in the capital-intensive industry experience a relatively larger net increase in the incentives to trade than non-capital-intensive producers, which explains the differential response of industry-level trade shares across industries.

I therefore find that there is a large reallocation of industry-level trade shares: while capital-intensive industries increase the extent to which they trade, non-capital-intensive industries actually decrease the extent to which they do so. These findings are consistent with the strong industry-level relationship between financial development and international trade documented by Beck (2003) and Manova (2013), among others. In Section 5, I study quantitatively the extent to which the industry-level implications of the model are consistent with empirical estimates.

4.4 Aggregate implications

I then 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 subsections. I report these results in Table 4. As before, each column reports the equilibrium outcomes corresponding to the stationary equilibria of the different economies that I study.

When the financial constraint is relaxed the aggregate ratio of credit to value-added increases sharply, from 0.00 to 1.63, since firms can then increase the amount that they borrow. 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 0.35, as we move from an economy without credit to the financial development benchmark. These findings suggest that, while financial frictions have a strong impact on industry-level trade flows, these do not translate to strong effects on the extent of international trade at the aggregate-level.

As reported in Table 4, financial development not only increases the capital-intensive industry’s trade share, but the share of domestic output that it produces relative to the non-capital-intensive industry. Specifically, this share increases from 0.66 in the environment without credit, to 0.87 in the financial development benchmark. 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 drivers of the reallocation of domestic output toward the capital-intensive industry are the same to those behind the reallocation of industry-level trade shares. As financial development leads firms in each sector to increase their scale, they increase their demand for labor and bid up the wage. This increases marginal costs and reduces profits, impacting non-capital-intensive firms relatively more given their relative intensity in labor for production. We therefore observe an increase in the relative contribution of the capital-intensive industry to the total output sold domestically.

These findings stand in sharp contrast with not only the industry-level implications of the model, but also with the strong industry-level relationship between trade and finance previously documented in the literature. While such relationship may be interpreted as evidence that financial frictions may also distort international trade flows at the aggregate level, my findings imply that this need not be the case: the model implies that, while financial develop-

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34Note that the aggregate trade share can be expressed as a weighted sum of the industry-level trade shares, with the weights given by the relative size of each industry in the domestic market: $\frac{X}{D} = \frac{D_l}{D_l + D_h} \times \frac{X_l}{D_l} + \frac{D_h}{D_l + D_h} \times \frac{X_h}{D_h}$ 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, for $i \in \{l, h\}$. 

27
Table 4: Aggregate implications

<table>
<thead>
<tr>
<th></th>
<th>No credit</th>
<th>Baseline</th>
<th>High credit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Credit / Value added</td>
<td>0.00</td>
<td>0.33</td>
<td>1.63</td>
</tr>
<tr>
<td>Exports / Domestic Sales</td>
<td>0.33</td>
<td>0.33</td>
<td>0.35</td>
</tr>
<tr>
<td>Share of domestic output by $\alpha_h$ firms</td>
<td>0.66</td>
<td>0.71</td>
<td>0.87</td>
</tr>
</tbody>
</table>

development can lead to a large reallocation of trade shares at the industry-level, the aggregate share of output traded internationally may remain virtually unchanged.

5 Empirical evidence

In this section, I contrast the quantitative implications of the model with estimates from cross-country industry-level data. The data that I study has been previously used in the literature to investigate the impact of financial development on industry-level trade flows, thus serving as a reasonable benchmark with which to compare my findings.

5.1 Industry-level estimates

I ask: To what extent are the implications of the model consistent with the relationship between financial development and international trade observed in the data at the industry-level?

To answer this question, I construct an empirical counterpart to the industry-level implications of the model.\(^{35}\) I do so by using cross-country industry-level data to estimate the relationship between the trade share of an industry in a given country as a function of two key variables: a measure of the country’s level of financial development, and its interaction with a measure of the industries’ degree of dependence on external finance. I then use the estimated specification to compute the change of industry-level trade shares

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\(^{35}\)Given the lack of accessible and comparable cross-country plant-level datasets, I interpret the implications of the model as capturing the impact of financial development across countries. The underlying assumption is that the implied impact of financial development on international trade is approximately independent of the parameter values that one would use to calibrate the model for countries other than Chile. I recalibrated the model to match moments from US data reported in the literature and found that this is indeed the case for the US.
associated with a change in the extent of financial development across industries with heterogeneous dependence on external finance. Finally, I contrast these empirical estimates with the implications of the model presented above.

5.1.1 Empirical specification

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

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

where \( S_j \subset S \) denotes the set of all entrepreneurs that operate a technology with capital-intensity \( \alpha_j \), and \( X_j \subset S_j \) denotes the subset of these that export.

To estimate an empirical counterpart of this expression, I use a cross-country panel of industry-level data and extend the empirical specification of Manova (2013) and Beck (2003). Notice that the first two terms in the expression above are only a function of country-level characteristics (such as the level of development of financial markets and the distribution of productivity across plants), and are thus identical for all industries in a given economy. The third and fourth ones, however, are also a function of industry-specific features, such as the extent to which the industry depends on external finance.

Therefore, I estimate the relationship between an industry’s trade share and measures of both financial development and external finance dependence, while including country and industry fixed effects, as well as year fixed effects to control for potential changes over time:

\[
\ln \frac{\text{Exports}_{ijt}}{\text{Domestic sales}_{ijt}} = \alpha_i + \beta_j + \gamma_t + \frac{\text{Credit}_{it}}{\text{GDP}_{it}} [\omega_1 + \omega_2 \times \text{EFD}_j] + \varepsilon_{ijt}
\]

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; \( \text{Exports}_{ijt}/\text{Domestic sales}_{ijt} \) denotes the ratio of total exports to the rest of the world to total domestic sales corresponding in industry \( j \), country \( i \), and year \( t \); \( \text{Credit}_{it}/\text{GDP}_{it} \) denotes country \( i \)’s ratio of credit to GDP, which is a widely-used
outcome-based measure of financial development; and finally, $EFD_j$ denotes a measure of industry $j$’s external finance dependence (EFD).

Throughout the next subsection I restrict attention to $\omega_1$ and $\omega_2$, which capture the empirical association among industry-level trade shares and the interaction between the country-level extent of financial development and the industries’ need for external finance. These are the main objects that I need to construct an empirical counterpart of the model’s industry-level implications. I interpret this empirical relationship, however, just as a moment of the data to be contrasted with the implications of the model — I remain agnostic about the extent to which these parameters capture a relationship that is causal in nature.

5.1.2 Data

The data used in this section consists of the dataset constructed by Manova (2013), which I downloaded from the publisher’s website and adjusted accordingly to estimate the empirical specification above. The dataset has a panel structure with 107 countries and 27 sectors at the 3-digit ISIC rev. 2 level, which are observed over the period 1985-1995.

To construct the industry-level trade shares, I compute the ratio between exports and domestic sales. Exports are obtained from Feenstra’s *World Trade Database* and aggregated to the 3-digit ISIC rev. 2 level using Haveman’s concordance tables. Domestic sales are computed by subtracting exports from a measure of total sales constructed by the United Nations Industrial Development Organization (UNIDO) at the 3-digit ISIC rev. 2 level.\(^{36}\)

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 0.04 in Guinea-Bissau in 1989, to 1.79 in Japan in 1995 — the mean value is 0.40 and its standard deviation is 0.35.

The industry-level measure of external finance dependence used is the share of capital expenditures not financed with cash flows from operations, as de-

\(^{36}\)Observations with industry-level trade shares below zero or above one are dropped.
Table 5: Industry-level implications, regression estimates

<table>
<thead>
<tr>
<th></th>
<th>$\ln(\text{Exports/Domestic sales})$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Credit/GDP</td>
<td>-0.73</td>
</tr>
<tr>
<td></td>
<td>(0.14)</td>
</tr>
<tr>
<td>Credit/GDP $\times$ EFD</td>
<td>0.68</td>
</tr>
<tr>
<td></td>
<td>(0.10)</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.49</td>
</tr>
<tr>
<td># of observations</td>
<td>15,945</td>
</tr>
</tbody>
</table>

Note: Fixed effects for each country, industry, and year are included. Heteroskedasticity-robust standard errors are reported in parentheses.

fined by Rajan and Zingales (1998). The measure used was constructed by Braun (2003) based on data for all publicly listed US-based companies from Compustat’s annual industrial files. 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.

For further details on the construction of the data see Manova (2013).

5.1.3 Regression estimates

Table 5 reports the coefficients of the empirical specification above estimated through ordinary least squares (OLS). Only the coefficients on the aggregate ratio of credit to GDP and its interaction with external finance dependence 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.

To examine the implied relationship between financial development and international trade across industries with heterogeneous dependence on external finance, I compute the partial derivative of the trade share (in logs) with respect to the credit-to-GDP ratio, which is given by $\omega_1 + \omega_2 \times \text{EFD}_j$. The estimates of $\omega_1$ and $\omega_2$, both of which are statistically significant, imply that in countries with more developed financial markets, industries that are finance-intensive have relatively higher trade shares. In contrast, I find that industries with low finance-intensity have relatively lower trade shares in financially developed countries. These estimated relationships are qualitatively consistent with the model’s industry-level implications.
5.1.4 Model vs. empirical estimates

I now study the extent to which the industry-level implications of the model are also quantitatively consistent with the empirical estimates reported in the previous subsection.

To do so, I use the regression estimates reported above to compute the change in industry-level trade shares associated with a change in the aggregate credit-to-GDP ratio of the same magnitude implied by the model between the no credit and high financial development economies – that is, an increase of this variable from 0.00 to 1.63.

To construct an empirical counterpart to the change in the trade shares featured by the model’s capital-intensive and non-capital-intensive industries, I respectively evaluate the estimated regression at the highest and lowest levels of external finance dependence observed in the data. This choice is consistent with my calibration of the model’s industry-level capital shares at the highest and lowest values estimated from the Chilean plant-level data, given that the model implies a monotonic relationship between the empirical measure of external finance dependence and each industry’s capital share.

The results from this empirical exercise are reported in Table 6, along with their model counterparts (in log-changes). I find that the change of industry-level trade shares implied by the model in response to the development of financial markets is quantitatively consistent with the relationship implied between them by the empirical specification estimated above.

I first find that the model as well as the empirical estimates both imply an increase in the trade share of the industry with high external finance dependence. I also find that they imply a modest increase in this share: by approximately 0.08 log-points in both the model and the data. On the other hand, I find that there is a very sharp decrease in the trade share of the industry with low dependence on external finance in both the model and the data: by 1.14 and 1.31 log-points, respectively. Thus, the model can respectively account for 98% and 86% of the change in the trade shares of the capital-

\[37\] I restrict attention to the set of industries that is observed in both datasets, which leads me to exclude ISIC rev. 2 code 314 (tobacco).
Table 6: Industry-level implications, model vs. data

<table>
<thead>
<tr>
<th>External finance dependence</th>
<th>Model</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>0.08</td>
<td>0.08</td>
</tr>
<tr>
<td>Low</td>
<td>-1.14</td>
<td>-1.31</td>
</tr>
</tbody>
</table>

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

and non-capital-intensive industries implied by the empirical specification estimated above.\(^{38}\)

I therefore conclude that the model can successfully capture quantitatively the empirical relationship between industry-level trade shares and financial development across industries with heterogeneous dependence on external finance. These findings can be interpreted as a validation exercise that provide further support to the aggregate implications of the model as well as to the mechanisms at play.

5.2 Aggregate-level estimates

Finally, I contrast the aggregate implications of the model with evidence from the data. I ask: What is the empirical relationship between financial development and international trade when examined from the lens of an empirical specification consistent with the structural model examined above?

To answer this question, I aggregate the cross-country industry-level data used above across industries up to the country-level, and use it to examine the relationship between financial development and aggregate trade shares. To do so, I estimate an empirical specification that is consistent with my quantitative model and examine the statistical significance of the link between the development of financial markets and the extent of international trade.

Notice that the expression of the aggregate trade share from Section 3 can be used to derive an empirical specification analogous to the one derived when

\(^{38}\)These empirical estimates are unchanged when the empirical specification is extended to control for the measure of asset tangibility used by Manova (2013), setting it at its average value when computing the industry-level implications. The results are also robust to controlling for GDP per capita as well as for the average distance with the country’s trade partners.
conducted the industry-level empirical analysis. The only difference here is that industry-level fixed effects need to be excluded. Then, I estimate:

$$\ln \frac{\text{Exports}_{it}}{\text{Domestic sales}_{it}} = \alpha_{i} + \gamma_{t} + \omega \frac{\text{Credit}_{it}}{\text{GDP}_{it}} + \phi \ln \text{Distance}_{it} + \mu \ln \text{GDP per capita}_{it} + \varepsilon_{it}$$

where $i$ and $t$ index countries and years, respectively; $\alpha_{i}$ and $\gamma_{t}$ are fixed effects corresponding to the different countries and years, respectively; $\frac{\text{Exports}_{it}}{\text{Domestic sales}_{it}}$ denotes the ratio of total exports to the rest of the world to total domestic sales corresponding in country $i$ and year $t$; $\frac{\text{Credit}_{it}}{\text{GDP}_{it}}$ denotes country $i$’s ratio of credit to GDP; and finally, $\text{Distance}_{it}$ is the trade-weighted average distance between country $i$ and its trade partners, while GDP per capita$_{it}$ denotes its GDP per capita in year $t$ according to data from Penn World Tables 6.1.\footnote{I include distance and GDP per capita to control for two variables that may be simultaneously correlated with financial development and international trade, and whose changes over time are not properly controlled for by the fixed effects. I report results with and without controlling for these variables.}

The estimation results are reported in Table 7. I find that the relationship between financial development and aggregate trade shares is not statistically significant, with and without controlling for the level of the economy’s economic development as well as its average distance with its trade partners. While these estimates are simply the partial correlation between the two variables of interest, they are consistent with the aggregate implications of the structural model examined above. From the light of such model, they suggest that financial development has a negligible impact on the aggregate trade share, despite the strength of its effects at the industry-level.

6 Conclusion

In this paper, I investigate the aggregate implications of financial frictions on international trade. To do so, I study a general equilibrium model with heterogeneous firms subject to borrowing constraints and export entry costs, estimated using Chilean plant-level data. I find that financial frictions have a large impact on the extent of international trade across industries with different degrees of dependence on external finance, that is quantitatively consistent
with empirical estimates of this relationship. Yet, I find that the model implies that financial frictions have a negligible effect on the extent of international trade at the aggregate-level. General equilibrium effects lead to a reallocation of trade shares and production across industries, offsetting the impact of financial development on the aggregate trade share.

Recent studies have documented a strong relationship between measures of access to external finance and the extent of international trade at both the firm- and industry-level, suggesting that there may be large gains from financial development via international trade. My findings show that financial frictions, in fact, need not have a large impact on international trade at the aggregate-level. While financial development leads to a sharp reallocation of industry-level trade shares across industries heterogeneous in external finance dependence, it has a negligible impact on aggregate trade shares due to the offsetting response of general equilibrium prices.

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

**References**


WYNNE, J. (2005): “Wealth as a Determinant of Comparative Advantage,”