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Financial Frictions and International Trade: A Review*

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Abstract

This paper reviews recent studies on the impact of financial frictions on international trade. We first present evidence on the relation between measures of access to external finance and export decisions. We then present an analytical framework to analyze the impact of financial frictions on firms' export decisions. Finally, we review recent applications of this framework to investigate the impact of financial frictions on international trade dynamics across firms, industries, and in the aggregate. We discuss related empirical, theoretical, and quantitative studies throughout.

Keywords: financial frictions, international trade, export decisions, trade distortions, firm dynamics

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1 Introduction

A widespread view among economists and policymakers is that international trade is an integral component of the path to economic development (e.g., Krueger 1997, Frankel and Romer 1999, and Estevadeordal and Taylor 2013). However, developing economies are often subject to numerous barriers that prevent them from fully exploiting the benefits of international trade. One such barrier documented in the literature arises from frictions in financial markets, which limit firms' potential to exploit the economies of scale offered by international trade. Thus, firms in economies with underdeveloped financial markets are less likely to export, and export less if they do.

While financial frictions distort firms' decisions along various margins, a large literature shows that they have a disproportionate effect on firms' export decisions. For example, firms are subject to large fixed and sunk export costs (Das, Roberts, and Tybout 2007 and Alessandria and Choi 2007); exporting is associated with higher working capital needs (Djankov, Freund, and Pham 2010, Amiti and Weinstein 2011, and Feenstra, Yu, and Li 2014); and because it is hard to enforce contracts across countries, banks may charge higher borrowing costs to compensate for the riskiness of exports (Ahn 2020, 2021). Thus, exporting is a credit-intensive activity that can be particularly affected by frictions in financial markets.

In this paper, we provide an overview of a rapidly growing literature that investigates the extent to which financial frictions affect firms' export decisions and trade patterns. This literature has grown over the past decade following the global financial crisis of 2008-2009, which brought to the forefront the importance of financial factors for macroeconomic outcomes. Our goal here is threefold. First, we provide evidence on the relation between measures of access to external finance and international trade. Second, we present a model to study theoretically and quantitatively the link between trade and finance. Finally, we provide in-depth coverage of specific quantitative studies that use extended versions of this baseline model to investigate key dimensions of the nexus between trade and finance. We also discuss related empirical, theoretical, and quantitative studies throughout.

Our review consists of three parts. In the first part, we present evidence on the relation between measures of access to external finance and export decisions. Using firm-level data for a large number of countries, we document that countries with less-developed financial markets have a smaller share of firms that export. Moreover, within these countries, those

firms that do export tend to export a smaller fraction of their total sales. Importantly, these relations are robust to controlling for key determinants of export decisions previously emphasized in the literature, such as productivity or relative country size. These patterns suggest that there is a significant link between financial factors and international trade across countries as well as across firms within countries. We conclude this part of the paper by discussing related work that measures the impact of frictions in financial markets on export decisions at the firm and industry levels.

In the remainder of the paper, we take the empirical link between trade and finance as a starting point to identify the causal impact of finance on trade using quantitative models with heterogeneous firms. To do so, in the second part of the paper we present an analytical framework to interpret the empirical evidence and to serve as a foundation for the quantitative studies reviewed in the rest of the paper. The model is a stylized version of the setup developed by Kohn, Leibovici, and Szkup (2016, 2020a,b) and Leibovici (2021). We consider a small open economy populated by entrepreneurs that produce differentiated varieties with heterogeneous productivity levels using capital and labor. Firms accumulate capital internally and do so either by using internal funds or by borrowing in financial markets. However, borrowing is subject to a collateral constraint that limits loans to a fraction of the value of the capital stock. Finally, we model trade as in Melitz (2003), with firms that endogenously choose whether to sell their goods internationally subject to fixed and variable export costs.[1]

We show that financial frictions distort firms' export decisions along two key margins. First, financial frictions lead exporters with relatively low net worth to operate at a suboptimal scale, reducing their exports relative to their optimal choice in the absence of credit market frictions. Second, financial frictions distort firms' decision to export, leading some productive but low-net-worth firms to be non-exporters. This is because firms' suboptimal scale of operation reduces the returns to exporting, making it unprofitable to pay the export costs. Finally, the above two channels reduce the demand for labor and, hence, result in lower wages, encouraging unproductive but high-net-worth firms to export.

We then provide a detailed discussion of the main assumptions underlying our model. First, we discuss alternative approaches to modeling financial frictions. Next, we discuss

[1]Early contributions to model export decisions include theoretical work by Baldwin and Krugman (1989) and Dixit (1989), and empirical work by Roberts and Tybout (1997), among others.

additional channels from which we abstract in our analysis, such as working capital needs and financing of export costs, sunk export entry costs, multiple export destinations, alternative international financial environments, and firms entry and exit via occupational choices. We turn to related literature to discuss the potential importance of these channels and their impact on firms' export decisions.

In the third part of the paper, we provide an overview of the implications of financial frictions for international trade along various dimensions. While we focus on quantitative studies that use different versions of the framework introduced in the previous part of the paper, we also provide a broader discussion of the related literature. We begin by discussing the implications of financial frictions for firm-level dynamics. Motivated by the inability of standard models of international trade with sunk export entry costs to account for salient features of new exporter dynamics, Ruhl and Willis (2017) and Kohn, Leibovici, and Szkup (2016) investigate whether these dynamics might be informative about the underlying frictions affecting firms' export decisions. They use a similar model to the one presented in this study to show that financial frictions can indeed account for salient features of the dynamics of new exporters while inducing hysteresis in exporting as sunk export entry costs.

These findings raise numerous questions on the implications of financial frictions for international trade at the aggregate level. In the remainder of this review we discuss papers that address these issues. Motivated by these findings as well as by the strong link between finance and international trade at the industry-level (Beck 2003 and Manova 2013), Leibovici (2021) studies the implications of financial development on the extent to which industries and countries trade internationally. To do so, it studies a multi-industry version of our analytical framework and finds that financial development increases the extent to which finance-intensive industries trade, but decreases it across less finance-intensive industries. The substantial reallocation of industry-level trade shares largely offset each other, leading to a significantly smaller change in the aggregate trade share. These findings are shown to be qualitatively and quantitatively consistent with estimates from industry-level and aggregate data.

We then focus on studies that investigate the aggregate effect of financial frictions on international trade when the economy is subject to aggregate shocks, such as a large devaluation or a reduction in international trade barriers. Motivated by earlier literature documenting the contractionary impact of large devaluations due to balance-sheet effects

(Edwards 1986, Aguiar 2005, and Frankel 2005), Kohn, Leibovici, and Szkup (2020a) study the role of financial frictions and balance-sheet effects in accounting for the gradual response of aggregate exports following large devaluations, as documented by Alessandria, Pratap, and Yue (2014). To do so, they extend the analytical framework presented here to feature debt denominated in domestic and foreign units. They show that financial frictions and balance-sheet effects explain only a modest fraction of the patterns observed in the data. This is because, despite the negative impact of financial frictions and balance-sheet effects on firms' investment and output, firms reallocate sales from domestic to foreign markets to benefit from increased demand due to the change in the real exchange rate.

Finally, we revisit studies on the impact of financial frictions on the gains from trade liberalization. We begin by summarizing quantitative studies on the impact of reducing trade barriers for imports of goods in economies with frictions in financial markets. We then focus on the work of Kohn, Leibovici, and Szkup (2020b), who investigate the role of credit constraints on the impact of reducing trade barriers on capital and intermediate inputs. To do so, they extend the analytical framework presented here to feature use-specific aggregators of domestic and imported varieties: one to produce a composite consumption good, and one to produce composite investment goods and intermediates. Consistent with cross-country evidence, they show that aggregate output, consumption, and capital increase more slowly in economies that are not financially developed, with a significant negative impact on the welfare gains from trade liberalization.

Given the large literature on the interaction between finance and trade, providing an exhaustive review of the literature is beyond the scope of this paper. Thus, we have purposefully omitted related areas of the literature that have been previously covered by other reviews.[2] For instance, we abstract from discussing studies that investigate the determinants and impact of alternative payment arrangements in international trade transactions, a complementary and growing literature that has been recently reviewed by Ahn (2021). Similarly, while we discuss related empirical work, this discussion in not exhaustive, as our primary focus is on quantitative studies that investigate the impact of financial frictions using equilibrium models with heterogeneous firms. **?**, Contessi and De Nicola (2012), Foley

[2]There also exists a large related literature that investigates the impact of financial frictions on firm dynamics in closed economies. See, for example, Cooley and Quadrini (2001), Albuquerque and Hopenhayn (2004), Clementi and Hopenhayn (2006), or Arellano, Bai, and Zhang (2012), among others. Buera, Kaboski, and Shin (2015) review both theoretical and empirical studies on entrepreneurship and financial frictions.

and Manova (2015), and Vaubourg (2016) provide complementary coverage of the related empirical literature.

2 Empirical evidence

How do frictions in financial markets affect firms' export decisions? How does export performance depend on a country's level of financial development? In this section, we present evidence on the relationship between measures of access to external finance and export decisions at the firm and aggregate levels. In particular, we use firm-level data from a large number of countries to investigate the extent to which measures of access to external finance account for cross-country and cross-firm differences in export performance after controlling for other determinants of export decisions previously emphasized in the literature. At the end of this section, we discuss some of the related empirical literature.

2.1 Data

The firm-level data that we study is from the World Bank Enterprise Survey (WBES; The World Bank 2021), which collects detailed information on numerous dimensions of firms' operations across a representative sample of firms in a large number of countries. We focus on two firm-level measures of export performance: (*i*) whether a firm exports or not (extensive margin) and (*ii*) the ratio of exports to total sales conditional on exporting (intensive margin). We investigate two alternative measures of access to external finance. The first gauges whether finance is at least a moderate obstacle for firms' operations.[3] The second is the aggregate credit-to-GDP ratio that we obtain from Beck, Demirgüç-Kunt, and Levine (2010) and their updated database.

We consider two key non-financial determinants of export performance that have been widely investigated in the literature. The first determinant is firm-level total factor productivity (TFP), which plays a fundamental role in accounting for firm-level export participation across the vast literature that followed Melitz (2003) and Chaney (2008). We measure firm-level TFP using the estimates for firms in the WBES from Francis, Karalashvili, Maemir,

[3]This is based on the following question asked in the WBES to surveyed firms: "Is access to financing, which includes availability and cost, No Obstacle, a Minor Obstacle, a Moderate Obstacle, a Major Obstacle, or a Very Severe Obstacle to the current operations of this establishment?" We consider firms reporting finance to be "at least a moderate obstacle for their operations" as those that find financing to be an obstacle.

and Rodriguez Meza (2020). The second determinant is each economy's size relative to the rest of the world, which captures variation across countries in the relative incentives to export. We measure each economy's size with real GDP (chained PPP) from the Penn World Tables 10.0 (Feenstra, Inklaar, and Timmer 2015).

While the WBES dataset contains representative firm-level information across the whole economy, we restrict attention to manufacturing firms. We do so to avoid cross-country differences in manufactures' shares of economic activity from driving our findings. This is a non-trivial concern since the countries surveyed differ substantially in their levels of economic development and, thus, in the manufactures's shares of economic activity. Additionally, focusing on manufacturing firms keeps our findings comparable with most of the literature.

Finally, we restrict attention to countries with at least 100 firms with non-missing information on the export, financial, and productivity variables.

2.2 Cross-country evidence

We investigate the extent to which differences in access to finance at the firm and aggregate levels can account for cross-country differences in export performance, after controlling for the standard channels mentioned above.[4] To do so, we estimate the following specification:

$$y_i = \alpha + \beta \text{ Finance}_i + \gamma \ln \text{TFP}_i + \eta \ln \text{GDP}_i + \varepsilon_i, \tag{1}$$

where i denotes countries, y_i is the dependent variable, Finance_i is a measure of access to finance, TFP_i is the average total factor productivity across all firms in country i, GDP_i denotes aggregate gross domestic product (PPP, chained), and ε_i is a zero-mean error term.

We estimate six alternative versions of Equation 1. On the one hand, we consider two alternative dependent variables: the share of exporters and the average export-to-sales ratio across all exporters.[5] On the other hand, we consider a specification without finance variables as well as two alternative measures of access to finance: the financing problem (FP) variable described above and the credit-to-GDP ratio. Table 1 reports the estimation

[4] To the extent that financial frictions also distort productivity and aggregate market size, our findings provide a lower bound for the role of finance-related variables.

[5] A complementary approach is to investigate the role of financial factors on each of the three components of exports to total sales, as decomposed by Alessandria and Choi (2014a). For simplicity, here we focus on two key components of such decomposition, the share of exporters and export intensity.

Table 1: Cross-country evidence

	Share of exporters			Exports / Sales		
	(1)	(2)	(3)	(4)	(5)	(6)
Financing problem		-0.211			-0.407	
		(0.069)			(0.000)	
Aggregate Credit / GDP			0.296			0.130
			(0.000)			(0.040)
TFP (log)	0.501	0.460	0.304	-0.138	-0.216	-0.199
	(0.000)	(0.000)	(0.002)	(0.197)	(0.033)	(0.113)
Aggregate GDP (log)	-0.004	-0.008	-0.022	-0.006	-0.015	-0.011
	(0.689)	(0.391)	(0.031)	(0.533)	(0.101)	(0.355)
Constant	-0.239	-0.034	0.085	0.687	1.081	0.758
	(0.063)	(0.841)	(0.562)	(0.000)	(0.000)	(0.000)
R-squared	0.196	0.231	0.356	0.026	0.198	0.066
Obs.	93	93	84	93	93	84

Note: Exports/sales and TFP are averages across all firms within each country. Exports/Sales is averaged conditional on exporting. Financing problem is the share of firms in each country that report access to finance to be at least a moderate problem for the firm's operations. All variables except aggregate Credit/GDP and aggregate GDP correspond to manufacturing firms. p-values are reported in parentheses.

results. Appendix A presents summary statistics for the variables used throughout.

2.2.1 Extensive margin: Share of exporters

The first three columns of Table 1 report the estimated values using the share of exporters as the dependent variable. We find that both finance variables are statistically significant in accounting for variation in the shares of exporters across countries, even after controlling for firm-level average productivity and aggregate market size. Countries with more firms reporting access to finance as a problem tend to feature a lower fraction of exporting firms. Similarly, economies with a lower aggregate credit-to-GDP ratio have fewer exporters.

Moreover, we find that financial variables account for a significant degree of cross-country variation in the share of exporters. In particular, the R-squared increases from 0.196 in column (1) to 0.231 in column (2) and 0.356 in column (3).

These estimated relations between trade and finance are quantitatively significant. For instance, increasing the FP from its 25$^{\text{th}}$ to its 75$^{\text{th}}$ percentile (that is, from 39% to 59% of firms reporting finance to be a problem) is associated with a 4.5-percentage-point decline in the share of exporters (a 16% decline in the average fraction of exporters relative to the cross-country average). Similarly, decreasing the credit-to-GDP ratio from its 75$^{\text{th}}$ to its 25$^{\text{th}}$ percentile (that is, from 17% to 56%) is associated with a 5.9-percentage-point decline in the share of exporters (a 20% decline in the average fraction of exporters relative to the cross-country average).

2.2.2 Intensive margin: Exports-to-sales ratio

The fourth to sixth columns of Table 1 report the analogous estimates with the average exports-to-sales ratio among exporters as the dependent variable. Both finance variables are statistically significant in accounting for variation in export performance along the intensive margin, after controlling for standard determinants of exporting such as firm-level TFP and market size. The estimated coefficients imply that limited access to finance (a higher value of FP or a lower credit-to-GDP ratio) is associated with a lower average export-to-sales ratio.

As with the share of exporters, we find that financial variables account for a significant degree of cross-country variation in average export intensity. In particular, the R-squared increases from 0.026 in column (4) to 0.198 in column (5) and 0.066 in column (6).

The estimated relations are quantitatively significant. For instance, increasing FP from its 25$^{\text{th}}$ to its 75$^{\text{th}}$ percentile is associated with a 8.1-percentage-point decline in the average export-to-sales ratio (an 18% decline in terms of the cross-country average export-to-sales ratio). The analogous worsening of access to finance based on the credit-to-GDP ratio is associated with a 5-percentage-point decline of export intensity (an 11% decline in terms of the cross-country average export-to-sales ratio).

These findings show that even after controlling for standard determinants of exporting performance, cross-country variation in various measures of access to finance can account for substantial variation in export participation along both the extensive and intensive margins.

2.3 Firm-level evidence

The analysis above is informative about the potential for differences in access to finance to account for cross-country differences in exporting performance. However, countries differ along numerous dimensions, some of which could be correlated with our finance measures. To address such potential sources of bias, we now conduct an analogous analysis at the firm-level. This alternative approach allows us to exploit within-country variation in access to finance to evaluate its potential to account for cross-firm variation in exporting performance. As above, we do so while simultaneously controlling for standard determinants of export decisions such as firm-level productivity.[6]

We estimate the following specification:

$$y_{f,i,j,t} = \alpha_{i,j,t} + \beta \ \mathrm{FP}_{f,i,j,t} + \gamma \ln \mathrm{TFP}_{f,i,j,t} + \varepsilon_{f,i,j,t}, \tag{2}$$

where f, i, j, and t index firms, countries, industries, and time periods, respectively. We focus on variation within country-industry-year triples by controlling for fixed effects $\alpha_{i,j,t}$ at this level. We control for our firm-level measure of access to finance $\mathrm{FP}_{f,i,j,t}$ (Finance problem, as described above), and our standard determinant of export performance, $\mathrm{TFP}_{f,i,j,t}$.

Equation 2 is estimated for two alternative dependent variables. On the one hand, we consider a specification with an indicator variable that is equal to 1 if the firm exports and zero otherwise. On the other hand, we estimate the specification using the firm-level export-to-sales ratio conditional on exporting. Table 2 reports the estimation results.

The first column of Table 2 reports the estimated coefficients for the specification with the exporter indicator variable as the dependent variable. We find that the FP is statistically significant. Controlling for country, industry, and year fixed effects as well as for firm-level TFP, firms that report financing to be a problem are 2.7% less likely to be exporters (reducing the unconditional cross-country probability of exporting by 9.3%).[7]

The second column reports the analogous estimates for the specification with the exports-to-sales ratio as the dependent variable. The FP is statistically and economically significant, with a 1.7-percentage-point lower exports-to-sales ratio than firms that do not report finance

[6] To the extent that financial frictions also distort firm-level productivity, our findings provide a lower bound for the role of finance-related variables.

[7] We interpret the average share of exporters across countries (Table 4 in the appendix) as the unconditional export probability.

Table 2: Firm-level evidence

	Exporter	Exports / Sales
Financing problem	-0.027	-0.017
	(0.000)	(0.011)
TFP (log)	0.038	0.010
	(0.000)	(0.119)
Constant	0.312	0.451
	(0.000)	(0.000)
R-squared	0.268	0.430
Obs.	43,608	14,527

Note: Exporter is equal to 1 if firms export and 0 otherwise. Exports/Sales is conditional on exporting. Financing problem is equal to 1 if firms report access to finance to be at least a moderate problem for its operations. The regressions control for country-industry-year fixed effects. All variables correspond to manufacturing firms. p-values are reported in parentheses.

to be a problem for their operations (reducing the exports-to-sales ratio by 3.7% relative to the unconditional cross-country average; see Table 4 in the appendix).

Thus, we find that finance is significantly associated with variation in firm-level export performance along both the extensive and intensive margins, even after controlling for standard exporting determinants such as productivity. We also find evidence consistent with standard firm-level theories of international trade that associate higher productivity with higher export performance.

2.4 Discussion and related literature

While the empirical evidence discussed in this section suggests that financial factors may have important implications for international trade, a key identification problem remains. At the firm-level, it is difficult to determine whether low use of external finance is due to a limited need for credit (perhaps because firms face low demand for their goods), or due to a limited credit supply. Similarly, at the aggregate level, low credit-to-GDP ratios may arise from either low aggregate credit demand due to limited growth opportunities or because of

severe financial frictions. For instance, one alternative interpretation of our findings is that they might reflect reverse causality, with non-exporting firms having less access to finance.

To overcome this issue, the literature has followed a number of different approaches. Beck (2003) and Manova (2013) identify the impact of access to credit on international trade from the interaction between a country-level measure of financial development and an industry-level measure of external finance dependence (extending the approach of Rajan and Zingales 1998 to the context of international trade). They show that, indeed, finance-intensive industries trade relatively more in financially developed economies, which they interpret as evidence that financial considerations are an important determinant of international trade patterns across industries.[8]

Other studies use firm-level balance-sheet information to link credit constraints to firms' exporting choices. Using this approach Bellone, Musso, Nesta, and Schiavo (2010), Berman and Hericourt (2010), and Egger and Kesina (2013) find evidence that financial frictions distort firms' exports decisions along both the intensive and extensive margins. Minetti and Zhu (2011) and Muûls (2015) complement firm-level balance-sheet data with credit scores and survey data, respectively, and also find evidence that access to credit is an important determinant of firms' export decisions. Finally, Friedrich and Zator (2021) show that firms with high leverage respond negatively to export demand shocks in the context of the boycott of Danish products by Muslim countries in 2006.[9]

Yet another approach consists of comparing the behavior of local firms relative to local affiliates of multinational firms. This approach is based on the observation that affiliates of multinational firms have access to internal capital markets and, thus, are expected to be less financially constrained. This approach is used by Desai, Foley, and Forbes (2008) and Manova, Wei, and Zhang (2015) to argue that credit constraints distort firms' investment and exporting choices, respectively (see also Bilir, Chor, and Manova 2019).

Finally, other empirical studies such as Amiti and Weinstein (2011) and Paravisini, Rappoport, Schnabl, and Wolfenzon (2015) identify the causal impact of financial frictions on international trade by exploiting disaggregated firm-level data on exports matched with information on firms' exposure to banks affected by an aggregate financial shock. In par-

[8]Related evidence at the aggregate and industry levels is documented by Beck (2002), Hur, Raj, and Riyanto (2006), and Svaleryd and Vlachos (2005).

[9]In contrast to these studies, Greenaway, Guariglia, and Kneller (2007) find no evidence for credit constraints.

ticular, controlling for detailed information on the types of goods and destinations to which firms export, these studies identify the role of credit on exports from systematic variation in export performance across firms that obtain credit from banks with heterogeneous exposure to an aggregate financial shock.

Overall, this large and diverse empirical literature suggests there is a significant link between trade and finance. In the following sections, we introduce an alternative way to address the identification problem: The use of a quantitative model of heterogeneous firms estimated to match salient features of firm-level data to investigate the link between access to finance and export decisions. We also discuss the related theoretical and quantitative literature.

3 Financial frictions and trade: An analytical framework

A complementary strategy to assessing the importance of financial frictions on international trade is to quantitatively analyze the implications of a structural model of trade with credit market frictions. After formulating the model, one can calibrate it to match salient features of the data and use it to quantify the impact of financial frictions on key outcomes of interest. In particular, to the extent that the model indeed captures key features of financial frictions, one can use it to conduct counter-factual analysis, such as evaluating their role in accounting for the response to large devaluations or trade liberalization.

One advantage of this approach is that it allows for an internally consistent analysis of the impact of financial frictions on export decisions while being explicit about the assumptions underlying the mechanism under analysis. However, it also has its limitations: a drawback of this approach is that it narrows the analysis to the mechanisms featured by the model, abstracting from other potentially relevant channels through which finance might interact with international trade. Thus, we view the quantitative work presented here as complementary to empirical studies: empirics guide modeling choices, while quantitative and theoretical results inform further empirical analyses.

In the rest of this section, we present a quantitative model to interpret the evidence from Section 2 and to quantify the impact of financial frictions. The model described below is a simplified version of the setup developed in Kohn, Leibovici, and Szkup (2016), Kohn, Leibovici, and Szkup (2020a), Kohn, Leibovici, and Szkup (2020b), and Leibovici (2021). We

use this framework to study the channels through which financial frictions affect firms' decisions and their aggregate consequences. We conclude this section by discussing alternative ways to model financial frictions and mechanisms from which we abstract here.

3.1 Model

We consider a small open economy populated by a unit measure of entrepreneurs who produce differentiated varieties that are sold domestically and abroad.[10] The economy is also populated by final goods producers who produce final goods by aggregating domestic varieties purchased from entrepreneurs and imported varieties purchased from the rest of the world.

Entrepreneurs Entrepreneurs are risk-averse, with preferences over consumption of final goods given by

$$\sum_{t=0}^{\infty} \beta^t \frac{c_{it}^{1-\gamma}}{1-\gamma}, \tag{3}$$

where $i \in [0,1]$ indexes entrepreneurs. Each entrepreneur produces differentiated varieties by operating a production technology

$$y_{it} = z_{it} k_{it}^{\alpha} n_{it}^{1-\alpha}, \tag{4}$$

where z_{it} denotes an idiosyncratic level of productivity, k_{it} is the capital stock, n_{it} is the amount of labor hired, and $\alpha \in (0,1)$ is the capital share. Capital is accumulated internally and depreciates at the rate $\delta \in (0,1)$. Idiosyncratic productivity follows an AR(1) process:

$$\ln z_{it} = (1-\rho)\mu_z + \rho z_{i,t-1} + \varepsilon_{it}, \tag{5}$$

where $\varepsilon_{it} \sim N(0, \sigma_\varepsilon)$ and μ_z is the average level of productivity. Finally, entrepreneurs are endowed with one unit of labor that they supply inelastically to a competitive labor market.

Entrepreneurs are monopolistically competitive and sell their varieties to domestic final goods producers and to the rest of the world. As in Melitz (2003), exporting requires

[10] We interchangeably refer to entrepreneurs as firms.

entrepreneurs to pay a fixed export cost $F > 0$ denominated in units of labor, and a variable cost τ that requires them to ship $\tau > 1$ per unit that arrives at the destination.

Entrepreneurs have access to financial markets, where they can borrow or save by trading a one-period non-contingent bond. However, borrowing is constrained to be at most a fraction θ of their capital stock at the time of repayment. The amount borrowed (i.e., debt), d_{it}, has to satisfy

$$d_{it} \leq \theta k_{i,t+1} \tag{6}$$

and the natural borrowing limit. Financial markets are integrated internationally, and there is a perfectly elastic supply of bonds from the rest of the world at a given interest rate $r > 0$.

The timing of the model is similar to the one considered in Buera and Moll (2015) and others. Entrepreneurs begin the period by hiring labor, producing their variety, and then selling that variety in each of the markets in which they choose to operate. They pay for labor and export costs (if applicable) and repay their debt from the previous period. Then, they choose their consumption and the amount of net worth to begin with next period. At the end of the period, after the above decisions have been made, entrepreneurs observe the following period's productivity shock and choose the composition of next period's net worth between debt and physical capital.[11]

Final goods producers Final goods producers purchase varieties from entrepreneurs and the rest of the world and aggregate them to produce final goods with a constant elasticity of substitution technology. They are perfectly competitive, so they take all prices as given. The problem is given by

$$\begin{aligned} &\max Y_{h,t} - \int_0^1 p_{h,it} y_{h,it} di - \xi_t p_m y_{m,t} \\ &s.t. \quad Y_t = \left[\int_0^1 y_{hi,t}^{\frac{\sigma-1}{\sigma}} di + y_{m,t}^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}}, \end{aligned}$$

where $Y_{h,t}$ is the amount of final goods produced; $\{p_{h,it}\}_{i\in[0,1]}$ and p_m are the prices of varieties sold by entrepreneurs and the rest of the world, respectively; $\{y_{h,it}\}_{i\in[0,1]}$ and $y_{m,t}$ denote

[11] As in Buera and Moll (2015), these timing assumptions imply that the relevant endogenous state variable is net worth $a_{it} = k_{it} - \frac{d_{it}}{1+r}$, which reduces the number of state variables.

the amount of domestic and imported varieties purchased, respectively; and σ denotes the elasticity of substitution between domestic and imported varieties. We normalize prices relative to the price of the domestic final goods and ξ is the relative price of the foreign final goods in units of the domestic final goods (the real exchange rate). The solution to this problem is given by $y_{h,it} = (p_{h,it})^{-\sigma} Y_{h,t}$ and $y_{m,t} = (p_m)^{-\sigma} Y_{h,t}$, which are the demand schedules faced by entrepreneurs and the rest of the world, respectively.

Rest of the world The rest of the world demands varieties from entrepreneurs (the economy's exports) and supplies varieties to final goods producers (the economy's imports). The rest of the world's demand for varieties produced by entrepreneurs is downward sloping with the same constant elasticity of substitution σ as the domestic demand for varieties: $y_{f,t} = (p_{f,t})^{-\sigma} Y_f$, where Y_f is the exogenous amount of final goods produced in the rest of the world and $p_{f,t}$ is the price charged in units of the foreign final goods.

Entrepreneurs' problem Given our timing assumptions, the entrepreneurs' problem can be divided into a consumption-savings problem and a net worth composition problem.[12] Let $v(k, d, z)$ denote the value function of an entrepreneur with capital k, debt d, and productivity z, who makes consumption-savings as well as production decisions. Let $g(a', z')$ denote the value function of an entrepreneur at the end of a period with next period's net worth a' and productivity z', who decides how to allocate her net worth between capital k and debt $\frac{d}{1+r}$. Then,

$$\begin{aligned} v(k, d, z) = \max_{c, a' \geq 0} \frac{c^{1-\gamma}}{1-\gamma} + \mathbb{E}_{z'} \left[g(a', z') \right] \\ \text{subject to} \quad c + a' + d = w + (1-\delta)k + \pi(k, z), \end{aligned}$$

[12] To ease the exposition, we restrict attention to a stationary environment in which all aggregate variables are constant; we omit entrepreneur-specific indexes i to simplify the notation.

where $\pi(k,z)$ denotes profits earned this period given capital k and productivity z. Entrepreneurs make production choices to maximize profits. These are given by

$$\pi(k,z) = \max_{p_h,y_h,p_f,y_f,n,e\in\{0,1\}} p_h y_h + e\,\xi p_f y_f - wn - ewF$$

$$\text{subject to} \quad y_h + \tau y_f = z k^{\alpha} n^{1-\alpha}, \quad y_h = p_h^{-\sigma} Y_h, \quad y_f = p_f^{-\sigma} Y_f,$$

where e denotes the entrepreneur's export choice ($e = 1$ if she exports, $e = 0$ otherwise).

The entrepreneur's net worth allocation between debt and capital is given by

$$g(a',z') = \max_{k',d'} \beta v(k',d',z')$$

$$\text{subject to}$$

$$d' = (1+r)(k'-a') \tag{7}$$

$$k' \leq \frac{1+r}{1+r-\theta} a'. \tag{8}$$

Note that Equation 8 results from combining Equations 6 and 7. Thus, even though the borrowing constraint in Equation 6 limits the amount of debt for entrepreneurs, it implies a constraint on the total amount of capital they can accumulate.

Stationary equilibrium Let $\mathcal{S} \equiv \mathcal{A} \times \mathcal{Z}$ denote the state space of entrepreneurs, and let $s \in \mathcal{S}$ denote an element of the state space. For a given interest rate r, a *recursive stationary competitive equilibrium* of this economy consists of a wage and real exchange rate $\{w, \xi\}$, policy functions $\{d'(s), k'(s), e(s), c(s), n(s), y_h(s), y_f(s), p_h(s), p_f(s), Y_h, y_m\}$, value functions v and g, and a stationary measure $\phi : \mathcal{S} \to [0,1]$ such that (i) policy and value functions solve the problems of entrepreneurs and final goods producers and (ii) labor and final goods markets clear.

Numerical solution We solve the model numerically using global methods, approximating the value functions at a discrete number of grid points of the state variables z and a. We discretize the stochastic process followed by productivity z using Tauchen's method (Tauchen 1986). We approximate the value function through value function iteration, obtaining the optimal net worth accumulation policy in each state.

3.2 The effects of financial frictions on international trade

In this section, we study the mechanisms through which financial frictions distort export decisions. We begin our analysis by discussing how borrowing constraints distort capital choices, since this is a channel through which financial frictions end up distorting trade flows. We then analyze how financial frictions distort export volumes conditional on exporting (intensive margin) and discuss their impact on entrepreneurs' decision to export (extensive margin).

To highlight the role of financial frictions, we consider three versions of the model: (i) a general equilibrium model with no financial frictions ($\theta \geq 1+r$);[13] (ii) a partial equilibrium model with financial frictions, $\theta \in (0, 1+r)$, with prices fixed at the level of the frictionless economy; and (iii) a general equilibrium model with financial frictions, $\theta \in (0, 1+r)$. Contrasting the implications of the first two models allows us to characterize the direct impact of financial frictions on economic outcomes. Examining the general equilibrium model with financial frictions allows us to assess the interplay between financial frictions and general equilibrium forces. The parametrization of these models is described in the appendix.

3.2.1 Capital choice

Figure 1 plots the relation between capital choice and net worth across the three models for a firm with relatively low productivity (left panel) and relatively high productivity (right panel). We note first that in the frictionless model, entrepreneurs' choices of capital do not depend on entrepreneurs' net worth (red dashed line). Thus, regardless of net worth, in this model, entrepreneurs can always operate with the first-best amount of physical capital.

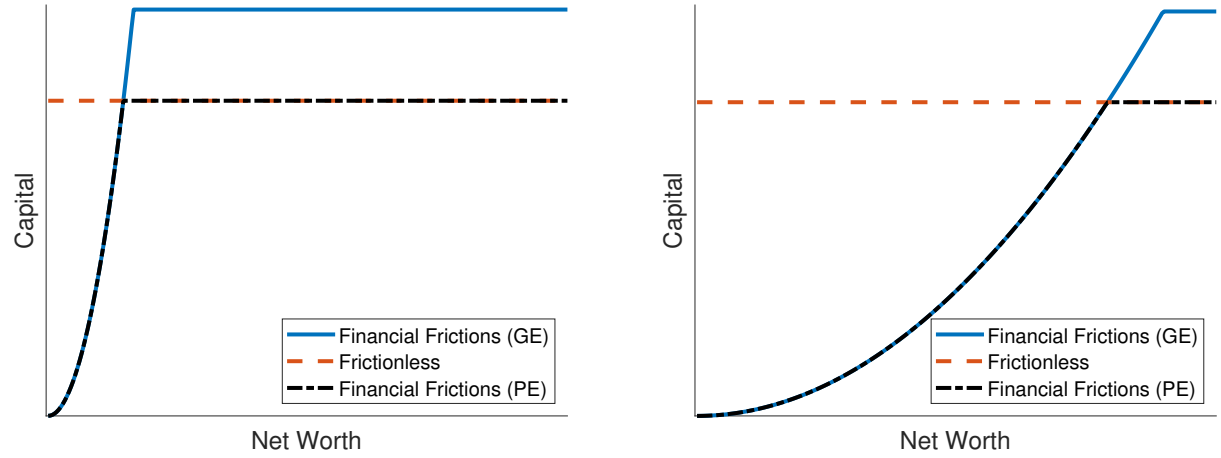
Consider now the economy with financial frictions, but with prices fixed at the values of the frictionless equilibrium. We see that entrepreneurs' capital choice is now increasing in net worth and that for sufficiently low levels of net worth, their capital choice is below the frictionless level. In addition, note that relatively unproductive firms require low levels of net worth to be able to operate at the optimal level of capital. In contrast, firms with high productivity need to accumulate a high amount of net worth before reaching the optimal level of capital stock.[14] It follows that it takes a while before firms that receive a good

[13] If $\theta \geq 1+r$, then the financial constraint is never binding.

[14] The fact that relatively unproductive firms require less net worth to achieve their optimal scale implies that in the economy with financial frictions domestic producers' choices are less distorted than those of

productivity shock are able to achieve their optimal scale. This implies that, on average, new exporters will begin exporting while being severely financially constrained (in the sense that their capital will be far from its optimal unconstrained level), and it will take them a while to accumulate enough assets to achieve their optimal scale. Kohn, Leibovici, and Szkup (2016) use this observation to argue that financial frictions are an important driver of new exporter dynamics.

Figure 1: Capital choice



(a) Low Productivity **(b) High Productivity**

Note: Optimal choice of capital as a function of net worth for an entrepreneur with relatively low productivity (left panel) and high productivity (right panel). See the appendix for calibration details. In the partial equilibrium version of the model with financial frictions, prices are set at their frictionless levels. GE refers to general equilibrium and PE refers to partial equilibrium.

The above observations also apply to the model with financial frictions in general equilibrium. However, the inability of some entrepreneurs to operate at the optimal level of capital decreases demand for labor and the demand for final goods, decreasing the real wage and increasing the real exchange rate. Since labor input is cheaper than in the frictionless economy, unconstrained entrepreneurs choose higher capital than they would in the absence of borrowing constraints. Then, as can be observed in Figure 1, entrepreneurs with low net worth have to operate with capital below their frictionless level while entrepreneurs with

new exporters.

high levels of net worth choose capital higher than they would in the absence of financial frictions.

Figure 1 also shows that unproductive entrepreneurs operate with the level of capital above the frictionless level even if they have a relatively low level of net worth. In contrast, only the richest productive entrepreneurs are able to do so. It follows that financial frictions distort production towards unproductive firms. Kohn, Leibovici, and Szkup (2017) and Tetenyi (2019) explore misallocation induced by financial frictions in more details in the context of open economy models.[15]

3.2.2 Export volume

Figure 2 plots the relation between export sales and net worth across the three models for a firm with a given level of productivity.[16] Our first observation is that, in the frictionless model, export sales do not depend on entrepreneurs' net worth (red dashed line). Thus, regardless of net worth, in this model entrepreneurs can always operate with the first-best amount of physical capital.

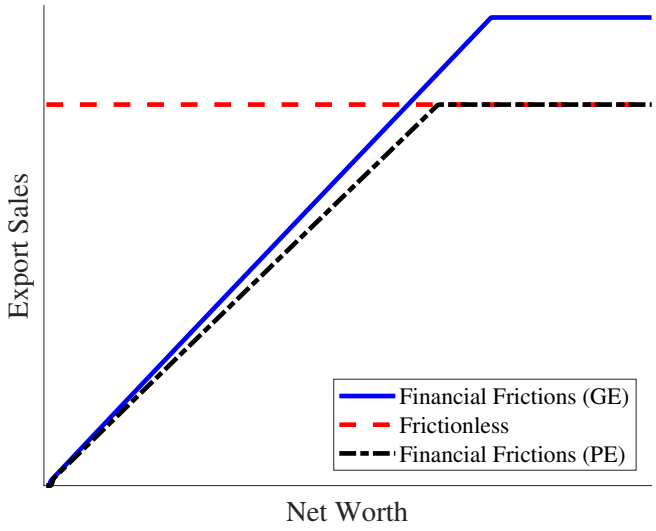
Consider now the economy with financial frictions, but with prices fixed at the values of the frictionless equilibrium. Exports are now increasing in net worth and, for sufficiently low values of net worth, we observe that exports are below their frictionless level. Financial frictions constrain entrepreneurs' access to external funds, forcing them to choose a suboptimal level of physical capital. As net worth increases, entrepreneurs are able to invest more and operate at a scale closer to the optimal. For sufficiently high net worth, entrepreneurs are not constrained by financial frictions and export as much as in the frictionless economy.

A similar pattern arises with financial frictions in general equilibrium. However, the inability to operate at the optimal scale in the model with financial frictions lowers the demand for labor and the demand for final goods, as constrained entrepreneurs earn lower profits, decreasing the real wage and increasing the real exchange rate. Then, for a given level of productivity and net worth, exporters have stronger incentives to export than at the equilibrium prices of the frictionless economy: the lower wage leads them to hire labor and

[15] The misallocation of resources induced by financial frictions has also been explored extensively in the context of a closed economy. See Buera, Kaboski, and Shin (2011), Midrigan and Xu (2014), or Moll (2014). Buera, Kaboski, and Shin (2015) provide an excellent summary of that literature.

[16] We consider a productivity level such that entrepreneurs choose to export for any positive level of net worth.

Figure 2: Export volume



Note: Optimal export volume as a function of net worth, given a sufficiently high level of productivity such that firms export. See the appendix for calibration details. In the partial equilibrium version of the model with financial frictions, prices are set at their frictionless levels. GE refers to general equilibrium and PE refers to partial equilibrium.

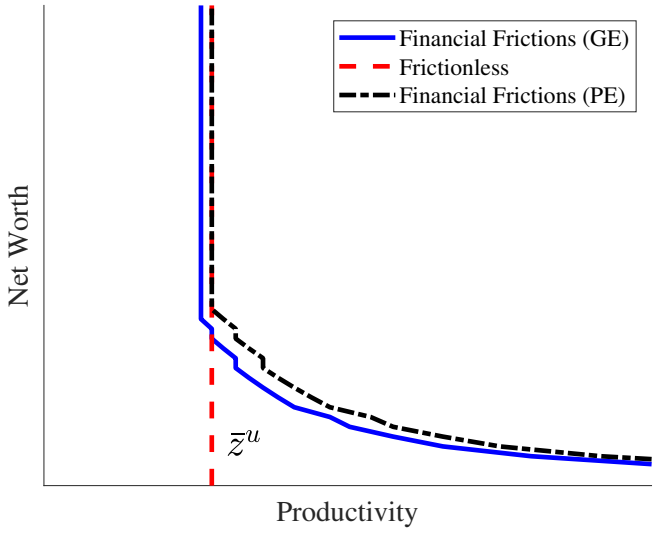
increase their scale, while the higher real exchange rate increases the foreign demand for domestic varieties, raising the returns to exporting. Then, as observed in Figure 2, exports are below the frictionless level for entrepreneurs with low net worth but they are above the frictionless level for sufficiently high levels of net worth.

Finally, it is worth pointing out that in this simple framework, export intensity (defined as the ratio of export sales to total exports) is undistorted by the presence of financial frictions. That is, in all versions of the model, all exporters have the same export intensity. Kohn, Leibovici, and Szkup (2016) consider a version of this model with working capital needs that are asymmetric across the domestic and foreign markets and show that in such model, export intensity is an increasing function of assets.

3.2.3 Decision to export

We next examine the effect of financial frictions on firms' decision to export. To do so, Figure 3 characterizes the export threshold as a function of net worth and productivity for

Figure 3: Decision to export



Note: To the right of the respective lines firms choose to export. See the appendix for calibration details. In the partial equilibrium version of the model with financial frictions in partial equilibrium, prices are set at their frictionless levels. GE refers to general equilibrium and PE refers to partial equilibrium.

each of the economies considered in the previous subsection.

Consider first the economy without financial frictions. Figure 3 shows that, as in Melitz (2003), firms with productivity higher than $\bar{z}^u$ choose to export (red dashed line). Firms' decisions to export are independent of net worth since they can all operate at their optimal scale. Thus, the profits of firms with productivity higher than $\bar{z}^u$ are sufficiently high to pay the fixed export costs.

Next, consider the economy with financial frictions with prices fixed at their frictionless equilibrium values. The export threshold now becomes a function of net worth (yellow dash-dot line). For firms with sufficiently high levels of net worth, the export decision is as in the frictionless model: they export only if productivity is higher than $\bar{z}^u$. But for firms with sufficiently low net worth, the productivity threshold required to export becomes higher than $\bar{z}^u$. In particular, firms with low net worth and productivity in a neighborhood above $\bar{z}^u$ are forced to operate with a suboptimal capital stock, making the returns to exporting lower than the fixed export costs; thus, they choose not to export.

Finally, consider the model with financial frictions in general equilibrium. As discussed in Section 3.2.2, this economy features a lower wage and a higher real exchange rate than the frictionless setup since there is a lower demand for labor and for the domestic final goods. Thus, production costs are lower and foreign demand for domestic varieties is higher, which make exporting more attractive. Thus, the export threshold shifts to the left of its counterpart for the economy with financial frictions but frictionless equilibrium prices. This implies that some low-productivity but high-net-worth firms that would choose not to export in the frictionless economy now choose to do so. These unproductive but high-net-worth entrepreneurs replace those with high productivity but low net worth who are prevented from exporting due to financial frictions.

The above discussion shows that the direct impact of financial frictions is to prevent productive firms with low net worth from exporting, leading to a lower share of exporters. But the indirect impact via general equilibrium effects is to allow unproductive entrepreneurs with high net worth to export, increasing the share of firms that export. Thus, the overall effect of financial frictions on the share of exporters is ambiguous.

3.3 Discussion of model assumptions

The setup presented in Section 3.1 captures the key channels through which financial frictions distort international trade. Nevertheless, it is a stylized model that makes some simplifying assumptions and abstracts from several mechanisms that might strengthen or attenuate the effects of financial frictions. In this section, we discuss some of these additional mechanisms and the implications of our simplifying assumptions.

Modeling of financial frictions Following Buera, Kaboski, and Shin (2011) and Midrigan and Xu (2014), we model financial frictions by assuming that entrepreneurs accumulate capital internally and face a collateral constraint on the amount of debt they can issue. Buera and Moll (2015) show that this setup is equivalent to assuming that entrepreneurs rent capital from capital markets and face a constraint that limits the amount of capital they can rent to a fraction of their wealth (see also Moll 2014 and Buera and Shin 2013).

A distinguishing feature of the financing constraint that we study is that the maximum amount that firms can borrow is only determined by the capital stock installed at the time of repayment; in particular, it is not directly affected by firms' productivity or net

worth. Closer to Buera, Kaboski, and Shin (2011), Buera and Shin (2017), and Gopinath, Kalemli-Özcan, Karabarbounis, and Villegas-Sanchez (2017), one could consider a borrowing constraint $d_{t+1} \leq \theta(a_t, z_t)k_{t+1}$, where $\theta(a, z)$ is increasing in net worth and productivity. In our context, the net impact on productive but low net worth firms, whose export decisions are primarily distorted, would be ambiguous.

Brooks and Dovis (2020) consider a financial constraint in which the maximum amount that can be borrowed depends on future firm profitability, following Albuquerque and Hopenhayn (2004). They show that such forward-looking constraints imply that the gains from trade liberalization are identical to those in a model without financial frictions. Further work is needed to better understand the type of constraints firms face and whether they are primarily backward or forward looking.[17]

The papers above assume that the relative value of collateral and debt is fixed. Kiyotaki and Moore (1997) instead consider a constraint $d_{t+1} \leq \theta P_{k,t} k_{t+1}$, where P_k is the price of capital in units of consumption. In their model, the price of capital is endogenous, leading to the value of collateral varying with aggregate conditions, amplifying the macroeconomic impact of aggregate shocks (see also Bernanke, Gertler, and Gilchrist 1999). Kohn, Leibovici, and Szkup (2020b) study constraints of this type to analyze the impact of changes in intermediate input and capital goods tariffs.

Finally, most of the literature that studies the effects of financial frictions on international trade abstract from long-term borrowing. Notable exceptions are Gross and Verani (2013) and Bergin, Feng, and Lin (2021). The former studies how financial frictions affect firms' export decisions and growth in an environment with long-term contracts as in Clementi and Hopenhayn (2006). The latter introduces an endogenous choice between long-term debt and equity financing into a trade model with heterogeneous firms and export entry.

Working capital needs and financing of fixed costs Our model abstracts from working capital needs. Requiring firms to pay for a fraction of the labor costs in advance might tighten financing constraints, amplifying the distortions. Similarly, we do not require

[17] For instance, Aguirre, Tapia, and Villacorta (2021) provide evidence in support of the importance of backward-looking financial constraints. In particular, they use Chilean firm-level data to document that (*i*) the reaction of investment to productivity shocks depends on the level of collateral, with larger responses from unconstrained firms; and that (*ii*) productive firms accumulate wealth after positive and persistent productivity shocks, with larger effects across firms with lower wealth levels.

firms to pay fixed costs of exporting in advance (as in Chaney 2016 or Leibovici 2021).[18] Such additional financial needs are likely to force low net worth firms to operate at an even lower scale than in our model, further discouraging them from exporting.

Sunk export entry costs Our model abstracts from sunk export entry costs, that is, one-time costs paid by firms only when they start exporting. Sunk export entry costs make firms' export decisions dynamic and were first introduced to account for hysteresis in exporting decisions (Baldwin and Krugman 1989, Dixit 1989), generating equilibria with relatively unproductive exporters and productive non-exporters. Alessandria and Choi (2014a,b) additionally show that sunk export entry costs are important to account for key features of export dynamics, while Alessandria, Pratap, and Yue (2014) argue that they are important to account for the slow growth of exports following large devaluations.

We abstract from sunk export entry costs motivated by Kohn, Leibovici, and Szkup (2016), who show that financial frictions can generate the observed coexistence of relatively unproductive exporters with productive non-exporters, as sunk costs do.[19] Manova (2013) and Leibovici (2021) study economies with both financial frictions and sunk export entry costs where the latter exacerbate the distortionary impact of financial frictions.

Multiple export destinations Our model considers exporting as a discrete decision among two options: being an exporter or a non-exporter. This approach abstracts from the more granular choice made by firms across the set of destinations to export to if they choose to do so. As argued by Manova (2013), financial frictions can also distort the set of destinations to which firms export. She considers a model where exporting to each destination is associated with a destination-specific fixed export cost and the financing of fixed export costs is subject to financial frictions. This approach implies that firms with limited access to internal and external funds export to fewer destinations. Consistent with this implication of the model, Manova (2013) documents that finance-intensive industries export to fewer destinations in countries with less financial development.

[18] Chaney (2016) considers a model with financing constraints that only distort the payment of fixed export costs. Thus, in this environment financial frictions have "direct" effects only on the extensive margin. He studies the coexistence of competitive devaluations and revaluations.

[19] Abstracting from sunk export entry costs also simplifies the numerical solution of the model, since export status becomes a state variable in economies with sunk export entry costs.

International financial integration In our model, the economy is fully integrated with international financial markets, allowing agents to save or borrow at an exogenous world interest rate r. Under either international financial autarky or imperfect financial integration, the interest rate would respond endogenously to the degree of financial development. As borrowing increases with financial development, the interest rate also increases to restore balance between demand and supply in financial markets. The increase of the interest rate has two opposite effects, with an ambiguous overall impact. On the one hand, it increases the cost of debt and effectively tightens the borrowing constraint, amplifying distortions. On the other hand, it encourages savings, leading to higher average net worth.

Tetenyi (2019) investigates the impact of financial integration on the gains from trade in a similar model with financial frictions. Under international financial integration, trade liberalization exacerbates the misallocation due to financial frictions. However, trade liberalization has minor effects on misallocation under international financial autarky.

Occupational choice Our model also abstracts from individuals' occupational choice between being workers or entrepreneurs, among other occupational choices they might face. Kohn, Leibovici, and Szkup (2017) and Leibovici (2021) study economies in which individuals choose whether to be workers or entrepreneurs. Without financial frictions, the occupational choice is characterized by a productivity threshold $\underline{z}^u$ such that individuals with $z \geq \underline{z}^u$ choose to be entrepreneurs, and the rest choose to be workers. Financial frictions distort this decision by making productive individuals with low net worth to be workers rather than entrepreneurs. It follows that financial frictions distort firms' entry, further distorting the set of firms that choose to export in equilibrium. Moreover, occupational choice leads to misallocation of talent across occupations, amplifying the misallocation of capital and labor relative to an economy without occupational choice.[20]

[20]There exists a large literature that investigates the impact of financial frictions on occupational choices (see Buera, Kaboski, and Shin 2015 for a detailed summary). Similarly, yet in a framework with homogeneous firms, Bergin, Feng, and Lin (2018a,b) stress the importance of financial frictions in determining firms' entry decisions and show that this mechanism can moderate the impact of financial shocks on aggregate output but can lead to a prolonged export decline.

4 Aggregate and firm-level implications of financial frictions

We now discuss how alternative versions of the framework presented above have been used to quantitatively study various implications of financial frictions on international trade. We focus on their implications for firm-level dynamics and for aggregate and industry-level outcomes, and conclude with their implications for the aggregate dynamics following aggregate shocks such as large devaluations or trade liberalization. For each of these dimensions, we provide an in-depth description of a particular paper while also discussing various related studies.

4.1 Implications for firm-level dynamics

We begin by focusing on the implications of financial frictions for the dynamics of new exporters. In the data, firm-level exports and export intensity are increasing on average in the length of export spells, while the probability that firms stop exporting decreases as firms continue to export. Ruhl and Willis (2017) first documented these dynamics using Colombian plant-level data and showed that standard models of international trade generate new exporter dynamics at odds with the data.[21] These findings suggest that the dynamics of new exporters might be informative about the underlying frictions affecting firms' export decisions.

Kohn, Leibovici, and Szkup (2016) show that introducing financial frictions to a standard model of international trade can reconcile its implications for new exporter dynamics while continuing to account for key empirically-consistent implications of these models along other dimensions.[22] To do so, they consider a simplified version of the framework presented in the previous section. Firms are assumed to use labor as their only input subject to both working capital and collateral constraints. That is, firms have to pay a fraction of their wage bill in advance and have to post collateral to access external funds. Furthermore, working capital requirements are assumed to be asymmetric across markets, with exports requiring a higher fraction of the wage bill to be paid upfront.[23] The combined working capital and collateral

[21] Similar patterns of new exporter dynamics have also been documented for Chile (Kohn, Leibovici, and Szkup 2016) and Ireland (Fitzgerald, Haller, and Yedid-Levi 2016).

[22] Gross and Verani (2013) reach similar conclusions using a multi-country model with endogenous financial constraints that arise due to asymmetric information as in Clementi and Hopenhayn (2006).

[23] See Kohn, Leibovici, and Szkup (2016) for evidence on asymmetric working capital needs across markets.

constraint is given by

$$\alpha w_t n_{it} + e_{it} \left[w_t F + w_t n_{it}^* \right] \leq \lambda a_{it}, \tag{9}$$

where e_{it} is an indicator function equal to 1 if firm i exports in period t and zero otherwise; F denotes the fixed costs denominated in labor units; w_t is the wage rate; a_{it} denotes net worth; and n_{it} and n_{it}^* denote the labor hired to produce for the domestic and foreign markets, respectively. Finally, α denotes the share of labor costs used for domestic sales that needs to be paid in advance. All export-related costs, including fixed export costs, are assumed to be paid fully in advance. Firms can either pay these costs out of their net worth a_{it} or by borrowing up to a multiple $\lambda - 1 \geq 1$ of their net worth.[24]

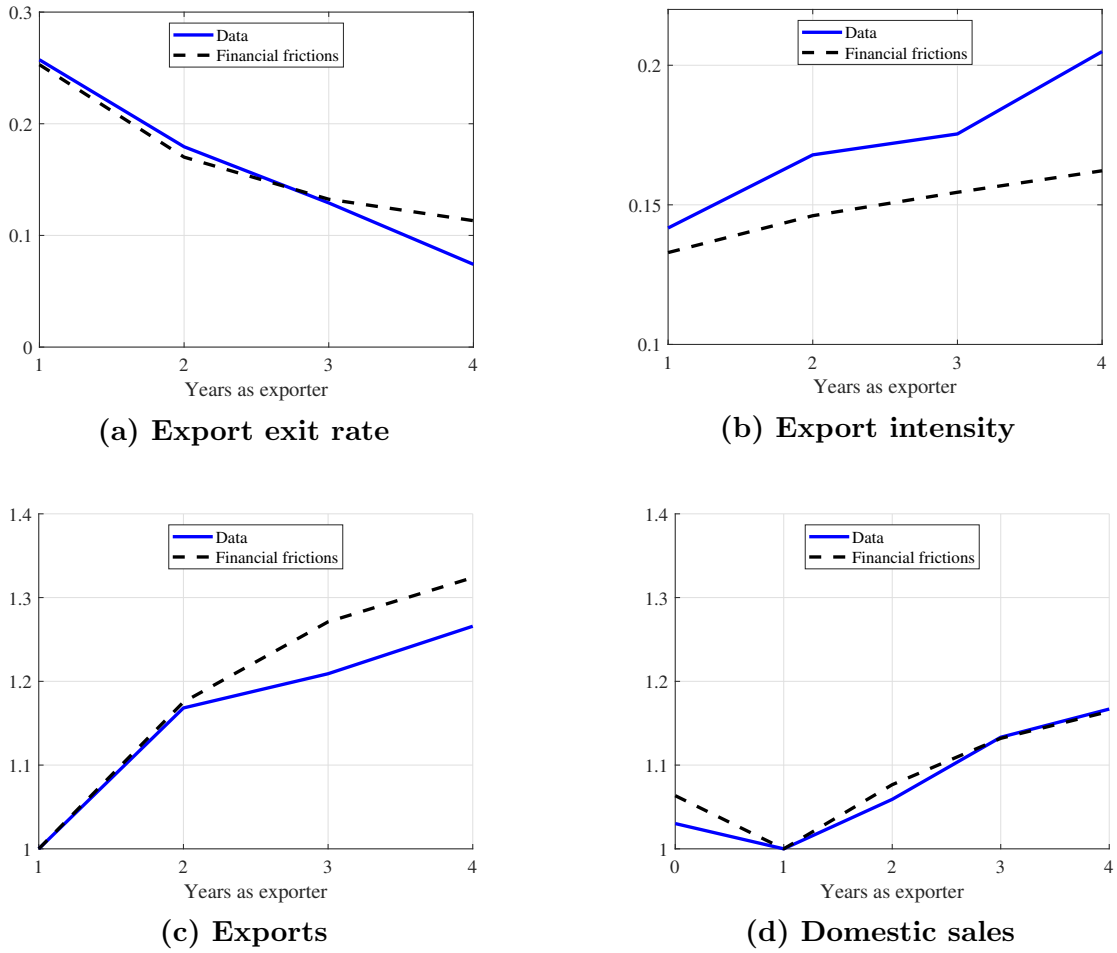
The gradual growth of new exporters' net worth is the key channel that allows the model to capture the stylized facts described above, as shown in Panels (a)-(c) of Figure 4. Firms typically start exporting after receiving a positive productivity shock but with a limited net worth, so they are initially constrained and unable to produce at the optimal scale. As new exporters increase their net worth, they relax their borrowing constraints and increase their scale. This allows them to gradually increase their exports, making exporting more attractive and, thus, decreasing the probability that they stop exporting. Thus, financial frictions act as sunk costs in inducing hysteresis: a firm that exports in a given period has a higher probability of exporting the following period. Finally, the model implies that new exporters initially export a small fraction of their total sales and that this share grows gradually as firms continue to export: since exports require relatively more working capital, the opportunity cost of using funds for exports in terms of forgone domestic sales decreases as exporting firms accumulate net worth and relax their borrowing constraints, so firms choose to export a higher fraction of their total production.[25]

Kohn, Leibovici, and Szkup (2016) show that their model can also account for additional

[24] Net worth constrains total production similarly to Equation 8, with $\lambda \equiv \frac{1+r}{1+r-\theta}$.

[25] Complementary explanations for these dynamics include search frictions (Eaton, Eslava, Jinkins, Krizan, and Tybout 2014), slow market penetration (Arkolakis 2010), capital adjustment costs (Rho and Rodrigue 2016), or learning about uncertain demand (Nguyen 2012 and Albornoz, Pardo, Corcos, and Ornelas 2012). Alessandria, Choi, and Ruhl (2021) generate these export dynamics by allowing exporters to invest in lowering their future variable trade costs, and the authors use their framework to evaluate the welfare gains from trade liberalization. Alessandria and Avila (2020) use the same framework to evaluate the welfare gains from trade reforms that Colombia underwent in the 1980s and early 1990s. Alessandria, Arkolakis, and Ruhl (2021) provide an extensive review of the literature that studies the dynamics of firms in foreign markets and their aggregate implications.

Figure 4: New exporter dynamics



(a) Export exit rate

(b) Export intensity

(c) Exports

(d) Domestic sales

Notes: Export exit rate t is computed as the share of firms that export for t consecutive periods but not $t+1$, while continuing to operate domestically at $t+1$. Export intensity is the median ratio of exports to total sales, among firms that export for at least four years. Exports and domestic sales are computed from median growth rates for firms that export for at least four years, with levels normalized to 1 in the first period that firms export. Plant-level data from the Chilean Manufacturing Survey (ENIA). The financial-frictions model and calibration are from the "model with homogeneous export entry costs" in the online appendix of Kohn, Leibovici, and Szkup (2016).

features of the data relative to standard models. Panel (d) of Figure 4 shows that financial frictions lead to a decline of domestic sales when firms start to export, a stylized fact in both Chilean and French firm-level data (see Kohn, Leibovici, and Szkup 2016 and Berman,

Berthou, and Héricourt 2015, respectively). Consistent with Chilean data, the model also implies that the probability that firms reenter export markets after ceasing to export is decreasing over time, and that firms make increasing use of external finance as they begin to export.

Other papers that investigate the firm-level distortions of financial frictions on international trade include Caggese and Cunat (2013), Manova (2013), Chaney (2016), and Gross and Verani (2013) (see Foley and Manova 2015 for a review of this literature). While these papers highlight the importance of financial frictions at the firm-level, they are silent about their aggregate implications. Are the effects described in this section important for the aggregate economy? Can these effects be partially offset when general equilibrium effects are taken into account? The papers described below address these questions.

4.2 Implications for industry-level and aggregate outcomes

As discussed above, there is substantial evidence that financial frictions play a key role in accounting for export decisions at the firm-level. An important question is then how these firm-level distortions affect trade patterns at the industry and aggregate levels. Beck (2003) and Manova (2013) use cross-country industry-level data to document that finance-intensive industries trade less in countries with less-developed financial markets. Leibovici (2021) uses a quantitative general equilibrium model to quantify the industry-level and aggregate implications of financial development on international trade.[26]

To do so, the paper studies a rich framework based on the model presented in Section 3.1. The key extensions are the analysis of multiple tradable industries that differ in capital intensity and agents that choose whether to be workers or entrepreneurs.[27] Entrepreneurs can freely switch between sectors and choose the sector in which to operate to maximize utility. As in our model, entrepreneurs face a constraint that limits how much they can borrow:

$$k_{i,t+1} \leq \frac{1+r}{1+r-\theta}\left(a_{it} - \mathbb{I}_{\{e_{it}=1,e_{i,t-1}=0\}} w\xi_0 - \mathbb{I}_{\{e_{it}=1\}} w\xi_{1j}\right), \tag{10}$$

where a_{it} denotes net worth, k_{it} denotes the firm's capital stock, ξ_0 is the sunk export entry

[26] For a theoretical discussion of how credit market imperfections distort capital and trade flows, see Matsuyama (2004, 2005) and Antras and Caballero (2009).

[27] The model also features a non-tradable sector, sunk export costs, and input-output linkages.

Table 3: Financial development and international trade

		No credit	*Baseline*	*High credit*
A. Industry-level implications				
$\frac{\text{Exports}}{\text{Domestic sales}}$	Sector L	0.25	0.23	0.08
	Sector M	0.23	0.23	0.22
	Sector H	0.33	0.35	0.47
B. Aggregate implications				
Credit / Value added		0.00	0.19	1.63
Exports / Domestic sales		0.28	0.28	0.30

cost, and ξ_{1j} is the fixed cost of exporting in tradable sector j. Firms pay sunk export entry costs if they export in period t ($e_{it} = 1$) but did not export in $t-1$ ($e_{i,t-1} = 0$); fixed export costs are paid if they export in period t ($e_{it} = 1$).

The model is calibrated using Chilean firm-level data and uses it to quantify the impact of financial frictions on international trade relative to domestic sales. There are three aggregate tradable sectors: high capital intensity (H), medium capital intensity (M), and low capital intensity (L). The analysis then consists of contrasting the industry-level and aggregate implications of the model across stationary equilibria with varying levels of θ, the parameter that controls the level of financial development.[28]

As shown in Table 3, Leibovici (2021) finds that financial development has a differential impact across sectors. In capital-intensive industries, highly dependent on external finance, relaxing the financial constraint increases the trade share. In contrast, the trade share decreases in labor-intensive industries with low dependence on external finance. Two key forces are at play. On the one hand, financial development allows firms to operate on a larger scale. On the other hand, the expansion of firms' scales of production leads to an increase in the demand for labor and production inputs, raising factor prices. The former effect dominates across capital-intensive firms since they are disproportionately distorted by financial frictions. The latter effect dominates across labor-intensive firms since their scales of operation are less distorted by financial frictions.

In contrast to the strong relation between trade and finance implied by the model and observed in the data across industries, Leibovici (2021) finds that financial development has

[28] Andreasen, Bauducco, and Dardati (2019) use a version of this framework to analyze how capital controls interact with financial frictions and exporting decisions.

a minor effect on the share of trade at the aggregate level (see Panel B of Table 3). Industry-level trade shares reallocate substantially, but the changes largely offset each other, leading to a significantly smaller change of the aggregate trade share.

Finally, Leibovici (2021) contrasts the implications of the model with estimates from industry-level and aggregate data. Consistent with the implications of the model, the paper shows that financial development is associated with an increase of the trade share in capital-intensive industries, but it is associated with a decrease of the trade share in labor-intensive ones. In the aggregate, the author shows that there is a positive but mild relation between financial development and the aggregate trade share. Together, these findings show that financial frictions have a significant impact on trade shares across sectors but only mildly affect the aggregate trade share.

4.3 Implications for dynamics following aggregate shocks

The model presented in Section 3.1 has also been used to study the dynamics following aggregate shocks: we review that literature in this section. Even if self-financing mitigates the impact of financial constraints in stationary environments (Midrigan and Xu 2014), these frictions can nevertheless impact the adjustment of all firms in response to large unexpected aggregate shocks, such as shocks to commodity prices, trade policy, and exchange rates. We begin this section by discussing the impact of financial frictions on aggregate trade dynamics following large devaluations. We then describe the effect of financial frictions on the gains from trade liberalizations. Finally, we summarize studies in related areas.

4.3.1 Export dynamics following large devaluations

In recent decades, many emerging economies experienced large real exchange rate devaluations. As these economies' exports became cheaper for consumers in the rest of the world following these episodes, standard models of international trade imply that exports would rapidly increase. Yet, Alessandria, Pratap, and Yue (2014) document that aggregate exports typically increase only gradually.

While devaluations can be expansionary by making exports cheaper, Edwards (1986) and Frankel (2005) argue that they might be contractionary in emerging economies due to balance-sheet effects. If firms face financial constraints and tend to borrow in foreign

currency, as is common in many emerging economies, then a large devaluation may depress firms' investment and output by increasing the domestic value of their debt burden.[29]

Kohn, Leibovici, and Szkup (2020a) investigate the extent to which frictions in financial markets can account for the slow response of exports following large devaluations. To do so, they study a similar model to the one in Section 3.1, extended to feature debt denominated in both domestic and foreign units. As in the baseline model, firms can only borrow up to a fraction of the value of their capital stock. The authors sidestep the portfolio choice problem to simplify the numerical solution of the model by assuming that firms borrow a fraction $\lambda \in [0, 1]$ of the total borrowed amount in domestic units, with the remaining fraction $1 - \lambda$ borrowed in foreign units. The financial constraint is then given by

$$d_{i,t+1} \left[\lambda + (1 - \lambda) \frac{\xi_{t+1}}{\xi_t} \right] \leq \theta k_{i,t+1}, \tag{11}$$

where $\frac{\xi_{t+1}}{\xi_t}$ is the change in the real exchange rate, and θ is the amount that firms can borrow per unit of physical capital installed at the time of repayment. Firms can finance their capital stock either with net worth or by borrowing, implying that $k_{i,t+1} = a_{i,t+1} + d_{i,t+1}/(1 + r)$. Combining this expression with the borrowing constraint, we obtain

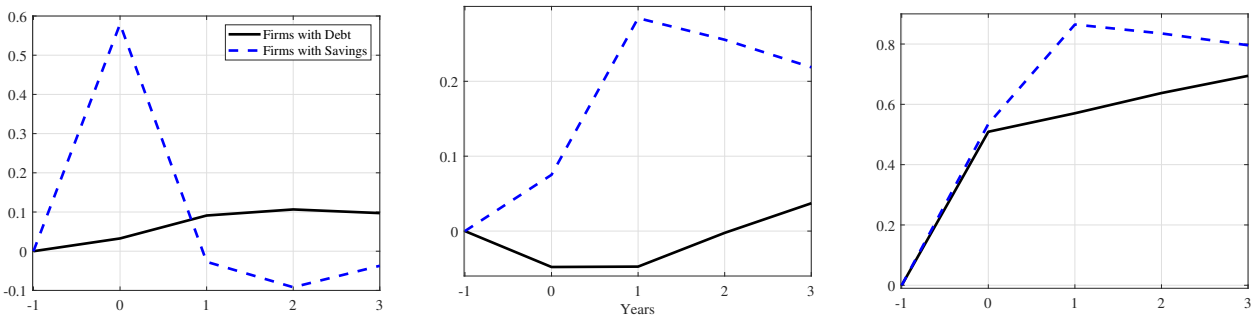
$$k_{i,t+1} \leq \frac{\left[\lambda + (1 - \lambda) \frac{\xi_{t+1}}{\xi_t} \right] (1 + r)}{\left[\lambda + (1 - \lambda) \frac{\xi_{t+1}}{\xi_t} \right] (1 + r) - \theta} a_{i,t+1}. \tag{12}$$

If all debt is denominated in domestic units ($\lambda = 1$), then the borrowing constraint in Equation 12 simplifies to the borrowing constraint of the baseline model (Equation 8). In this case, changes in the real exchange rate have no impact on firms' borrowing capacity. In contrast, if some of the debt is denominated in foreign units ($\lambda < 1$), then firms become exposed to exchange rate shocks. Equation 12 shows that an unexpected large devaluation (i.e., an increase in $\frac{\xi_{t+1}}{\xi_t}$) tightens firms' borrowing constraints, potentially forcing some firms to reduce their investments and, thus, their future output.[30]

[29] For empirical evidence on the role of balance-sheet effects, see Aguiar (2005), Berman and Berthou (2009), Berman and Hericourt (2010, 2011), Desai, Foley, and Forbes (2008), and Kalemli-Ozcan, Kamil, and Villegas-Sanchez (2016).

[30] A real exchange rate depreciation will also affect the budget constraint by increasing the ex-post cost of debt.

Figure 5: Firm-level impact of financial frictions



(a) Investment / output **(b) Output** **(c) Exports**

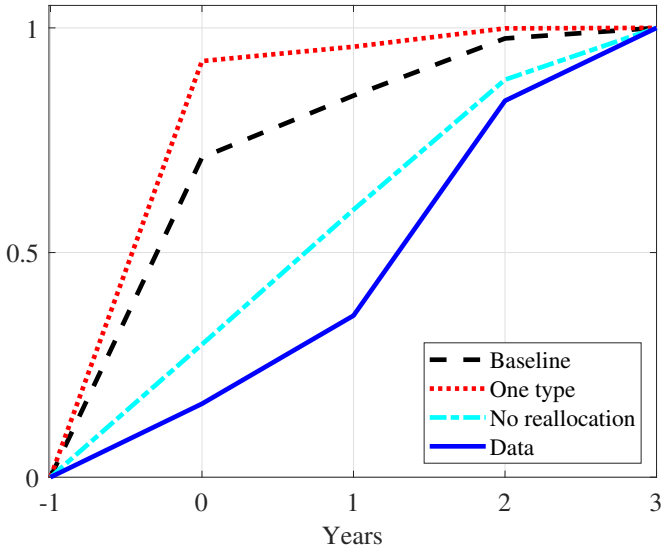
Notes: Percentage change from steady state. See Figure 3 in Kohn, Leibovici, and Szkup (2020a) for details.

Figure 5 illustrates these effects, contrasting firms with a given productivity level but that differ in financial position (debt vs. savings). In a frictionless economy, both types of firms would respond similarly to a large devaluation. Yet, with financial frictions and foreign-denominated debt, we observe that firms with savings rapidly increase their investment and total sales, while firms with debt reduce their investments and output. Notice, however, that exports increase similarly for both types of firms (see Panel (c) of Figure 5), as firms with debt reallocate sales across markets (the "reallocation channel") since following devaluation exporting becomes more attractive than selling domestically.

Kohn, Leibovici, and Szkup (2020a) quantify the effect of financial frictions and balance-sheet effects on the dynamics of exports following large devaluations by calibrating the model to match key features of Mexican plant-level data for the year prior to the 1994 devaluation. In particular, the degree to which firms can reallocate sales across markets is disciplined by accounting for export-intensity heterogeneity across firms. The experiment consists of considering unexpected shocks to the terms of trade, interest rate, and aggregate productivity such that the dynamics of the real exchange rate, investment, and real GDP implied by the model mirror the dynamics observed in Mexico following the 1994 devaluation.

Figure 6 shows the elasticity of aggregate exports relative to the real exchange rate for alternative specifications of the model as well as for the data. To focus on the speed of adjustment following the devaluation, the elasticities are expressed as percentages of their

Figure 6: Elasticity of exports to real exchange rate



Notes: Elasticities for each model and the data expressed as a percent of their long-run values. See Figure 4 in Kohn, Leibovici, and Szkup (2020a) for details.

final steady-state values. The main finding is that financial frictions and balance-sheet effects only explain a modest fraction of the slow response of exports observed in the data. This is primarily accounted for by the reallocation channel: given that exporters typically only export a small fraction of their total sales, they can substantially increase their exports by reallocating sales across markets even if severely affected by financial frictions and balance-sheet effects.

To illustrate the importance of the reallocation channel, Kohn, Leibovici, and Szkup (2020a) recompute the experiment under two alternative environments. First, they show that an economy in which this channel is shut down implies a response of exports much closer to the one observed in the data. Second, they show that an economy estimated to target the low median export intensity observed in the data, rather than additional features of the export intensity distribution, features an even faster adjustment of exports than in the baseline model.

A key take-away message of this paper is that the dynamics of aggregate exports in economies with financial frictions hinge on firms' ability to reallocate sales across markets.

In Kohn, Leibovici, and Szkup (2020a), reallocating sales is costless and, thus, exports adjust rapidly despite financial constraints. To the extent that firms actually face reallocation costs, either because exports are more finance intensive (as in Manova 2013, Chaney 2016, or Kohn, Leibovici, and Szkup 2016) or because it is costly to adapt goods for different destination markets, financial frictions and balance-sheet effects are likely to have a stronger impact on the dynamics of aggregate exports.[31]

4.3.2 Trade liberalization and financial development

Another important question is whether frictions in financial markets affect the gains from trade liberalization. Caggese and Cunat (2013) and Kohn, Leibovici, and Szkup (2016) study partial equilibrium frameworks to analyze how financial development affects the gains from lowering export barriers. Using Italian and Chilean data, respectively, these studies find that trade liberalization in the presence of financial frictions leads to a 25% lower increase in TFP and 18% lower increase in exports, respectively, than in their absence. Both studies find that financial frictions reduce the gains from trade primarily by distorting the extensive margin of trade. While informative about industry-level effects, the partial equilibrium nature of the analysis is a limitation for the study of aggregate effects.

Brooks and Dovis (2020) consider a general equilibrium model based on Melitz (2003) to investigate how financial frictions affect the gains from bilateral trade liberalization.[32] They find the impact of financial frictions on the gains from trade depends on the type of frictions that firms face. On the one hand, they find that backward-looking collateral constraints lead to lower welfare gains than an economy with perfect credit markets. In contrast, they find that forward-looking constraints do not affect the gains from trade liberalization. Lower trade barriers increases the future profits of exporters, relaxing their financial constraints upon trade liberalization — a channel that is absent in economies with backward-looking collateral constraints.

The above papers do not differentiate between trade in consumption, intermediate, and capital goods. However, Amiti and Konings (2007), Wacziarg and Welch (2008), and others document that a key channel through which trade liberalization promotes growth is reduc-

[31] A separate but related literature investigates the impact of exchange rate volatility on trade (see, for example, Héricourt and Poncet 2015 and Lin, Shi, and Ye 2018).

[32] More generally, Bai, Jin, and Lu (2019) and Berthou, Chung, Manova, and Sandoz (2020) study the role of misallocation in trade liberalization.

tions in the costs of importing capital and intermediate inputs. Since financial frictions slow down capital accumulation, they might particularly affect the gains from trade liberalization of intermediates and capital goods.

Kohn, Leibovici, and Szkup (2020b) investigate this possibility empirically and quantitatively. First, they document that following a reduction in import tariffs on capital and intermediate inputs, financially developed economies grow faster than less-developed ones. Then, they study the extent to which this differential impact of trade liberalization is accounted by financial frictions, and investigate their distributional and welfare implications. To do so, they use an extension of the model from Section 3.1 featuring trade in intermediate and capital goods. In particular, there are two types of final good composites: a consumption good and an investment good, each produced by competitive firms that aggregate domestic and imported varieties. The consumption good is consumed by individuals, while the investment good is used either for producing capital or as an intermediate input in the production of domestic varieties. Importantly, varieties imported for the production of consumption or investment-intermediate goods are subject to tariffs that can be potentially different.

Similarly to the baseline model, firms now face the following financial constraint:

$$P_{k,t}k_{i,t+1} \leq \frac{1+r}{1+r-\theta}a_{i,t+1}, \tag{13}$$

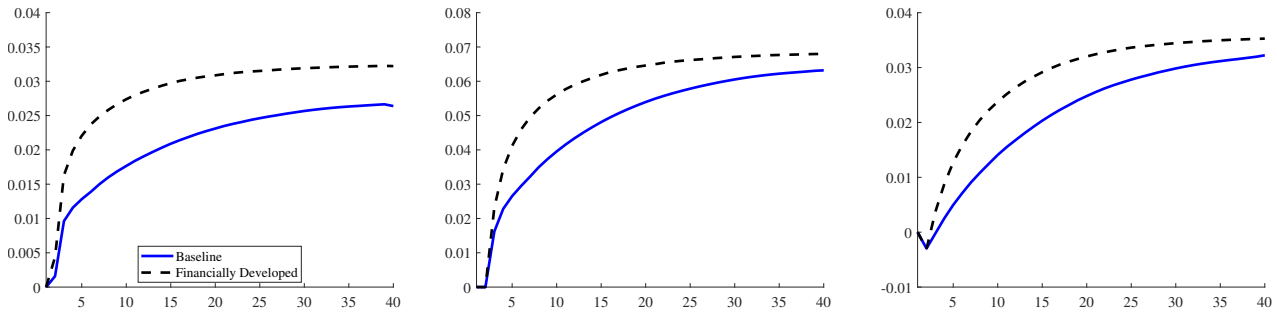
where $P_{k,t}$ is the price of capital goods. This constraint limits the current value of next period's capital stock to be lower than a multiple of the firm's net worth in period $t+1$. Note that the tightness of the borrowing constraint is increasing in the price of capital.[33]

In this model, reducing tariffs on imported varieties for the production of capital and intermediate goods has three effects. First, lower tariffs reduce the price of these imported varieties, increasing imports partially at the expense of domestic varieties. Second, lower tariffs lead to cheaper investment goods, decreasing the cost of production and investment while relaxing the borrowing constraints. Finally, lower tariffs lead to real exchange rate depreciation, increasing the foreign demand for domestic varieties.

Kohn, Leibovici, and Szkup (2020b) calibrate the model using Colombian data (see Roberts and Tybout 1997) and investigate the effect of reducing import tariffs on capital goods and intermediates, as implemented in Colombia over 1988-1992. They find that ag-

[33]If $P_{k,t} = 1$ then Equation 13 simplifies to Equation 6.

Figure 7: Transition dynamics following a reduction in capital tariffs



(a) Real GDP **(b) Capital** **(c) Consumption**

Source: Kohn, Leibovici, and Szkup (2020b). See the paper for further details.

gregate output, consumption, and capital increase slower than in a financially developed economy (i.e., an economy in which borrowing constraints are calibrated to match the average credit-to-GDP ratio across OECD economies), as shown in Figure 7. Moreover, they show that these findings are consistent with cross-country evidence.

The slower adjustment following trade liberalization reduces the welfare gains from trade liberalization: these are 0.16% in consumption-equivalence units relative to 0.86% in the financially developed economy. Moreover, they show that if the economies could transition to the final steady state immediately, then the welfare gains would be not only larger in both economies but also very similar. Thus, they conclude that the difference in welfare gains between the two economies is accounted for by the faster transition in the financially developed economy. Finally, they show that financial frictions also distort the distributional effects of trade liberalization: financial frictions increase the concentration of the gains from trade among rich entrepreneurs, while these gains are more uniformly distributed in the financially developed economy.[34]

[34]Lanteri, Medina, and Tan (2020) emphasize that slow adjustments to an increase in import competition can be driven by capital-reallocation frictions. In the presence of such frictions, firms postpone their capital adjustment choices, which results in a gradual adjustment towards the new steady state.

5 Financial frictions and trade: Additional channels

The previous sections summarize a growing literature that investigates the impact of credit market frictions on firms' export decisions. Our presentation throughout inevitably required us to abstract from some channels related to the interaction between trade and finance that might be important but which would have taken us beyond the scope of this paper. In this section, we briefly describe some of these channels and the related studies.

Trade finance Recent studies have investigated the determinants of alternative payment arrangements observed in international trade transactions. Sometimes importers pay for goods before exporters ship the goods internationally; other times they pay for them after the goods arrive at the destination. Sometimes these payments are intermediated by banks through letters of credit; other times they are paid for directly by the parties involved. Understanding the determinants of these alternative arrangements and the role of financial constraints has been recently investigated empirically and theoretically by Ahn (2020), Schmidt-Eisenlohr (2013), Antras and Foley (2015), and Demir and Javorcik (2018), among others. The studies reviewed in this paper abstract from these channels and instead focus on the extent to which firms engaged in international trade are more finance intensive and how this affects firms' export decisions and other aggregate outcomes.

Financial institutions Another complementary literature has focused on understanding the role of banks in international trade. This literature is particularly complementary to the aforementioned studies on trade finance, providing a more focused analysis on the role played by banks in promoting or hindering international trade transactions. For recent studies in this literature, see Engemann, Eck, and Schnitzer (2014), Paravisini, Rappoport, and Schnabl (2015), Niepmann and Schmidt-Eisenlohr (2017a,b), Caballero, Candelaria, and Hale (2018), and Claessens and Van Horen (2021), among others.[35] The studies reviewed in this paper abstract from the role of banks and, instead, take credit constraints as given and examine their impact on firms' production and export decisions.

[35] For a recent study on the impact of banking crises on exports, see Iacovone, Ferro, Pereira-López, and Zavacka (2019).

Pattern and logistics of trade Credit market frictions have also been documented to impact various additional dimensions of the pattern and logistics of international trade transactions. For instance, Chan and Manova (2015) show that financial frictions distort the choice of trade partners. Relatedly, financial frictions determine whether firms use trade intermediaries (Chan 2019) and whether they engage in ordinary or processing trade (Manova and Yu 2016). These additional dimensions complement those reviewed in this paper, and are likely to further amplify the distortionary impact of financial frictions on international trade.

Innovation Another channel through which frictions in financial markets affect international trade is by distorting firms' technology and innovation decisions, as documented by Egger and Keuschnigg (2015), Foellmi, Legge, and Tiemann (2015), and Faustino and Matos (2015). To the extent that exporting is dependent on innovation, the finance-intensive nature of R&D and innovation activities implies that this channel may amplify the distortionary impact of credit market frictions. Indeed, Bonfiglioli, Crinò, and Gancia (2019) show that financial frictions can discourage entering firms from investing in risky but innovative projects. In a similar spirit, Foellmi and Oechslin (2020) show that in the presence of financial frictions, opening to trade may force firms to switch to less productive (traditional) technologies.

Multinational firms Multinational firms have long been documented to serve as an additional source of finance in economies with underdeveloped financial markets (Desai, Foley, and Forbes 2008). In particular, multinational firms are typically considered to be less subject to credit constraints faced by host countries since they can also access foreign sources of capital. Manova, Wei, and Zhang (2015) show that the financial advantages of multinational firms play an important role in shaping the patterns of both international trade and multinational activity. Spencer (2020) develops a quantitative model with firm heterogeneity and financial frictions to study the impact of corporate tax reforms targeted at multinationals.

6 Concluding remarks

This paper reviews recent studies on the impact of financial frictions on international trade, a literature that has grown rapidly following the global financial crisis of 2008-2009. A

wide range of studies shows that financial factors are not only important determinants of macroeconomic outcomes but also important determinants of international trade decisions. Yet, much work remains to be done to sharpen our understanding of the channels through which credit market frictions affect international trade and these frictions' implications for aggregate outcomes. Data availability has been a key limiting factor for the progress of this area of research.

First, while much of the literature has investigated the determinants of firms' export decisions using manufacturing surveys, these have typically failed to systematically collect the detailed financial information required to deepen our understanding of the impact of financial channels on real outcomes. Improved collection of firm-level financial information that can be linked to real outcomes at higher frequencies and with broader sectoral coverage will help advance our understanding of the channels discussed in this paper.

Second, limited data availability on importers has likely amplified the literature's focus on understanding firms' export decisions. The result has been a more limited understanding of importers and the role that financial factors may play in accounting for their choices. As new and more detailed firm-level datasets become available, we might have a more comprehensive picture of the role of financial factors along this margin.

Third, increased data availability across countries is also likely to spur the growth of related areas of research. For instance, with the increased growth of global value chains and their importance for international trade, financial shocks in a location are increasingly likely to be transmitted across countries. Thus, the trade-finance nexus is likely to be an increasingly important channel for the transmission of financial shocks across countries, raising novel questions on the design of trade and financial policies. We expect the present review to serve researchers and practitioners alike as a starting point to conduct further research and design policies to address these and other important questions about the link between trade and finance.

Finally, a better understanding of the trade-finance nexus holds the promise of improving our knowledge of how financial frictions affect economic outcomes more broadly. In some respects, trade data is richer and more systematically collected than data on firms' domestic transactions and operations. Thus, this line of research has the potential to shed light on key aspects of financial market frictions.

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Appendix

Appendix A Summary statistics

Table 4 reports summary statistics for each of the variables analyzed in Section 2. We restrict attention to summary statistics after aggregating the firm-level information to the country level. The ratio of exports to total sales and TFP is averaged across all firms within each country, and the FP reports the share of firms in each country that report finance to be a problem as defined above.

We observe substantial heterogeneity across countries in exporting performance. While the average share of exporters across countries is 29%, the 25^{th} and 75^{th} percentiles vary widely: 16% and 37%, respectively. We find that exporters in most countries tend to sell a significant fraction abroad on average. The average share of production that exporters sell abroad is 46%, with the 25^{th} and 75^{th} percentiles ranging from 36% to 53%.

Similarly, we observe substantial heterogeneity in financial development across countries according to both the share of firms that report finance to be a problem and from the lens of the aggregate credit-to-GDP ratio. On average, 49% of all firms report finance to be a problem, with the 25^{th} and 75^{th} percentiles ranging from 39% to 59%. The credit-to-GDP ratio is 41% on average, with the corresponding percentiles range from 17% to 56%, respectively.

Appendix B Calibration

In this section we describe the calibration underlying the figures presented in Section 3.2. We calibrate the model with financial frictions following Kohn, Leibovici, and Szkup (2020a). We partition the parameter space into two groups. The parameters in the first group are set to values commonly used in the literature, as reported in Panel A of Table 5.

The parameters in the second group are the iceberg trade cost τ, fixed cost of exporting F, persistence of productivity shocks ρ, standard deviation of productivity shocks σ_ε, and the tightness of the financial constraint θ. We choose them to match the following moments: (i) the average export intensity (i.e., the average share of export sales in total sales), (ii) the share of exporters, (iii) the share of sales accounted by the largest 25% of firms, (iv) the

Table 4: Summary statistics

Variable	Avg.	Std. dev.	p25	p50	p75	Countries
Share of exporters	0.29	0.18	0.16	0.24	0.37	93
Exports / Sales	0.46	0.15	0.36	0.44	0.53	93
Financing problem	0.49	0.16	0.39	0.48	0.59	93
Aggregate credit / GDP	0.41	0.28	0.17	0.36	0.56	84
TFP (log)	1.15	0.16	1.04	1.15	1.25	93
Aggregate GDP (log)	11.90	1.53	10.70	11.55	13.06	93

Note: Each country's value of Exports/Sales and firm-level TFP are within-country averages. Exports/Sales is averaged conditional on exporting. Financing problem is the share of firms in each country that report access to finance to be at least a moderate problem for the firm's operations. All variables except Credit/GDP and country-level GDP correspond to manufacturing firms. Avg. and std. dev. denote average and standard deviation, respectively. p25, p50, and p75 denote the 25^{th}, 50^{th}, and 75^{th} percentiles, respectively. Countries denotes the number of countries.

standard deviation of log sales, (v) the net exports-to-GDP ratio, and (vi) the credit-to-GDP ratio. These moments are computed using Mexican plant-level data for the year 1994 from the Annual Manufacturing Survey (Encuesta Industrial Anual), collected by the National Institute of Statistics and Geography (INEGI). For more details about this data set, see Iacovone (2008) and Kohn, Leibovici, and Szkup (2020a). We report the estimated values of these parameters in Panel B of Table 5.

To study the model without financial frictions, we keep all parameters fixed except for θ, which we set to a value sufficiently high such that it never binds.

Table 5: Parameterization for Section 3

Panel A: Predetermined parameters				
Parameter	Value	Description		
γ	2	Risk aversion		
σ	4	Elasticity of substitution		
δ	0.06	Capital depreciation rate		
r	0.08	Interest rate		
α	0.33	Capital share		
p_m	1	Price imports		
Y_f	10	Rest of the world aggregate demand		
Panel B: Estimated parameters				
Parameter	Value	Target moment	Data	Model
τ	5.18	Export intensity	0.23	0.23
F	0.07	Share of exporters	0.32	0.32
ρ	0.89	Share of sales accounted by top 25%	0.84	0.84
σ_ε	0.24	Standard deviation of log sales	1.52	1.52
β	0.84	Net exports / GDP	-0.03	-0.03
θ	0.21	Credit / GDP	0.44	0.44

Note: The parameters reported in this table are used to compute the results for the financial-frictions model reported in Figures 1 and 2 of the paper.