Trade Intermediation, Financial Frictions, and the Gains from Trade

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Abstract

This paper presents a simple heterogeneous firm model of international trade with trade intermediation and financial frictions. Indirect exporting through intermediaries entails lower fixed costs but larger variable costs, and thus intermediaries alleviate financial frictions which magnify the costs of exporting. The model finds strong empirical support in firm-level data on indirect exports for over 100 countries as well as country-level data on entrepôt trade through Hong Kong for over 50 countries. Financially more constrained exporting firms and financially less developed countries are more likely to use trade intermediaries, with both of these effects stronger in financially more vulnerable industries. Calibrating a two-country version of the model in general equilibrium for China and US reveals important gains from trade intermediation. When indirect exporting is eliminated from China, welfare, exports, and the share of exporting firms fall by 0.24%, 18%, and 59% respectively. Moreover, as financial frictions in China increase, the share of exporting firms relying on trade intermediation relative to direct exporting rises.

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1 Introduction

In many markets, intermediaries facilitate transactions between agents on the demand and supply sides. For example, financial intermediaries such as banks connect lenders and borrowers, while labor market intermediaries match unemployed workers with firms.[1] In international trade, third-party intermediaries allow firms to sell goods abroad without having to directly export to the destinations themselves. These indirect trade flows are observed through trade intermediaries like retailers, wholesalers, or trading companies. Despite reductions in barriers to trade, exporting to foreign countries remains a costly endeavor. Thus, indirect exporting is a cheaper alternative for producers that cannot finance the large upfront costs incurred when selling abroad. This paper examines the determinants of intermediary trade, with an emphasis on the role of financial frictions, and quantifies the effect of trade intermediation on the gains from trade.

Trade intermediaries may be located in domestic or foreign markets. An estimated 10 to 20% of exports are sold through domestic intermediaries in countries like the US, Italy, China, and France, and across many developing countries, this ratio is also substantial at 21%.[2] Indirect exports that flow through intermediaries in a foreign country before reaching their final destination are commonly referred to as "re-exports", or the exports of foreign goods. Globally, the share of re-export trade has been estimated to be around 15% (Andriamananjara et al., 2004). Re-export trade activity is especially large for entrepôts or trading ports like Hong Kong. Trading companies in Hong Kong such as Li & Fung Limited have a network of manufacturers in Asia and assist these firms in finding customers for their products. In 2010, the value of re-exports through Hong Kong was almost $400 billion USD, while the ratio of re-exports to gross exports from Hong Kong was 96%.

To study how financial frictions affect firms' export mode decision, I develop a tractable, heterogeneous firm model of international trade with trade intermediation and financial frictions. Exporting firms choose between indirect and direct exporting. By indirectly exporting through an intermediary, firms save on fixed costs (e.g., marketing, distribution, product design), but pay higher variable costs on additional transportation and a fee for the intermediary. This trade-off implies that the most productive firms with high revenue export directly while less productive firms sell indirectly. Importantly, besides productivity, financial market frictions also affect the sorting of firms into export modes. Fixed and variable costs of exporting require outside financing, and are therefore magnified by financial frictions which raise the cost of capital. These frictions incentivize firms to export indirectly as the relatively cheaper alternative. The theory thus predicts that financially constrained firms are more likely to be indirect exporters. Correspondingly, at the aggregate level, financially developed countries with lower costs of credit

[1] See Gorton and Winton (2002) and Allen et al. (2013) for surveys on financial intermediation, and Autor (2009) for numerous papers on labor market intermediation.

[2] See Bernard et al. (2010), Bernard et al. (2013), Ahn et al. (2011), and Crozet et al. (2013) for studies on trade intermediation in US, Italy, China, and France respectively. The average share of indirect exports for developing countries comes from the author's calculations using the World Bank Enterprise Surveys (see Section 4.1). On the import side, Chilean wholesalers accounted for 35% of imports from Argentina (Blum et al., 2010).

for all firms have a smaller fraction of exports that are indirectly sold. Furthermore, both firm and country-level effects are more pronounced in financially more vulnerable sectors which, for example, require greater outside financing.[3]

The predictions of the model are supported by complementary evidence from firm-level and country-level data. First, I test the firm-level implications of the model using the World Bank Enterprise Surveys, a firm-level dataset covering 129 developing countries. The surveys collect information on firms' indirect exports through domestic intermediaries and direct exports, as well as the extent to which access to financing, like availability and cost, is an obstacle to firms' business operations. This provides a measure of the financial frictions that firms face. The results confirm that firms with greater difficulty in accessing finance are more likely to be indirect exporters. Moreover, exploiting variation in sector financial vulnerability, exogenous from the perspective of individual firms, I find that the effect of financial constraints on the likelihood of indirect exporting is indeed stronger in sectors with higher external finance dependence and lower asset tangibility. These two financial vulnerability measures capture, respectively, firms' demand for outside financing within a given industry and the availability of collateralizable assets to raise financial capital (Rajan and Zingales, 1998; Braun, 2003).

At the aggregate level, I examine the bilateral share of indirect exports in total exports for pairs of countries. Systematic data on this aggregate indirect export share is available only for re-exports by foreign intermediaries in the entrepôt of Hong Kong. This data of intermediary trade is unique in identifying both origin and destination countries. Using a sample of 56 exporters, 85 importers, and 25 industries, I estimate a fractional probit model using the methodology in Papke and Wooldridge (2008), where the regressors are the exporter's financial development and its interactions with sector financial vulnerability. Consistent with the theory, the indirect export share decreases with the exporter's financial development, as measured by the private credit-to-GDP ratio, especially in financially vulnerable sectors. This result is robust to the inclusion of other factors that might affect indirect trade shares such as market size, geography, and costs of trade.

To evaluate the gains from trade intermediation, a two-sector version of the model is calibrated in general equilibrium for China and the US in 2005. The intermediated share of manufacturing exports from China to the US in 2005 was around 37%. After recovering the costs of exporting, I perform counterfactuals to gauge the relative importance of indirect exporting for consumer welfare and firm export performance. Eliminating indirect exporting and direct exporting from China leads to a static welfare loss in the real wage of, respectively, 0.24% and 0.40% for China. Thus, the loss from removing intermediaries is close to 60% of the welfare change from removing direct exporting. Exports from China to the US fall by 18% upon removing trade intermediaries, and the share of exporting firms declines dramatically by 59%. Furthermore, as financial frictions increase, trade intermediation becomes more important for firms. I find that the proportion of exporting firms relying on trade intermediaries relative to direct exporting rises by over 50% when the cost of capital (proxied by the lending rate) is

[3]As discussed in Section 2, the inclusion of trade intermediaries in the framework of Manova (2013) where credit constraints are modeled explicitly delivers the same qualitative predictions.

doubled.

For countries with weak credit institutions, exporting remains an expensive undertaking that could benefit from policies that favor greater trade intermediation and increased competition amongst the intermediaries. The quantitative exercises here show large gains from trade intermediation for producers and consumers alike. Evidence from previous research shows that indirect exporting can be a stepping stone to selling abroad directly, and additional positive externalities and productivity-enhancing effects are generated when trade intermediaries share their knowledge with producers and manufacturers (e.g., Ahn et al., 2011; Ellis, 2003). In particular, Bai et al. (2015) show that selling through an intermediary can lead to increased productivity through learning-by-exporting. If so, the static gains from intermediated trade analyzed here may be magnified in a dynamic setting.

This paper seeks to understand the role of trade intermediaries and to quantify their economic impact. Most directly, it merges two strands of research in international trade: intermediated trade and the effect of financial market imperfections on trade. Theoretically, intermediaries have a comparative advantage in locating buyers, and act as matchmakers for producers faced with search frictions (e.g., Rauch and Watson, 2004; Antràs and Costinot, 2010; Petropoulou, 2011; Krishna and Sheveleva, 2014). In the context of the Melitz (2003) heterogeneous firm model, selling through a third-party translates to an additional mode of exporting with a lower fixed cost, as modeled in this paper and others.[4] The productivity sorting pattern of heterogeneous firms has been studied in other contexts, for instance, when there are trade-offs between horizontal foreign direct investment and exporting, or vertical integration and outsourcing (e.g., Helpman et al., 2004; Nunn and Trefler, 2013b).

Using firm-level data from different countries, the recent burgeoning empirical literature on trade intermediation has identified country size, geography, trade costs, and the contracting environment as determinants of intermediary trade. For example, Ahn et al. (2011) find that intermediary shares in China are larger for smaller, more distant destinations associated with higher trade costs. Bernard et al. (2013) and Felbermayr and Jung (2011) show trade intermediation increases with weaker governance quality and greater expropriation risk respectively.[5] Besides incorporating findings from the prior literature here, I highlight a new and important channel where financial frictions can affect firms' export mode and aggregate intermediated trade. Data from the Enterprise Surveys indicate that access to financing is one of the major problems that firms face (see Table 1). The results here show that trade intermediaries can alleviate financial market frictions at the firm and country level.

[4]For example, Blum et al. (2011), Felbermayr and Jung (2011), Tang and Zhang (2012), Akerman (2014), and Bai et al. (2015) use similar models of heterogeneous firms with productivity sorting into indirect and direct exporting but without financial frictions.

[5]Bernard et al. (2013) examine Italian wholesalers while Felbermayr and Jung (2011) use US industry-level data. Other papers this area of research include Akerman (2014) for Sweden, Crozet et al. (2013) for France, Blum et al. (2010, 2011) for Argentina, Chile, and Colombia, Fryges (2007) for Germany and the United Kingdom, and Hessels and Terjesen (2010) for the Netherlands. Studies that use the Enterprise Surveys to examine indirect exporting include Lu et al. (2011), Abel-Koch (2013), and Hoefele et al. (2013). McCann (2013) find multi-product firms are more likely to use intermediaries than single product firms. Complementary research studies the so called "carry-along" trade, where manufacturers export goods that they themselves do not make (e.g., Bernard et al., 2012; Eckel and Riezman, 2013).

The empirical analysis also makes novel use of the indirect export data through Hong Kong by running gravity-type regressions, as previous studies have focused on the trade relationship between Hong Kong and China alone (e.g., Feenstra and Hanson, 2004; Fisman and Svensson, 2007). My work is the first that I am aware of to perform quantitative welfare analysis for models with trade intermediation. This quantitative analysis is an important step towards understanding not just how intermediaries alter trade patterns, but also how *much* they affect the gains from trade, for both consumers and firms. The results reveal that welfare calculations that incorporate trade intermediation can be quite different from those that rely only on direct trade flows. Firm heterogeneity and the distinction between indirect and direct exporters is important in this regard.

The second strand of literature that this paper contributes to studies the effects of financial frictions on international trade at the firm and country levels.[6] Theoretically, Manova (2013) and Chaney (2013) show that financial or liquidity constraints affect the level of firm exports as well as entry into exporting. This is supported empirically at the aggregate level; Manova (2013) finds that financially more developed countries export more both at the intensive and extensive margins. Financial development also helps exporters in sectors and for destinations where fixed costs are high (Becker et al., 2013). The country-level empirical strategy in this paper follows Manova (2013) and Beck (2002, 2003) in exploiting the industry variation of financial vulnerability, while the firm-level approach is similar to Manova et al. (2015).[7]

At the firm level, studies such as Muûls (2008), Berman and Héricourt (2010), and Minetti and Zhu (2011) show that financial health is positively correlated with export status, but overall evidence is mixed. Although the link between bilateral trade and finance has been well studied, how financial markets affect intermediary trade, which constitutes a significant portion of global trade, is less understood. This paper aims to fill this void. More broadly, the strength of domestic institutions associated with, for instance, contracting and property-rights or financial development have been shown to be sources of comparative advantage and determinants of trade patterns (Nunn and Trefler, 2013a). The findings here suggest that countries without the comparative advantage of financial development can benefit from trade intermediation.

The paper proceeds as follows. Section 2 presents the theoretical model which generates the testable implications. Section 3 outlines the estimation strategies and Section 4 provides details on the datasets used. Section 5 presents the empirical results for firm and country-level regressions. Section 6 describes the model calibration and results from counterfactual exercises, and Section 7 concludes.

2 Model

The model incorporates features from Ahn et al. (2011) and Manova (2013), which extend the standard Melitz (2003) theoretical framework to study firm heterogeneity with trade in-

[6] See Foley and Manova (2015) for a recent survey.

[7] Other papers that have used similar empirical specifications include, for instance, Svaleryd and Vlachos (2005), Hur et al. (2006), and Chan and Manova (2015).

termediation and financial frictions respectively. Firms with heterogeneous productivity and financial frictions can export directly or indirectly through a third-party trade intermediary. Firms face a trade-off where exporting indirectly requires higher variable costs but lower fixed costs. Importantly, firms' choice in export mode is affected by financial frictions which magnify the variable and fixed costs of trade. As I discuss below, the assumption that frictions have an impact on both variable and fixed costs is not crucial; the same qualitative results hold if either variable and/or fixed costs are affected. Moreover, in Appendix A, I present a variant of the Manova (2013) framework, where credit constraints are modeled explicitly by assuming firms pledge collateral to obtain external capital, to include trade intermediation, and show that it delivers the same qualitative predictions. Thus, this section takes the simpler approach of modeling financial frictions as cost-shifters. The resulting model is also well-suited for calibration to examine counterfactuals; this quantitative exercise is carried out in Section 6.

2.1 Preferences

There are N countries in the world, each with a representative agent. Preferences exhibit constant elasticity of substitution, $\sigma > 1$, between the differentiated varieties. The utility of the representative consumer in country j is given by:

$$U_j = q_{j0}^{\mu_0} \prod_{s=1}^{S} \Big(\int_{\Omega_{js}} q_{js}(\omega)^{\frac{\sigma-1}{\sigma}} d\omega \Big)^{\frac{\sigma}{\sigma-1}\mu_s}, \tag{2.1}$$

where $\mu_0 + \sum_s \mu_s = 1$, q_{j0} denotes the consumption of the numeraire good, and $q_{js}(\omega)$ is the consumption of variety ω within the set of varieties Ω_{js} in sector s. Solving the consumer's maximization problem, the isoelastic demand function is $q_{js}(\omega) = p_{js}(\omega)^{-\sigma}\mu_s Y_j / P_{js}^{1-\sigma}$. Aggregate expenditure in country j is denoted as Y_j, $p_{js}(\omega)$ is the price that the consumer pays for variety ω, and $P_{js} = (\int_{\Omega_{js}} p_{js}(\omega)^{1-\sigma} d\omega)^{\frac{1}{1-\sigma}}$ is the ideal price index.

2.2 Firms, production, and exporting

All countries produce the numeraire good using a constant returns to scale technology; the wage of country i is w_i. Heterogeneous firms producing the differentiated goods pay a sunk cost of entry and draw productivity φ from the bounded Pareto distribution $G(\varphi) = \Big[1 - \varphi_L^k \varphi^{-k}\Big] / \Big[1 - \Big(\frac{\varphi_L}{\varphi_H}\Big)^k\Big]$. The support of the distribution is $[\varphi_L, \varphi_H]$, and $k > \sigma - 1$ is assumed. The marginal cost of production for a firm in country i is then w_i/φ.

A firm in country i serving the domestic market solves the following maximization problem:

$$\max_{p,q} \pi_{iis}^H(\varphi,\theta) = p_{iis}(\varphi,\theta) q_{iis}(\varphi,\theta) - \frac{\theta \eta_s}{\lambda_i} \left[q_{iis}(\varphi,\theta) \frac{w_i}{\varphi} + w_i f_{ii}^H \right] \tag{2.2}$$
$$s.t. \quad q_{iis}(\varphi,\theta) = \frac{(p_{iis}(\varphi,\theta))^{-\sigma} \mu_s Y_i}{P_{is}^{1-\sigma}}.$$

The fixed cost of domestic production in labor units is denoted by f_{ii}^H. Both variable and fixed

costs require some outside financing, and firms face financial frictions that increase their cost of capital and magnify the costs of production. These financial frictions have a firm-specific component θ and a country-specific component λ_i. Along with its productivity parameter, a firm draws firm-specific financial constraint θ from $F(\theta)$. This parameter represents the difficulty of individual firms' access to credit, for example from higher interest rates, fees, or stringent collateral requirements, and may vary across firms due to distortions in the capital market and the misallocation of capital (e.g., Hsieh and Klenow, 2009). Furthermore, countries with weaker financial institutions (low λ_i) have less credit available in the economy and this also serves to increase the cost of capital for all firms.

The industry-specific parameter η_s captures the fraction of costs that requires outside funds. Firms in financially vulnerable sectors with large η_s depend more on external financing. In the empirical analysis, sector financial vulnerability will be measured by external finance dependence as well as asset tangibility. Asset tangibility is another common measure which captures the ability of assets or collateral to secure external financing. While credit constraints may be micro-founded in different ways, financial frictions ultimately raise the cost of capital for firms. Solving the optimization problem, the domestic price is $p^H_{iis}(\varphi,\theta) = \frac{\sigma}{\sigma-1}\frac{\theta\eta_s}{\lambda_i}\frac{w_i}{\varphi}$, a simple markup over the variable costs of production, including the costs of obtaining external capital.

A firm in country i selling abroad to country j has the option of exporting directly or indirectly through an intermediary. By exporting *directly*, the firm faces an (additional) fixed cost of $\frac{\theta\eta_s}{\lambda_i}w_i f^D_{ij}$, and iceberg transportation costs $\tau^D > 1$. The cost of capital is assumed to magnify exporting costs as well, because, for instance, exporting requires similar upfront costs from distribution or product design. The optimization problem is:

$$\max_{p,q} \pi^D_{ijs}(\varphi,\theta) = p_{ijs}(\varphi,\theta)q_{ijs}(\varphi,\theta) - \frac{\theta\eta_s}{\lambda_i}\left[q_{ijs}(\varphi,\theta)\frac{\tau^D w_i}{\varphi} + w_i f^D_{ij}\right] \tag{2.3}$$
$$s.t. \quad q_{ijs}(\varphi) = \frac{(p_{ijs}(\varphi,\theta))^{-\sigma}\mu_s Y_j}{P^{1-\sigma}_{js}}.$$

The price set by firms that export directly is $p^D_{ijs}(\varphi,\theta) = \frac{\sigma}{\sigma-1}\frac{\theta\eta_s}{\lambda_i}\frac{\tau^D w_i}{\varphi}$.

A firm may instead export *indirectly* through a trade intermediary. Variable costs include transportation costs $\tilde{\tau}^I$ and the fee or commission for the intermediary's services γ. Moreover, the fixed cost of indirect exporting is f^I_{ij}. Thus, the indirect exporter solves:

$$\max_{p,q} \pi^I_{ijs}(\varphi,\theta) = p_{ijs}(\varphi,\theta)q_{ijs}(\varphi,\theta) - \frac{\theta\eta_s}{\lambda_i}\left[q_{ijs}(\varphi,\theta)\frac{\tilde{\tau}^I w_i}{\varphi} + w_i f^I_{ij}\right] \tag{2.4}$$
$$s.t. \quad q_{ijs}(\varphi,\theta) = \frac{(\gamma p_{ijs}(\varphi,\theta))^{-\sigma}\mu_s Y_j}{P^{1-\sigma}_{js}}.$$

Note that demand is a function of the intermediary's final price. Hence, the price that the intermediary charges to foreign buyers in the final destination is a double markup of the variable costs of production: $p^M_{ijs}(\varphi,\theta) = \frac{\sigma}{\sigma-1}\frac{\theta\eta_s}{\lambda_i}\frac{\gamma\tilde{\tau}^I w_i}{\varphi}$.

2.3 Trade intermediation at the firm-level

Solving the optimization problems of the domestic producer, indirect exporter, and direct exporter respectively, the following profit functions are derived:

$$\pi^H_{iis}(\varphi,\theta) = \Big(\frac{\sigma}{\sigma-1}\frac{\theta\eta_s}{\lambda_i}\frac{w_i}{\varphi}\frac{1}{P_{is}}\Big)^{1-\sigma}\frac{\mu_s Y_i}{\sigma} - \frac{\theta\eta_s}{\lambda_i}w_i f^H_{ii} \Rightarrow \varphi^H_{iis}(\theta), \tag{2.5a}$$

$$\pi^I_{ijs}(\varphi,\theta) = \Big(\frac{\sigma}{\sigma-1}\frac{\theta\eta_s}{\lambda_i}\frac{\tau^I w_i}{\varphi}\frac{1}{P_{js}}\Big)^{1-\sigma}\frac{\mu_s Y_j}{\sigma} - \frac{\theta\eta_s}{\lambda_i}w_i f^I_{ij} \Rightarrow \varphi^I_{ijs}(\theta), \tag{2.5b}$$

$$\pi^D_{ijs}(\varphi,\theta) = \Big(\frac{\sigma}{\sigma-1}\frac{\theta\eta_s}{\lambda_i}\frac{\tau^D w_i}{\varphi}\frac{1}{P_{js}}\Big)^{1-\sigma}\frac{\mu_s Y_j}{\sigma} - \frac{\theta\eta_s}{\lambda_i}w_i f^D_{ij} \Rightarrow \widehat{\varphi}_{ijs}(\theta), \tag{2.5c}$$

where $\tau^I \equiv \tilde{\tau}^I \gamma^{\frac{\sigma}{\sigma-1}}$. By setting $\pi^H_{iis}(\varphi,\theta)$ and $\pi^I_{ijs}(\varphi,\theta)$ equal to zero, we obtain respectively the cutoff productivities for which domestic production and indirect exporting are profitable, denoted as $\varphi^H_{iis}(\theta)$ and $\varphi^I_{ijs}(\theta)$. Furthermore, by equating $\pi^D_{ijs}(\varphi,\theta)$ with $\pi^I_{ijs}(\varphi,\theta)$, the cutoff productivity for direct exporting $\widehat{\varphi}_{ijs}(\theta)$ is recovered. f^D_{ij} is assumed to be sufficiently larger than f^I_{ij}, such that less productive firms find it more profitable to export indirectly while the most productive firms are willing to pay the higher fixed costs to directly export and obtain larger profits. Formally, the sufficient condition required to have $\widehat{\varphi}_{ijs}(\theta) > \varphi^I_{ijs}(\theta)$ is $f^D_{ij}/f^I_{ij} > (\tau^I/\tau^D)^{\sigma-1}$.[8] In addition, assuming that $\varphi^I_{ijs}(\theta) > \varphi^H_{iis}(\theta)$, all exporting firms would sell in the domestic market. Proposition 1 summarizes this productivity sorting pattern.

Proposition 1. *(Productivity sorting) The least productive firms sell only domestically, more productive firms sell domestically and export indirectly, and the most productive firms sell domestically and export directly.*

Figure 1 illustrates the trade-off between variable and fixed costs that determines the choice of export mode; profit curves are shown. Firms with productivity between φ_L and $\varphi^I_{ijs}(\theta)$ are not productive enough to export, while firms between $\varphi^I_{ijs}(\theta)$ and $\widehat{\varphi}_{ijs}(\theta)$ choose to export through an intermediary, and the most productive firms between $\widehat{\varphi}_{ijs}(\theta)$ and φ_H export directly.

The trade-off between variable and fixed costs has implications for firms' export mode in relation to firm financial constraints. Financial frictions raise the cost of capital and incentivize firms to be indirect exporters as opposed to direct exporters; this is Proposition 2.

Proposition 2. *(Firm financial constraints) Financially constrained exporting firms are more likely to export indirectly, especially in financially more vulnerable industries (*$\frac{\partial \Pr(indirect|exporting)}{\partial\theta} > 0$, $\frac{\partial^2 \Pr(indirect|exporting)}{\partial\theta\partial\eta_s} > 0$*).*

Proof. See Appendix A. □

Intuitively, since the fixed costs of direct exporting are larger, an increase in financial constraint θ raises the cutoff $\widehat{\varphi}_{ijs}$ more than φ^I_{ijs}. For a given draw of φ, the likelihood of indirect

[8] Selling through intermediaries is generally considered a cheaper alternative to direct exporting, as fixed costs related to marketing or distribution are handled by the intermediary. Moreover, considering the cost of exporting to businesses in Hong Kong, the city port has consistently ranked among the world's lowest in trade costs, either measured with the World Bank Doing Business costs of trade across borders or the Logistics Performance Index.

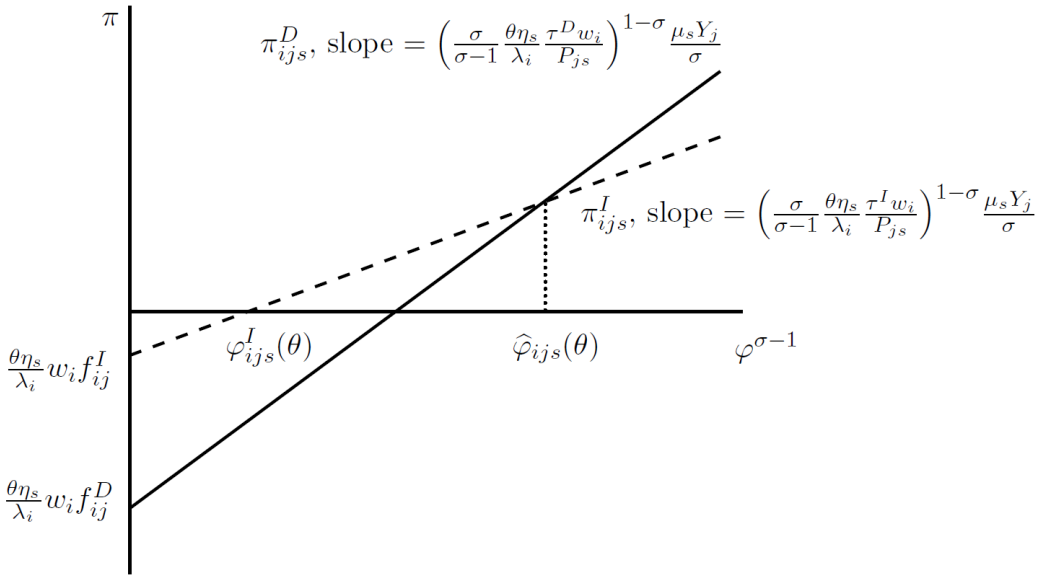

Figure 1: Profit curves of direct and indirect exporters

exporting increases (conditional on exporting) when the productivity distribution is taken into account. Thus, financially constrained firms are more likely to export through an intermediary, and this effect is more pronounced in financially vulnerable industries where η_s is larger.

Due to the presence of financial frictions, all productivity cutoffs are larger by the factor of $R = (\theta\eta_s/\lambda_i)^\sigma$, which can be thought of as the cost of capital incurred (see Appendix A). If the assumption is instead that only fixed costs required external financing, all cutoffs would simply be scaled down proportionally (with $R = \theta\eta_s/\lambda_i$), without any effect on the probability of indirect exporting conditional on selling abroad. The fixed versus variable cost trade-off displayed in Figure 1 remains for the exporting firm. As shown in Appendix A, an identical result is achieved when extending the Manova (2013) model to include trade intermediaries, with η_s separated into two components: d_s for external finance dependence and t_s for asset tangibility. However, despite explicitly modeling the need for external liquidity and the use of tangible collateral to obtain financing from investors, ultimately, θ, d_s, t_s, and λ_i raise the cutoffs in the same manner. Therefore, the same qualitative prediction as Proposition 2 (and Proposition 3 below) can be derived.

2.4 Trade intermediation at the aggregate level

To derive predictions at the aggregate level, assume that firm financial constraints θ are drawn independently from productivity.[9] For each exporter-importer-sector triplet, the total value of

[9]While firm-level distortions and productivity are unlikely to be independent, there is evidence on resource misallocation to suggest that they are not necessarily strongly correlated. For example, de Vries (2014) finds that the correlation between distortions to capital and productivity is positive and small in the Brazilian retail sector, but the relation between distortions to capital and employment is not statistically significant. Bartelsman et al. (2013) finds the within-industry cross-sectional covariance between size and productivity to be low for European countries, and close to zero for the transition European economies. Furthermore, the correlation between labor productivity and obstacles in accessing finance is very low in the Enterprise Surveys as discussed in Section 5.

indirect and direct exports can be computed. Given M_i^e potential producers in origin i, total indirect and direct exports arriving in the destination country are:

$$X_{ijs}^I = M_i^e \int_{\underline{\theta}}^{\bar{\theta}} \int_{\varphi_{ijs}^I}^{\widehat{\varphi}_{ijs}} p_{ijs}^M(\varphi) q_{ijs}^M(\varphi) dG(\varphi) dF(\theta). \tag{2.6a}$$

$$X_{ijs}^D = M_i^e \int_{\underline{\theta}}^{\bar{\theta}} \int_{\widehat{\varphi}_{ijs}}^{\varphi_H} p_{ijs}^D(\varphi) q_{ijs}^D(\varphi) dG(\varphi) dF(\theta), \tag{2.6b}$$

Goods that reach destination j indirectly from intermediaries are valued at the prices that the intermediaries sell at. Analytical expressions for Equations (2.6a) and (2.6b) are derived with the Pareto distribution assumption.

Thus, the indirect export share is defined as the bilateral share of indirect exports through intermediaries in total exports:

$$\Psi_{ijs} \equiv \frac{\text{Indirect Exports}}{\text{Total Exports}} = \frac{X_{ijs}^I}{X_{ijs}^I + X_{ijs}^D}. \tag{2.7}$$

The indirect export share Ψ_{ijs} varies with exporter, importer, and sector characteristics. The comparative static in partial equilibrium with respect to financial development λ_i is derived in Proposition 3.

Proposition 3. *(Financial development) Financially developed countries have lower indirect export shares, especially in financially more vulnerable industries* ($\frac{\partial \Psi_{ijs}}{\partial \lambda_i} < 0, \frac{\partial^2 \Psi_{ijs}}{\partial \lambda_i \partial \eta_s} < 0$).

Proof. See Appendix A. □

The intuition for this result is similar to the firm-level prediction. While a higher level of financial development helps producers export either directly or indirectly, the benefit for direct exporters is larger. Hence, a country with less credit constraints on producers has a lower fraction of firms that rely on intermediaries. Again, the effect of financial development on indirect exports is relatively more pronounced in financially vulnerable sectors.

While Proposition 3 is the key prediction at the aggregate level, the model has other implications as well. For instance, the indirect export share is larger when the destination market has a lower level of expenditures ($\partial \Psi_{ijs} / \partial Y_j < 0$), when direct transportation costs are larger ($\partial \Psi_{ijs} / \tau^D > 0$), when indirect transportation costs are smaller ($\partial \Psi_{ijs} / \tau^I < 0$), and when the fixed costs of direct exporting are greater ($\partial \Psi_{ijs} / f_{ij}^D > 0$).

Note that the model setup does not explicitly distinguish between domestic and foreign trade intermediaries. These third-party intermediaries may or may not be located in the home country, and it would not affect the model's predictions. However, due to data limitations, I study domestic intermediation at the firm level (with the Enterprise Surveys), and foreign intermediation at the country level, examining indirect exports through intermediaries in Hong Kong.

3 Empirical framework

3.1 Testing firm-level predictions

Empirical support for the model's predictions is obtained from a series of regressions. First, to verify the sorting pattern as stated in Proposition 1, an ordered probit model is estimated:

$$Status_{fsit} = a_0 + a_1 \ln Productivity_{fsit} + a_Z Z_{fsit} + \nu_{fsit}, \tag{3.1}$$

where $Status_{fsit}$ is the export status of firm f in country i, sector s, and year t, $Productivity_{fsit}$ is the firm's productivity, and Z_{fsit} is a vector of control variables (such as age of the firm and percent of foreign ownership.) $Status$ is equal to 0 if the firm only sells in the home market, 1 if the firm is an indirect exporter, and 2 if the firm is a direct exporter. The hypothesis of Proposition 1 is $a_1 \geq 0$, so that productivity is positively correlated with exporting.

Proposition 2 is a statement regarding the effect of financial constraints on firms' export mode. A first attempt at empirically verifying the relation is to regress:

$$\mathbf{1}[indirect]_{fsit} = g_0 + g_1 FinCons_{fsit} + e_{fsit},$$

where $\mathbf{1}[indirect]$ is an indicator variable for indirect (as opposed to direct) exporting, and $FinCons$ is the measure of firm-level financial constraints. However, this regression will suffer from endogeneity, either due to omitted variable bias or reverse causality. Reverse causality may arise if for instance, direct exporters require more capital and consistently have greater difficulties in obtaining it.

To address these issues, I first include controls in the regression for firm characteristics such as productivity, firm age, and percent of foreign ownership as above. The correlation between $FinCons$ and productivity, as measured by sales per worker, for exporting firms is low at -0.03. Controlling for productivity is model driven as the comparative statics in Proposition 2 are derived conditional on the productivity draw of the firm. To address the second comparative static in Proposition 2, I exploit sector variation in financial vulnerability. Specifically, $FinCons$ is interacted with industry measures of financial vulnerability, namely external finance dependence and asset tangibility. As explained in Section 4.3, these measures are exogenous from the perspective of individual firms. This general difference-in-difference approach follows Beck (2003), Braun (2003), and Manova (2008, 2013) among others. Manova et al. (2015) use this method to investigate the effect of credit constraints on multinational activity at the firm-level with the inclusion of firm fixed effects. Unfortunately, the Enterprise Surveys do not permit this as it is not a panel dataset.[10] However, country, year, and sector fixed effects are included to control for any unobserved heterogeneity within these dimensions. These could, for example, be the country's geographic location, historical economic development, or industry business conditions that are correlated with trade intermediation. Other than financial vulnerability, sector

[10]While the Enterprise Surveys do have some firms that are linked across different survey years, this sample is relatively small and not useful for the purposes of this paper.

fixed effects subsume other characteristics like product specificity, contract intensity, or the cost of marketing and distribution. Thus, the following equation is estimated using the sample of exporting firms:

$$\begin{aligned}\mathbf{1}[indirect]_{fsit} = \gamma_{0t} + \gamma_1 FinCons_{fsit} + \gamma_2 FinCons_{fsit} \times ExtFin_s + \gamma_3 FinCons_{fsit} \times Tang_s \\ + \gamma_p \ln Productivity_{fsit} + \gamma_Z Z_{fsit} + c_s + c_i + \epsilon_{fsit}. \end{aligned} \tag{3.2}$$

According to Proposition 2, we expect γ_1 to be positive. Sector financial vulnerability is decomposed into external finance dependence ($ExtFin_s$) and asset tangibility ($Tang_s$). The interaction terms therefore provide the test for the model implication that the effect of firm-level financial constraints is more pronounced in financially vulnerable sectors. We would find empirical evidence consistent with this hypothesis if $\gamma_2 > 0$ and $\gamma_3 < 0$.

Although indirect exporters could potentially self-select into financially vulnerable industries, the data suggests that this is unlikely (see Figures 2(b), (c), and (d)). Furthermore, while firm financial constraints may partially capture the financial vulnerability of the industry to which it belongs, the correlation between the average level of financial constraints in a sector and $ExtFin_s$ ($Tang_s$) is -0.071 (-0.019) in the Enterprise Surveys, so there appears to be weak empirical support for this notion.

3.2 Testing country-level predictions

The approach to empirically validating Proposition 3 at the country level is similar to the firm-level test. Instead of individual firms' credit constraints, at the aggregate level, the relevant measure of financial frictions is the degree of financial development or strength of credit institutions. Identification again comes from interactions between financial development and sector external finance dependence as well as asset tangibility. With standard ordinary least squares (OLS), the corresponding regression equation to test the country-level prediction of Propositions 3 is:

$$\begin{aligned}\Psi_{ijst} = \Gamma_{0t} + \Gamma_1 FinDev_{it} + \Gamma_2 FinDev_{it} \times ExtFin_s + \Gamma_3 FinDev_{it} \times Tang_s \\ + \Gamma_Z Z_{ijst} + c_s + c_i + c_j + \varepsilon_{ijst}, \end{aligned} \tag{3.3}$$

where Ψ_{ijst} ($\equiv$ Indirect Exports/Total Exports) is the indirect export share for exporter i, importer j, sector s at time t. $FinDev_{it}$ stands for the financial development of origin i. The vector Z contains additional explanatory variables to guard against omitted variable bias. As mentioned in Section 2.4, other parameters in the model affect the indirect export share. Thus, Z_{ijst} includes the market size of the origin and destination countries, direct and rerouting distances between the origin and destination, and the costs of trading across borders. c_s, c_i, and c_j are group dummy variables for industry, exporter, and importer respectively, which control for unobserved group heterogeneity. Along with year fixed effects which account for temporal fluctuation, these could potentially capture other effects like differences in the wage rate.

In Equation (3.3), the dependent variable Ψ_{ijst}, or indirect export share, is a fraction between

0 and 1. Many countries do not trade indirectly through intermediaries in Hong Kong, so there are many observations at the boundary of 0 (see Figure 4(a)). The linearity assumption of OLS is therefore violated. Hence, I follow Papke and Wooldridge (2008) to estimate a fractional response model with time-constant unobserved effects.[11] In particular, the fractional probit model is assumed and the method of quasi-maximum likelihood estimation (QMLE) is applied. The extension of the framework in Papke and Wooldridge (2008) to multiple fixed effects is provided in Appendix B.

4 Data

4.1 World Bank Enterprise Surveys

To test the firm-level predictions of the model, the World Bank Enterprise Surveys dataset is used. These surveys are representative samples of the countries' private sectors (World Bank, 2014).[12] The proceeding analysis uses a sample of pooled cross-sections over 37,000 manufacturing firms from 129 countries, mostly low and middle income, between 2006 and 2015. Since some countries are surveyed multiple times, the dataset has a total of 202 country-years. The sampling methodology is stratified random sampling, with large firms being oversampled since they are less abundant; sampling weights are used in all analyses. Industry classification in these surveys is rather sparse, so there are 11 ISIC Rev. 2 3-digit manufacturing sectors used for the empirical analysis.[13]

A firm's mode of export is determined by the following survey question: "In [this] fiscal year, what percent of this establishment's sales were: 1) National sales, 2) Indirect exports (sold domestically to third party that exports products), 3) Direct exports?" Hence, the relevant trade intermediaries in this dataset are all domestic businesses. While the existence of foreign trade intermediaries is admittedly a concern, most of the countries in the dataset are located in Eastern Europe, Africa, and Latin America, and are not particularly close to well-known entrepôts such as Hong Kong, Singapore, or the Netherlands. Thus, re-exports or indirect exports to other countries should be relatively small.[14] Appendix Table B.1 presents aggregate summary statistics. More than one-quarter of firms export, and more than one-quarter of those

[11] Tang and Zhang (2012) and Abel-Koch (2013) also have the dependent variable as the share of indirect exports. Tang and Zhang (2012) run simple OLS only for their empirical analysis, and Abel-Koch (2013) finds that her results are robust using either OLS or the fractional response model. Demir and Javorcik (2014) also use a fractional response model for robustness.

[12] The surveys are at the establishment level, but for the purposes of this paper, the words "firm" and "establishment" are synonymous.

[13] The Enterprise Surveys are originally classified as 2-digit ISIC Rev. 3. The 11 industries are: Textiles (321), Leather products (323, 324), Garments (322), Food (311, 313), Metals and machinery (371, 372, 381, 382), Electronics (383), Chemicals and pharmaceuticals (351, 352), Wood and furniture (331, 332), Non-metallic and plastic materials (355, 356, 361, 362, 369), Auto and auto components (384), and Other manufacturing. For industries that combine multiple industries, the means of external finance dependence and asset tangibility are used. The values used for "Other manufacturing" are averages over all industries.

[14] Certainly, the Hong Kong re-exports data suggests that domestic intermediation quantitatively dominates foreign intermediation through Hong Kong for these low income countries. Since the classification of sales is restricted to the three categories, any indirect exports to foreign intermediaries must be categorized as direct exports. This limitation of the data, however, would imply that the amount of intermediation is underestimated.

Table 1: Firms' Most Serious Obstacle to Operations

	Obstacle	Proportion (%)
1	Access to finance	20.6
2	Tax rates	14.4
3	Practices of competitors in informal sector	13.6
4	Electricity	9.70
5	Inadequately educated workforce	8.67
6	Political instability	5.24
7	Tax administrations	4.89
8	Corruption	4.39
9	Labor regulations	4.10
10	Crime, theft and disorder	3.49
11	Transportation of goods, supplies, inputs	3.46
12	Access to land	3.31
13	Customs and trade regulations	1.88
14	Business licensing and permits	1.68
15	Courts	0.60

Notes: Author's calculations from the World Bank Enterprise Surveys. $N = 36{,}324$ manufacturing firms.

firms are indirect exporters. The share of exports that are directly sold is slightly larger at 79%, though large variation exists across countries. Thus, in this large sample of developing countries, direct exporters dominate the export market but their market shares are not disproportionately larger.

The severity of financing constraints are elicited by the following question: "Is access to financing, which includes availability and cost (interest rates, fees and collateral requirements): No Obstacle (0), Minor obstacle (1), Moderate obstacle (2), Major obstacle (3), a Very Severe Obstacle (4), to the current operations of this establishment?" A discrete 5 point scale is used for this self-reported individual firm-level measure of financial frictions. Similar questions are asked with the same scale for other potential obstacles related to the business environment that firms may face. In Table 1, these obstacles are ranked according to the proportion of firms that report they are the most serious obstacle to their business operations or investment climate. Access to finance ranks at the top of this list of constraints at over 20%. This provides motivation to focus on financial frictions and how they affect firm performance and the choice of export mode. Note that other distortions such as labor regulations are relatively minor impediments for most firms.[15]

The obstacle variables from the Enterprise Surveys are informative because they address the problems that firms specifically face. This is especially the case for access to finance, since they explicitly state that these costs arise from interest rates or collateral requirements. One may also be interested in more common measures of firm financial health, such as the debt ratio. Unfortunately, the Enterprise Surveys do not provide such detailed information.

Figure 2 presents preliminary evidence of the relationship between financial constraints and export mode at the firm and sector level. In Figure 2(a), I plot the share of exporters that

[15]In the sample of exporting firms, 14.7% of firms responded with access to finance as the most serious obstacle, second behind tax rates at 17.6%. The proportion of exporting firms stating that customs and trade regulations affects business operations the most remains low at 2.98%.

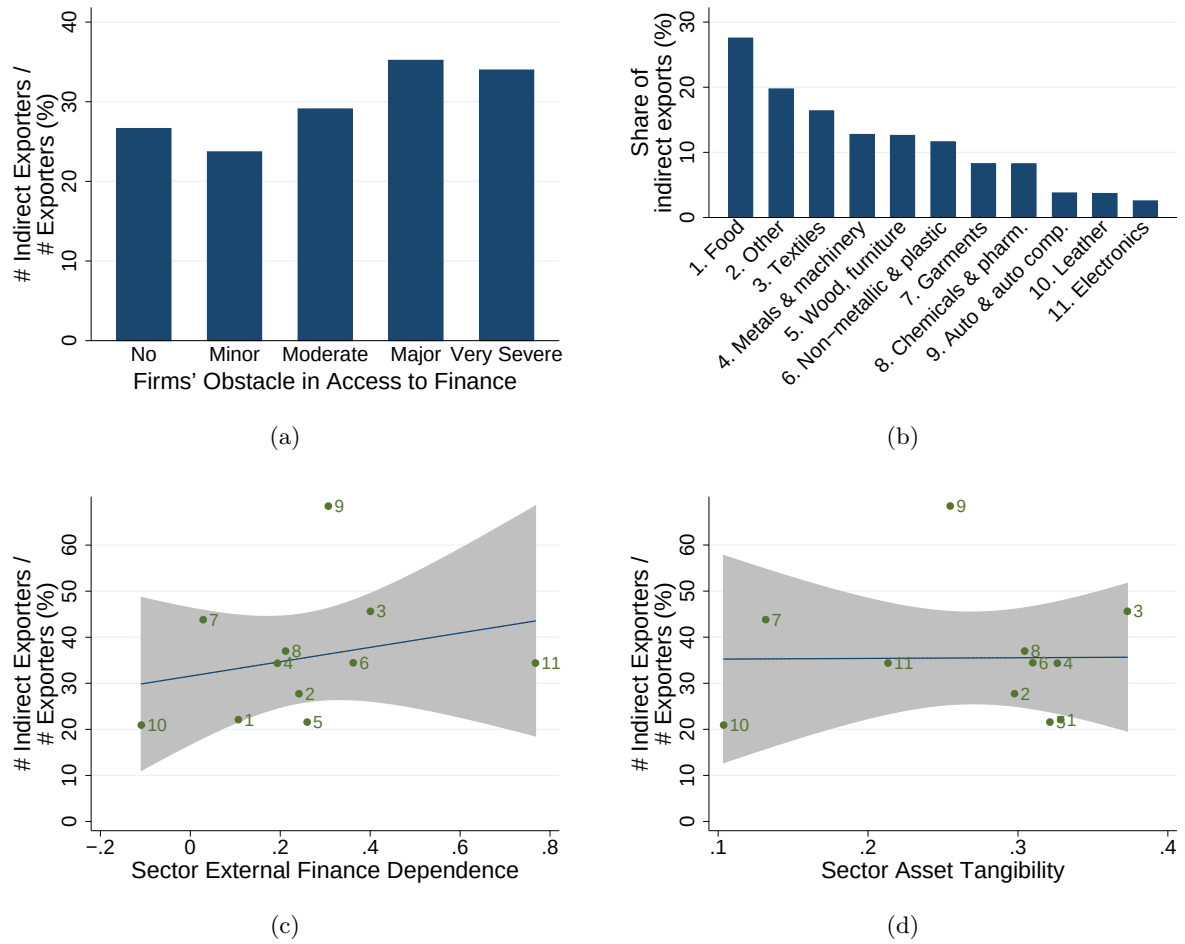

Figure 2: (a) Share of exporting firms that indirectly export in Enterprise Surveys and firms' obstacle in access to finance; (b) Breakdown of indirect exports by industry; (c) Share of exporting firms that indirectly export by sector and sector external finance dependence; (d) Share of exporting firms that indirectly export by sector and sector asset tangibility. Numeric marker labels in (c) and (d) corresponding to rankings in (b); gray bands indicate 95% confidence interval of the fitted line. $N = 9{,}658$ firms.

export indirectly across the different levels of financing barriers. While the percentages are close, there is positive correlation between the severity of credit constraints and the likelihood of exporting indirectly, as one might expect from the theory.

Next, Figure 2(b) graphs the use of domestic intermediaries across industries in the raw data. For each country, each industry's share of total indirect exports is computed; the unweighted mean of all countries is presented. Although the share of indirect exports that are in industries manufacturing food and textile products are indeed large, there is still a considerable amount of indirect exports in other industries. In particular, the percentages for Metals and Machinery, Wood and Furniture, and Non-metallic and Plastics are all greater than 10%.

Lastly, Figures 2(c) and (d) plot the share of exporters that export indirectly across different levels of sector financial vulnerability. Financially vulnerability is characterized by high external finance dependence and low asset tangibility (see Section 4.3 below). In the model, exporting firms in financially vulnerable sectors are also more likely to be export through intermediaries

($\partial \Pr(indirect|exporter)/\partial \eta_s > 0$), so we expect a positive (negative) relationship between external finance dependence (asset tangibility) and the likelihood of exporting indirectly. While Figure 2(b) examines sales, (c) and (d) are focused on the proportion of indirect exporting firms. The numeric marker labels beside each observation correspond to the rank of indirect sales in (b). The positive relationship between the share of indirect exporters and sectors' dependence on outside financing is clear, but the raw correlation with asset hardness is weak.

4.2 Indirect exports through Hong Kong

Empirical analysis at the country-level is conducted using data on indirect exports through the entrepôt of Hong Kong. This type of indirect exports is typically referred to as "re-exports", or the exports of foreign goods. The data are obtained from the Hong Kong Census and Statistics Department (2013a), and they define re-exports as

> ... products which have previously been imported into Hong Kong and which are re-exported without having undergone in Hong Kong a manufacturing process which has changed permanently the shape, nature, form or utility of the product.

Processes which do not confer Hong Kong origin include: simple diluting, packing, bottling, drying, simple assembling, sorting, and decorating. Also, "[g]oods in transit through Hong Kong and goods entered for transhipment on a through bill of lading are excluded from the trade statistics"(Hong Kong Census and Statistics Department, 2013a). The dataset captures all origins and destinations which have re-exports through Hong Kong, thus allowing the empirical analysis to exploit variation on both margins.[16]

Historically, the city-port of Hong Kong was critical for China's growth and interaction with the rest of the (Western) world. Figure 3 shows that the indirect export share of Chinese exports through Hong Kong reached a peak of 61% in 1993 before declining to just around 7% in 2011.[17] Clearly, Hong Kong's importance for China has precipitously deteriorated in the recent decade after China joined the WTO in 2001. It should be noted, however, that China's indirect export trade with Hong Kong has grown in absolute terms. Nonetheless, relative to direct trade with the rest of the world, it now represents a small portion.

Not surprisingly, China is the most popular origin as well as destination of indirect exports through Hong Kong. In 2010, the value of re-exports from China is $143 billion (51% of the

[16]The quality of data may be a concern, as the basis for Hong Kong's trade statistics is simply the information provided by the import or export declarations of trading companies. However, the Census and Statistics Department does attempt to maintain a high level of accuracy, through risk management, including computer validation and verification with traders for sampled cases. If the values seem suspicious, Hong Kong Customs will launch an investigation and enforce the law. Moreover, "prosecution may be initiated against any person who fails to lodge the required declaration, or knowingly or recklessly lodges any declaration that is inaccurate in any material particular" (Hong Kong Census and Statistics Department, 2013b). These types of issues have been pointed out in Young (1999). However, misclassification of goods should not be a great concern since the data are aggregated up to the broader industry level.

[17]Statistics on Chinese trade and its share through Hong Kong are missing between 1947 and 1986. The quality of statistics for the Chinese economy are generally poor in the period after World War 2 and before Chinese economic reform beginning in 1978.

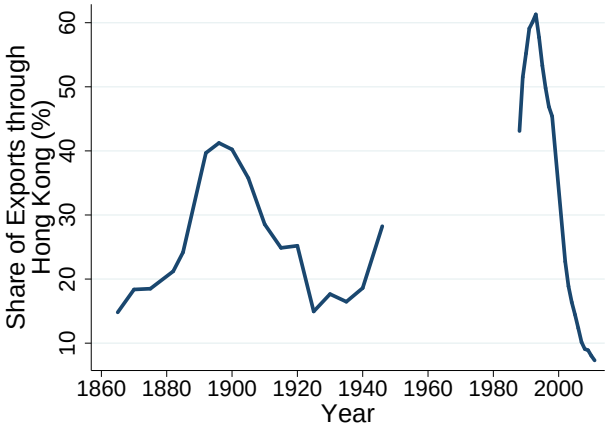

Figure 3: Share of China's exports through Hong Kong. *Sources:* Figure 5 in Keller et al. (2011), Table 1 in Feenstra and Hanson (2004), and author's own calculations with data from the Hong Kong Census and Statistics Department and UN Comtrade Database.

total re-exports), and to China is $110 billion (40%)).[18] Appendix Table B.2 lists the largest values of re-exports according to the origin and destination countries. Many of the origin and destination countries with the largest values of re-exports are in Asia; exceptions include the United States and Germany. Clearly, geography has a role to play in determining whether firms export indirectly through the entrepôt Hong Kong. Further cross-sectional patterns are presented in Appendix Table B.3, which shows the composition of re-exports for a sample of countries in different continents. Asia and especially China are the predominant destination or origin regions for re-exports, while Africa is the least popular.

The data also reveal that many countries engage in bilateral trade but do not have re-exports through Hong Kong. Helpman et al. (2008) document the fact that many countries (around 50% of country pairs) actually do not engage in bilateral trade. Figure 4(a) shows that of countries with positive trade flows, either directly with one another or indirectly through Hong Kong, the majority of country pairs do not trade through Hong Kong. Some 20% have positive indirect exports through Hong Kong in one direction, while around 15% have it in both directions.[19] This pattern of the extensive margin is very stable over these 10 years.

Figure 4(b) shows how the intensive margin of the re-export trade in Hong Kong has changed over time. On the left axis of Figure 4(b), the value of (log) total re-exports through Hong Kong is plotted. Of country pairs with positive indirect exports through Hong Kong, their bilateral direct exports is aggregated globally and shown as well. Values of (gross) exports come from the UN Comtrade Database. While both trade flows experience a net increase over this period,

[18] Around $91 billion actually re-enter China, which is almost 40% of the total re-exports from China. This number is worth investigating, but will not be the focus of this paper, which takes a more international view. However, the percentage that returns to other origin countries is typically very small. Possible explanations for re-exports returning to China include the processing activities that Hong Kong firms may engage in, which do not confer Hong Kong origin *per se*, but may be perceived by consumers in China to have higher quality since Hong Kong businesses played a part in the production chain. These observations will be omitted from analysis, since regressors include the distance between origin and destination countries. For more on this phenomenon of goods circling back to the origin, see Young (1999).

[19] In 2010, there were 83 country pairs with positive re-exports through Hong Kong but zero direct exports.

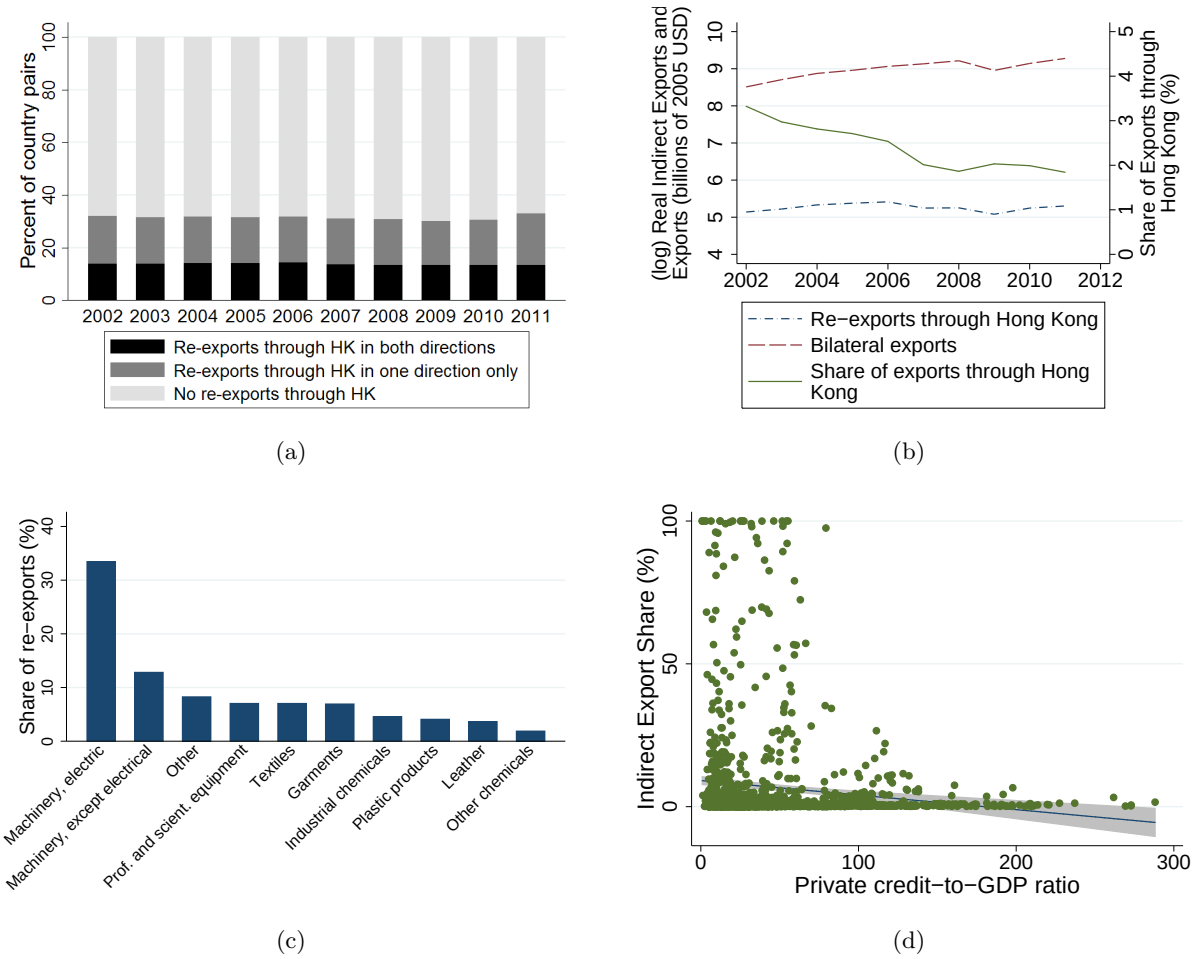

Figure 4: (a) Distribution of country pairs based on re-export trade through Hong Kong. Constructed from 136 exporters, 165 importers; maximum of 7856 country pairs in 2009-10. (b) The left axis plots (log) total real re-exports through Hong Kong, and total bilateral exports for country pairs with positive re-exports through Hong Kong. The right axis plots the average share of re-exports through Hong Kong in total exports. (c) Breakdown of Hong Kong re-exports by (top 10 shown). The share of Hong Kong re-exports for each manufacturing industry is shown, averaged over 2002-2011. (d) Exporter indirect export shares (across sectors and destinations) and private credit-to-GDP ratio. Gray bands indicate 95% confidence interval of the fitted line. $N = 1369$.

direct exports certainly rise more than indirect exports. This is consistent with the evidence of trade barriers gradually declining, whether in the form of tariffs or physical impediments such as transportation costs. The effect of the 2007-08 Financial Crisis is also clear. Re-exports generally fell, especially in 2009, then recovered thereafter. In particular, Europe and the United States faced the largest declines in 2009 as importers, and also had the slowest rebounds. Of course, global trade flows greatly diminished as a whole during this period. In 2009, re-exports fell by more than 16%, but direct exports contracted even more at 21%. On the right axis of Figure 4(b), the share of exports that flow through Hong Kong as re-exports is plotted. The overall trend is a decline from over 3% to less than 2%, but with an increase in 2009 before falling again. Appendix Table B.4 presents re-export shares in 2010 for various countries to and from regions. For China, around 9% of exports to the rest of Asia as well as Europe or the Americas are intermediated by Hong Kong.

Figure 4(c) shows the breakdown of indirect exports by industry. Again, the classification of an industry is 3-digit ISIC Rev. 2.[20] There are 25 industries in the data analysis.[21] For each year, each industry's proportion of total re-exports through Hong Kong is computed; averages over 2002 to 2011 for the top 10 industries are shown. The pattern in any one year is similar as the standard deviation across years is not large. As in Figure 2(b), other industries besides Textiles and Wearing apparel represent a large portion of indirect exports. In fact, both Machinery sectors, electrical and non-electrical, are consistently the top industries.

Finally, Figure 4(d) provides a first glance at the relationship between countries' strength of financial institutions and their indirect export share from intermediary trade through Hong Kong. Financial development is measured by the commonly used private credit-to-GDP ratio (see Section 4.4). A clear negative correlation is displayed, as more financially developed countries have lower indirect export shares. The correlation is also statistically significant, as the t-statistic from a simple OLS regression is -4.91, and with year fixed effects included, -4.35.

4.3 Sector characteristics

Measures of financial vulnerability are drawn from standard sources. Rajan and Zingales (1998) provides the measure for external finance dependence, defined as capital expenditures minus cash flow from operations divided by capital expenditures. In other words, this is the share of investment needs that cannot be financed with the firm's internal funds. The measure for asset tangibility is taken from Braun (2003), defined as net property, plant, and equipment over total assets. This captures the ability of of an firm in a particular industry to secure external finance by pledging collateralizable assets. The mean (standard deviation) of external finance dependence across industries is 0.24 (0.33), while for asset tangibility it is 0.30 (0.14). The correlation between them is low (0.0096), demonstrating they capture different aspects of financial vulnerability.

Both external finance dependence and asset tangibility measures are constructed using data from publicly listed US companies in Compustat. The industry median is chosen to summarize financial vulnerability across firms. The measures reflect large technological components associated with industries' demand for external financing and overall asset hardness (Rajan and Zingales, 1998; Claessens and Laeven, 2003). Therefore, they are regarded as exogenous from the perspective of individual firms. As noted by authors who have previously used these variables, there are certain advantages to using US data for measurement (Braun, 2003; Manova, 2008, 2013). Since US financial institutions are highly developed, this implies firms can closely attain their optimal quantity of external financing and asset structure. Moreover, the choice

[20]The original classification of Hong Kong re-exports is 5-digit SITC (Rev. 3 and Rev. 4). The UN Statistics Division provides tables for converting higher revisions of SITC, namely Rev. 4 and Rev. 3, to Rev. 2.

[21]These are: Food (ISIC Rev. 2 311, 312), Beverages (313), Textiles (321), Garments (322), Leather (323), Wood except furniture (331), Furniture except metal (332), Paper and products (341), Printing and publishing (342), Industrial chemicals (351), Other chemicals (352), Rubber products (355), Plastic products (356), Pottery, china, earthenware (361), Glass and products (362), Other non-metallic products (369), Iron and steel (371), Non-ferrous metals (372), Fabricated metal products (381), Machinery except electrical (382) Machinery, electric (383), Transport equipment (384), Professional and scientific equipment (385), and Other (390).

of a reference country mitigates endogeneity for country-level regressions. While the levels of these measures may vary for each country, identification requires that the ranking of sectors is similar across countries. Lastly, to the extent that the costs of production in manufacturing and distribution or marketing costs for domestic and foreign markets are comparable, the use of financial vulnerability as a measure of the cost arising from financial frictions is applicable to both producing for the domestic market and exporting abroad.

4.4 Country characteristics

Data for country-level explanatory variables are obtained from various sources. Following previous studies (e.g., Claessens and Laeven, 2003; Chinn and Ito, 2006; Manova, 2013), a country's level financial development is proxied with private credit-to-GDP ratio from Beck et al. (2000). This is an outcome-based measure that captures the use of external funds in an economy.[22] Real GDP is computed from the IMF World Economic Outlook Database. As standard practice, geographic distance is used as the proxy for iceberg variable transportation costs. The measure of geographic distance between countries is drawn from CEPII (Mayer and Zignago, 2011).

The proxy for the fixed cost of exporting is constructed from the World Bank Doing Business reports data. In this dataset, there are three separate measures of the cost of trade across borders: the number of documents, time, and cost (per container) of exporting or importing. These are commonly employed as measures of trade costs in the international trade literature (e.g., Bernard et al., 2013; Chan and Manova, 2015), and they do not depend on the value of shipment or quantity of exports. I compute an index that takes the average of all three, with a higher value indicating larger bilateral fixed costs of trade for a given country pair.

5 Empirical results

5.1 Firm-level evidence

5.1.1 Productivity sorting

The productivity sorting pattern from Proposition 1 between domestic producers, indirect exporters, and direct exporters has been previously confirmed, for example, in Ahn et al. (2011) and Olney (2016). Therefore, only brief empirical results are shown here to provide evidence consistent with the aforementioned studies. Results from the ordered probit regression of Equation (3.1) are shown in Table 2 columns 1 and 2. The sample consists of manufacturing firms and excludes service providers. The model's productivity sorting pattern implies that pure exporters without domestic sales should not exist. In the dataset, out of a total of 41,789 manufacturing firms analyzed, 5.44% are pure exporters. I exclude these firms from the estimation

[22]Taiwan is not in this dataset, so I follow the methodology of Beck et al. (2000) and use financial statistics data from the Central Bank of the Republic of China (Taiwan) (2013).

Table 2: Productivity Sorting, Ordered Probit and OLS Coefficient Estimates

Dependent variable:	Ordered Probit Status		OLS (log) Productivity	
	(1)	(2)	(3)	(4)
(log) Productivity	0.188***	0.158***		
	(9.89)	(5.79)		
1[indirect]			0.497***	0.033
			(2.91)	(0.22)
1[direct]			0.989***	0.591***
			(12.32)	(5.86)
(log) Age	0.253***	0.244***	0.039	0.098
	(4.10)	(4.52)	(0.66)	(1.55)
Share foreign	1.222***	1.293***	0.655***	0.577***
	(6.43)	(6.29)	(5.38)	(4.24)
Cut point 1	3.471***	3.479***		
	(12.20)	(6.81)		
Cut point 2	3.806***	3.846***		
	(14.18)	(7.69)		
Constant			10.004***	9.453***
			(62.38)	(17.29)
FE	No	i, s, t	No	i, s, t
N	37,764	37,764	37,764	37,764
R^2			0.060	0.417

Notes: Status = 0 a non-exporter, 1 for an indirect exporter, and 2 for a direct exporter. Productivity is measured by sales per worker and Share foreign is the share of foreign ownership in decimals. **1**[indirect] = 1 for an indirect exporter, **1**[direct] = 1 for a direct exporter, and the base group is non-exporters. T-statistics in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level.

sample, as well as firms which utilize both export modes (4.73% of the sample). The results are generally robust even if all of these firms were included.

Labor productivity is measured as sales per worker. Due to data limitations, two measures of productivity are typically employed when examining the Enterprise Surveys: sales per employee and value added per employee. The number of observations is reduced when using value added per worker, and further reduced when using total factor productivity (TFP). The main findings presented here rely on (log) sales per worker, but the regression results are qualitatively identical using any measure. The number of employees is permanent plus temporary workers (weighted by average length of employment). Standard errors are clustered by strata, but similar results are obtained if they are instead clustered by sector or country-sector.

The results of Table 2 are supportive of Proposition 1, firms' productivity sorting pattern. The coefficients on (log) productivity are positive and statistically significant, which suggests that more productive firms are more likely to be direct exporters and less likely to only sell in the home market. Using the two cut points from the estimation, the predicted probabilities of each status can be computed. With the specification of column 2, which includes country, industry, and year fixed effects, the predicted conditional probabilities of pure domestic production, indirect exporting, and direct exporting are respectively 0.817, 0.081, and 0.102. Subsequently, marginal effects can be calculated by taking the derivative of the predicted probability with

respect to each regressor. When firm productivity improves by 10%, the likelihood of being a indirect exporter and direct exporter increases respectively by around 0.14% and 0.28%, while the probability of not exporting falls by approximately 0.42%. Along with productivity, firm age and the share of foreign ownership also increase the probability of direct and indirect exporting. Similar results are obtained with an ordered logit model.

However, these estimates are potentially inconsistent and/or biased due to the incidental parameters problem for non-linear models with unobserved effects.Thus, I present results from an alternative approach to test the productivity sorting pattern: an OLS regression of productivity on indicator variables for indirect and direct exporting. The following equation is estimated:

$$\ln Productivity_{fsit} = b_0 + b_1 \mathbf{1}[indirect]_{fsit} + b_2 \mathbf{1}[direct]_{fsit} + b_Z Z_{fsit} + c_s + c_i + c_t + e_{fsit}. \quad (5.1)$$

Table 2 columns 3 and 4 display the results, which are generally consistent with previous findings. Direct exporters are certainly the most productive, while indirect exporters seem to only be marginally more productive than non-exporters.

5.1.2 Financial constraints and export mode

Besides Proposition 2, the model also predicts that financially constrained firms are more likely to be pure domestic producers and not export abroad. Unfortunately, the Enterprise Surveys are not the ideal data to test this hypothesis. This is in part due to the lack of information on firms' export destinations. It may be that financial constraints do prevent firms from selling to less profitable destinations, but they still manage to sell to some highly attractive markets. In this case, they are still classified as exporters and the effect of financial frictions is not observed. In unreported results, I regress an indicator for exporting on $FinCons$ and confirm that $FinCons$ actually does *not* have a significant effect on the likelihood of exporting. An ordered probit regression with $Status$ as the dependent variable yields the same conclusion. This data limitation is less problematic when studying the choice of export mode among exporting firms since the percentage of firms that have both positive indirect and direct exports is relatively small. Thus, the analysis proceeds by examining closely the relationship between firm-level financial constraints and export mode of firms selling abroad.

Table 3 reports the results from estimating Equation (3.2) and its variants, with the sample being exporting firms only. As before, all regressions include as regressors (log) productivity, firm age, and the share of foreign ownership. Again, more productive firms are more likely to export directly.

The empirical results presented in Table 3 are consistent with Proposition 2: financially more constrained exporting firms are more likely to be indirect exporters. In all columns of Table 3, the coefficient of $FinCons$ is positive and significant, suggesting that having greater obstacles in access to finance is positively correlated with indirect exporting. In the preferred specification in column 2, when $FinCons$ increases by one standard deviation (1.54), the probability of an exporting firm being an indirect exporter increases by around 8.3 percentage points.

The results also reveal important systematic variation in the likelihood of indirect ex-

Table 3: Firm Financial Constraints and Export Mode, Probit Estimates

	Dependent variable: **1**[indirect]				
	(1)	(2)	(3)	(4)	(5)
FinCons	0.165***	0.170***	0.154***	0.165***	0.167***
	(3.53)	(3.61)	(3.48)	(3.26)	(3.28)
FinCons × ExtFin_s		0.106**	0.119***		0.104**
		(2.38)	(2.90)		(2.38)
FinCons × Tang_s		-0.076**	-0.094***		-0.070**
		(-2.13)	(-2.80)		(-2.00)
(log) Productivity	-0.194***	-0.192***	-0.187***	-0.185***	-0.185***
	(-4.16)	(-4.12)	(-4.19)	(-4.44)	(-4.45)
(log) Number of workers			-0.282***		
			(-6.11)		
Tax rates				0.044	0.045
				(0.74)	(0.77)
Practices of competitors in informal sector				0.161***	0.156***
				(3.50)	(3.42)
Electricity				-0.079*	-0.076
				(-1.67)	(-1.61)
Inadequately educated workforce				-0.015	-0.014
				(-0.26)	(-0.24)
Political instability				0.037	0.043
				(0.68)	(0.80)
Tax administrations				-0.095	-0.089
				(-1.61)	(-1.57)
Corruption				-0.030	-0.034
				(-0.59)	(-0.66)
Labor regulations				-0.035	-0.042
				(-0.54)	(-0.65)
Crime, theft, and disorder				-0.086	-0.091*
				(-1.57)	(-1.68)
Transportation of goods, supplies, inputs				-0.023	-0.016
				(-0.37)	(-0.26)
Access to land				0.149***	0.157***
				(2.88)	(3.03)
Customs and trade regulations				-0.098*	-0.098*
				(-1.87)	(-1.86)
Business licensing and permits				0.114**	0.111**
				(2.13)	(2.14)
Courts				-0.127**	-0.123**
				(-2.09)	(-2.04)
FE	i, s, t	i, s, t	i, s, t	i, s, t	i, s, t
N	9,588	9,588	9,588	9,588	9,588

Notes: **1**[indirect] = 1 for an indirect exporter, 0 for a direct exporter. Sample includes only exporting firms. Productivity is measured by sales per worker, and $ExtFin_s$ and $Tang_s$ are standardized. All regressions include controls for firm age and share of foreign ownership. T-statistics in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level.

porting from differences in sector financial vulnerability, providing support for the second claim in Proposition 2. The coefficients on the interaction terms $FinCons \times ExtFin_s$ and $FinCons \times Tang_s$ are positive and negative respectively, just as the model predicts. Financially constrained exporting firms are especially likely to export through intermediaries in financially more vulnerable sectors that rely more on external finance and have soft, less tangible assets. To ease the interpretation of these coefficients, both external finance dependence and asset tangibility are standardized to mean 0 and standard deviation 1. The magnitudes of the

Table 4: Robustness Checks, Probit Estimates

Productivity measure:	Sales per per worker	Value added per worker	TFP
	Probit	Probit	Probit
	(1)	(2)	(3)
FinCons	0.113***	0.171***	0.164***
	(2.68)	(3.27)	(2.83)
FinCons × ExtFin_s	0.083**	0.112**	0.126**
	(2.35)	(2.17)	(2.33)
FinCons × Tang_s	-0.059**	-0.076*	-0.083*
	(-2.08)	(-1.87)	(-1.95)
(log) Productivity	-0.164***	-0.199***	-0.231***
	(-4.22)	(-4.00)	(-3.92)
FE	i, s, t	i, s, t	i, s, t
N	14,032	8,255	7,014

Notes: The dependent variable in all columns 3 is $\mathbf{1}$[indirect] = 1 for an indirect exporter, 0 for a direct exporter. Sample includes only exporting firms. $ExtFin_s$ and $Tang_s$ are standardized. All regressions include controls for firm age and share of foreign ownership. T-statistics in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level.

coefficients on the interaction terms are comparable to that of $FinCons$ alone, implying the differences across sectors is large. For example, comparing two firms in sectors which differ in their external finance dependence by one-standard deviation, the firm in the sector with greater dependence on outside financing is roughly 9.2 percentage points more likely to export indirectly given a one-standard deviation increase in $FinCons$.

To address potential endogeneity concerns due to omitted variable bias, the remaining columns in Table 3 include various regressors. The specification in column 3 controls for firm size with (log) number of employees. Correlation between size and financial constraints is weak at -0.043; the same is also true of the correlation between size and productivity (0.023). As one would expect, larger firms are less likely to be indirect exporters. More importantly, after controlling for firm size, the key result with regards to $FinCons \times ExtFin_s$ and $FinCons \times Tang_s$ is not affected. Lastly, in columns 4 and 5, the other obstacles to business operations from Table 1 are included, in order of their ranking from that list. While some of these obstacles appear to correlate firms' export mode, the main finding regarding the effect of distortions in capital markets remains.

Tables 4 and 5 present estimation results for various robustness checks which all reinforce the previous empirical findings. In Table 4 column 1, the sample consists of all exporting firms, including those with strictly positive indirect and direct exporters and those with zero domestic sales. Columns 2 and 3 consider alternative measures of productivity. Value added is measured as sales minus the cost of raw materials and intermediated goods used in production, while TFP is constructed from the residual of constrained log-log regression of sales per worker on capital and number of workers with country, sector, and year fixed effects.[23] All three

[23]To construct TFP, capital is measured as the net book value of machinery vehicles, equipment, land, and buildings.

Table 5: Robustness Checks, Alternative Estimation Methods

	OLS	Logit	Heckman		2SLS	
			First stage	Second stage	First stage	Second stage
	(1)	(2)	(3)	(4)	(5)	(6)
FinCons	0.053***	0.292***	-0.008	0.170***		0.167**
	(3.64)	(3.59)	(-0.14)	(3.63)		(2.04)
FinCons × ExtFin_s	0.032**	0.170**		0.105**		
	(2.34)	(2.11)		(2.37)		
FinCons × Tang_s	-0.025**	-0.124**		-0.076**		
	(-2.15)	(-1.98)		(-2.12)		
(log) Productivity	-0.060***	-0.320***	0.036	-0.191***	-0.070*	-0.054***
	(-4.13)	(-3.88)	(-4.09)	(0.79)	(-1.92)	(-3.57)
1[exported before]			6.464***			
			(25.43)			
Neighbors' FinCons					0.742***	
					(7.21)	
FE	i, s, t	i, s, t	i, s, t	i, s, t	i, s, t	i, s, t
N	9,588	9,588	36,777	9,588	9,588	9,588
R^2	0.231					

Notes: The dependent variable in all columns except columns 3 and 5 is **1**[*indirect*]; in column 3 it is an indicator for exporting, and in column 5 it is $FinCons$. Sample includes only exporting firms except column 3, which includes all firms. $ExtFin_s$ and $Tang_s$ are standardized. All regressions include controls for firm age and share of foreign ownership. T-statistics in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level.

measures of productivity all highly correlated: the correlation of (log) sales per worker with (log) value added per worker and TFP are 0.951 and 0.827 respectively. The coefficients on (log) Productivity are close in magnitude, and the coefficients on $FinCons$ and its interactions remain statistically significant at least at the 10% level.

Regressions in Table 5 examine alternative estimation methods and show consistent results. Column 1 estimates a linear probability model with OLS, which avoids the incidental parameters problem, and column 2 employs a logit model. Columns 3 and 4 reports results from estimating a bivariate probit model with selection to account for potential selection effects into exporting. Column 3 is the selection equation while column 4 is the equation of interest which includes the interaction terms. To satisfy the exclusion restriction, the selection equation in column 3 includes a dummy variable for having exported in the past, and empirically it is a strong indicator of whether the firm currently exports. Column 4 shows that the previous results are robust to this specification as well. Lastly, in columns 5 and 6, an instrumental variables approach is taken. For simplicity, a linear model is chosen instead of a probit model due to the presence of a potentially endogenous regressor. Similar to Fisman et al. (2008) and Olney (2016), the instrument for a firm's financial constraints is the (weighted) average level of financial constraints of other neighboring firms in the same country, region and year. Alternatively, neighbors could be defined as being in the same city. The results again demonstrate that financially more constrained exporters are more likely to be sell indirect through a third-party intermediary.

5.2 Country-level evidence

5.2.1 Financial development and indirect export shares

In this section, regression results with the Hong Kong manufacturing indirect exports data are presented. A fully balanced panel with this country-sector level dataset is created.[24] The years in the sample are 2007 to 2011, and 4 industries are dropped to generate the largest sample possible.[25] The baseline sample is comprised of 56 exporters and 85 importers. Out of 191,000 observations at the exporter-importer-sector level, 46,736 have positive values of re-exports.

Average partial effects (APE) from the estimated fractional probit model are presented in Table 6. These are directly comparable to the estimates with OLS and exporter, importer, and year fixed effects of Table 7 column 1. Standard errors are clustered by exporter-importer pair to allow for correlation of intermediated trade across sectors and years for a given set of origin and destination countries, and are obtained using 500 bootstrap replications following Papke and Wooldridge (2008). Moreover, the coefficients have been rescaled by multiplying by 100 so that the indirect export share ranges from 0 to 100 instead of the unit interval. As in the firm-level regressions, both sector external finance dependence and asset tangibility have been standardized.

The empirical patterns shown in Table 6 are consistent with Proposition 3. As expected, exporting countries with a higher level of financial development ($FinDev_{it}$), as measured by the private credit-to-GDP ratio, are associated with a lower indirect export share. Moreover, the share of indirect exports varies systematically across sectors as predicted by the model. The effect of $FinDev_{it}$ on the indirect export share is greater for industries that demand a higher degree with external finance, as seen by the negative sign on $FinDev_{it} \times ExtFin_s$, or industries with fewer collateralizable assets, as indicated by the positive sign on $FinDev_{it} \times Tang_s$. It is interesting to note that while the micro-level results suggest sector external finance dependence is a more crucial factor in the determination of export mode, at the aggregate level, it is asset tangibility that has a larger economic and statistical effect. The stylized model presented in Section 2 is agnostic about what measures of financial vulnerability should be used. Empirical results here demonstrate that industry asset tangibility appears to matter more than external finance dependence in determining the aggregate share of indirect exports.

The key result remains with the inclusion of additional regressors to help alleviate omitted variable bias. The control variables are standard gravity equation variables such as market size and distance and the cost of exporting $Cost_{it}$ ($Cost_{it}$ is standardized). Consistent with the model's predictions, the indirect export share is smaller for larger destination markets (GDP_{jt}), shorter direct distances between origin and destination ($\log(Dist_{ij})$), and longer rerouting distances ($\log(Dist_{iMj})$). The coefficient on $Cost_{it}$ is positive and significant, indicating aggregate indirect export shares are larger when the cost of exporting is higher.[26]

[24] For each exporter-importer country pair, there must be values of re-exports (which can be zero) and direct exports for every industry for every year in the sample.

[25] The industries dropped are: Tobacco (314), Footwear (except rubber or plastic) (324), Petroleum refineries (353), and Miscellaneous petroleum and coal products (354).

[26] It is difficult to find a measure that solely captures the cost of selling directly abroad without the cost of

Table 6: Financial Development and Indirect Export Shares, Fractional Probit APEs

	Dependent variable: Indirect export share [0,100]				
	(1)	(2)	(3)	(4)	(5)
FinDev_{it}	-0.320***	-0.237**	-0.152	0.003	-0.283
	(-3.06)	(-2.17)	(-1.41)	(0.03)	(-1.13)
$\text{FinDev}_{it} \times \text{ExtFin}_s$	-0.039		-0.052*	-0.054*	-0.107
	(-1.63)		(-1.74)	(-1.74)	(-1.47)
$\text{FinDev}_{it} \times \text{Tang}_s$	0.138***		0.203***	0.214***	0.430***
	(3.61)		(4.06)	(4.05)	(3.54)
$\log(\text{GDP}_{it})$		-1.039***	-1.023***	-0.914***	-2.007***
		(-7.28)	(-7.22)	(-6.54)	(-6.07)
$\log(\text{GDP}_{jt})$		-0.330**	-0.381**	-0.375**	-0.555*
		(-1.99)	(-2.32)	(-2.33)	(-1.71)
$\log(\text{Dist}_{ij})$		1.115***	1.000***	0.983***	2.531***
		(6.84)	(6.85)	(7.02)	(6.41)
$\log(\text{Dist}_{iMj})$		-1.877***	-1.350***	-1.076***	-4.008***
		(-4.20)	(-3.17)	(-2.75)	(-3.73)
Cost_{it}		0.060**	0.059**	0.206***	0.100*
		(2.56)	(2.44)	(2.81)	(1.91)
$\text{FinDev}_{it} \times \text{Cost}_{it}$				-0.143**	
				(-1.97)	
N	191,000	191,000	191,000	191,000	81,875

Notes: The unit of observation is at the exporter-importer-industry-year level. The measure of financial development is the private credit-to-GDP ratio. All regressions include averages of all explanatory variables $\bar{\boldsymbol{x}}_i, \bar{\boldsymbol{x}}_j$, and $\bar{\boldsymbol{x}}_s$ as described in Appendix B and year fixed effects. Standard errors for the APEs are obtained using 500 bootstrap replications. T-statistics in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level.

In column 4, I perform another test of the model by interacting financial development with the cost of trade. This is similar to the regressions in Becker et al. (2013). The comparative static tested is $\partial^2 \Psi_{ijs} / \partial \lambda_i \partial f_{ij}^D < 0$. The intuition for this result, as before, is that the effect of financial institution strength should be more pronounced when fixed costs are higher. Thus, this provides a simple test to the model's assumption that financial frictions amplify fixed costs and that the effect is multiplicative. The coefficient on the interaction term $FinDev_{it} \times Cost_{it}$ is indeed negative as predicted and statistically significant, providing validity to the model's assumption. Importantly, the pronounced effect of financial development in financially vulnerable sectors remains.

Lastly, in column 5, the sample size is reduced to include only Asian countries, either as an exporter, importer, or both. As an entrepôt in Asia, Hong Kong facilitates trade for and between many Asian countries. Indirect export shares through Hong Kong are larger with Asian countries either as an origin or destination country. On average the indirect export share is one-third larger with only Asian countries. Therefore, as expected, the size of the

selling indirectly through Hong Kong. However, the model's prediction $\partial \Psi_{ijs} / \partial f_{ij}^D > 0$ holds if one assumes fixed costs are multiplicative; that is, $f_{ij}^D = f_i \times f_j$ and $f_{ij}^I = f_i \times f_M$. Note that using the cost of importing is also problematic since intermediaries may also have to pay these costs. Regardless, the main finding of the effect of financial development on indirect export shares is robust to alternative measures of the fixed cost of trade. In particular, the World Bank Logistics Performance Index is used as another proxy. For both the Doing Business measure and Logistics Performance Index, the cost of importing and the average of the cost of exporting and importing have been considered as well. These results are available upon request.

coefficients are indeed larger in column 5 compared to column 3. In particular, the coefficients on $FinDev_{it}$, $FinDev_{it} \times ExtFin_s$, and $FinDev_{it} \times Tang_s$ roughly double in magnitude. Despite the smaller sample size, most of the coefficients remain significant.

5.2.2 Robustness

The result from the baseline specification in Table 6 column 3 survives a series of robustness checks. First, in Table 7 column 1, standard OLS is used instead of the fractional probit model. Note that except for the distance measures $\log(Dist_{ij})$ and $\log(Dist_{iMj})$, the coefficients from this regression with the averages of the explanatory variables are numerically identical to an OLS regression with exporter, importer, and sector fixed effects.[27] Note that the fractional probit model estimates of the APEs in Table 6 column 3 are directly comparable to the OLS estimates. The interaction effects are both underestimated with OLS relative to the fractional response model, but the signs of the coefficients are the same in either case.

Next, column 2 excludes year fixed effects while column 3 uses country-pair fixed effects as alternative specifications. The estimates are quantitatively similar to the baseline specification. Instead of the total rerouting distance, column 4 separates the effects of distance between the origin to Hong Kong ($\log(Dist_{iM})$) and Hong Kong to the destination ($\log(Dist_{Mj})$). Not surprisingly, both are negatively related to the indirect export ratio, and the magnitudes are close. As column 5 shows, these results are also robust to the additional control of the rerouting distances to another nearby entrepôt, Singapore. The negative coefficient on $Dist_{iSGPj}$ indicates that when rerouting to Singapore is farther, rather than increasing the share of indirect exports through Hong Kong, it has the opposite effect of lowering it. This suggests that Hong Kong may not really be a substitute trading port for Singapore. When transportation costs associated with rerouting are large, the use of intermediaries in either location is smaller. Lastly, in column 6, financial development of the *importing* country and its interactions with $ExtFin_s$ and $Tang_s$ are included as regressors. There does not appear to be any systematic variation of indirect export shares across importers' strength of financial institutions nor across sector financial vulnerability. Compared with exporter financial development, these effects are small and not statistically significant. This is consistent with the idea that financial frictions affect export decisions and intermediaries help exporting firms alleviate these frictions.

Similar qualitative patterns are observed in Table 8, which presents specifications including regressors as motivated by prior literature. First, tariffs are another type of trade barrier considered in column 1. Bilateral tariff data at the ISIC 3-digit industry level are drawn from the World Integrated Trade Solution (WITS) TRAINS database. Fisman et al. (2008) find a positive relationship between tariff rates and the re-export share from Hong Kong to China, suggesting possible tariff evasion through the entrepôt of Hong Kong. In terms of the model, a tariff simply increases variable costs and essentially reduces the effective destination market size. Both hypotheses suggest that a higher tariff rate should be associated with higher re-

[27] With a fixed effects model estimated with OLS, the coefficient on $\log(Dist_{ij})$ remains positive and significant while $\log(Dist_{iMj})$ is positive but insignificant.

Table 7: Robustness Checks, Alternative Specifications

	OLS	No t FE	ij FE	Reroute	Singapore	Importer
	(1)	(2)	(3)	(4)	(5)	(6)
FinDev_{it}	-0.703***	-0.130*	-0.126	-0.111	-0.131	-0.162
	(-5.96)	(-1.66)	(-1.13)	(-1.02)	(-1.20)	(-1.35)
$\text{FinDev}_{it}\times\text{ExtFin}_s$	-0.036	-0.051*	-0.053*	-0.047	-0.050*	-0.063**
	(-1.16)	(-1.74)	(-1.77)	(-1.57)	(-1.67)	(-2.00)
$\text{FinDev}_{it}\times\text{Tang}_s$	0.128**	0.203***	0.203***	0.210***	0.210***	0.209***
	(2.16)	(4.05)	(4.12)	(4.10)	(4.09)	(3.52)
$\log(\text{GDP}_{it})$	-2.565***	-0.841***	-0.993***	-0.998***	-1.015***	-1.111***
	(-8.08)	(-7.34)	(-7.06)	(-7.01)	(-7.18)	(-7.18)
$\log(\text{GDP}_{jt})$	-0.374	-0.157	-0.430**	-0.382**	-0.387**	-0.517***
	(-1.32)	(-1.18)	(-2.33)	(-2.42)	(-2.37)	(-2.78)
$\log(\text{Dist}_{ij})$	0.447***	0.999***	1.001***	0.755***	0.987***	1.194***
	(7.12)	(6.85)	(8.29)	(9.02)	(6.77)	(6.31)
$\log(\text{Dist}_{iMj})$	-4.297***	-1.351***	-1.809***		-0.757*	-2.166***
	(-4.45)	(-3.17)	(-11.05)		(-1.67)	(-4.13)
$\log(\text{Dist}_{iM})$				-0.972***		
				(-9.01)		
$\log(\text{Dist}_{Mj})$				-1.264***		
				(-9.72)		
$\log(\text{Dist}_{iSGPj})$					-0.572*	
					(-1.73)	
Cost_{it}	0.026	0.073***	0.055**	0.055**	0.056**	0.054**
	(0.88)	(3.16)	(2.33)	(2.41)	(2.32)	(2.01)
FinDev_{jt}						0.117
						(0.86)
$\text{FinDev}_{jt}\times\text{ExtFin}_s$						-0.015
						(-0.56)
$\text{FinDev}_{jt}\times\text{Tang}_s$						0.069
						(1.54)
N	191,000	191,000	191,000	191,000	191,000	171,625

Notes: The dependent variable is the indirect export share from 0 to 100. The unit of observation is at the exporter-importer-industry-year level. The measure of financial development is the private credit-to-GDP ratio. All regressions include averages of all explanatory variables $\bar{\boldsymbol{x}}_i, \bar{\boldsymbol{x}}_j$, and $\bar{\boldsymbol{x}}_s$ as described in Appendix B and year fixed effects. Standard errors for the APEs are obtained using 500 bootstrap replications. T-statistics in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level.

export shares, and this is indeed empirically observed (thought not statistically significant). However, distinguishing the two hypotheses is beyond the scope of the paper. Importantly, the empirically observed effect of financial development on indirect export shares is unchanged.

The regression in column 2 includes the corporate tax rates of the origin and destination countries as explanatory variables. These data are retrieved from KPMG International (2013). Feenstra and Hanson (2004) examine the single origin country of China and find that destination countries with lower corporate tax rates are associated with lower re-export shares.[28] The results here also show that a lower corporate tax rate in either the origin or destination country is correlated with smaller re-export shares; however, the effects are not precisely estimated.

[28]The idea proposed is that firms with business presence in China and Hong Kong have an incentive to set artificially low prices on Chinese exports to Hong Kong. Since the corporate tax rate is lower in Hong Kong than in China, firms would like to transfer profits and avoid taxes. The value of re-exports would thus be larger. From 2007-2011, Hong Kong has one of the lowest corporate tax rates in the sample. The idea is the same in the case of transferring profits from the origin country to Hong Kong.

Table 8: Robustness Checks, Additional Regressors, Alternative Measures of Financial Development

$FinDev_{it}$ measure:		Private credit-to-GDP		Risk of expropriation	Risk of contract repudiation
	(1)	(2)	(3)	(4)	(5)
$FinDev_{it}$	-0.086	-0.150	-0.130		
	(-0.73)	(-1.46)	(-1.20)		
$FinDev_{it} \times ExtFin_s$	-0.062*	-0.048*	-0.047	-0.035***	-0.009
	(-1.81)	(-1.72)	(-1.58)	(-3.62)	(-1.22)
$FinDev_{it} \times Tang_s$	0.154**	0.190***	0.198***	0.074***	0.054***
	(2.40)	(4.03)	(3.98)	(4.28)	(3.86)
$\log(GDP_{it})$	-0.858***	-0.988***	-0.955***	-0.468**	-0.457**
	(-4.80)	(-6.90)	(-7.05)	(-2.21)	(-2.20)
$\log(GDP_{jt})$	-0.549***	-0.363**	-0.350**	-0.331**	-0.336**
	(-3.67)	(-2.28)	(-2.24)	(-2.25)	(-2.24)
$\log(Dist_{ij})$	0.646***	0.935***	0.874***	0.520***	0.502***
	(4.20)	(7.15)	(6.65)	(5.24)	(5.03)
$\log(Dist_{iMj})$	-1.087**	-1.077***	-0.902**	-0.427	-0.442
	(-2.24)	(-2.85)	(-2.35)	(-1.22)	(-1.24)
$Cost_{it}$	0.063*	0.078***	0.054*	0.060***	0.064***
	(1.82)	(2.79)	(1.94)	(2.82)	(2.91)
$Tariff_{ijst}$	0.828				
	(1.53)				
Corporate $Rate_{it}$		0.171			
		(0.80)			
Corporate $Rate_{jt}$		0.244			
		(1.21)			
Rule of law_{it}			1.574**		
			(2.13)		
Rule of law_{jt}			0.060		
			(0.11)		
N	133,875	191,000	191,000	158,750	158,750

Notes: The dependent variable is the indirect export share from 0 to 100. The unit of observation is at the exporter-importer-industry-year level. All regressions include averages of all explanatory variables $\bar{\boldsymbol{x}}_i, \bar{\boldsymbol{x}}_j$, and $\bar{\boldsymbol{x}}_s$ as described in Appendix B and year fixed effects. Standard errors for the APEs are obtained using 500 bootstrap replications. T-statistics in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level.

Evidence for corporate tax evasion in this sample appears to be weak.

Bernard et al. (2013) find indirect exports are larger with a stronger contracting environment in the importing country. Column 3 indicates that the strength of the exporter's contracting environment, as measured by the rule of law index from the World Bank Governance Indicators, is correlated with indirect export shares through Hong Kong, but not the importer's. The private credit-to-GDP ratio and rule of law measures are highly correlated (0.638), so it is not too surprising to find financial development has less impact when both are included.

Lastly, alternative measures of financial development are employed in Table 8 columns 4 and 5. Specifically, these are indices for the risk of expropriation and risk of contract repudiation from La Porta et al. (1998). Both measures are highly correlated with the private credit-to-GDP ratio at 0.640 and 0.636 respectively. Prior literature has also utilized these different institutional measures as proxies for financial development. They reflect the strength of a country's contractual environment to support financial contracts, and ultimately influence outcomes like the amount of private credit in the economy. Because both measures are invariant across

time, the main effect of financial development, $FinDev_{it}$, is subsumed by the exporter fixed effect. Regressions with these alternative measures deliver the same qualitative patterns, as the coefficient signs of the interaction terms indicate, and support the key theoretical claims.

6 Calibration and counterfactuals

To quantitatively evaluate the contribution of trade intermediation on aggregate welfare and firm performance, I calibrate the model in Section 2 for two countries, China and the US in 2005, in general equilibrium.[29] Since indirect exporting is an extra option for producers, removing trade intermediaries can only hurt producers. Without a clean natural experiment, it is difficult to assess the importance of trade intermediaries in facilitating international transactions. From the calibration, the fixed costs of production and exporting are recovered. I then perform counterfactual exercises by varying the fixed costs and analyze, through the lends of the model, the effect on consumers and suppliers in various hypothetical scenarios.

Additional simplifications are introduced to the model in order to match it to the data. First, there is only one manufacturing sector for differentiated varieties ($S = 1$). Therefore the utility function is $U_j = q_{j0}^{1-\mu_j}\left(\int_{\Omega_{js}} q_{js}(\omega)^{\frac{\sigma-1}{\sigma}} d\omega\right)^{\frac{\sigma}{\sigma-1}\mu_j}$. Separate measures of μ_j are estimated for China and the US. P_j is the price index for manufacturing goods; the price index for the whole country combines P_j and the numeraire price of one. Thus, welfare as defined by the real wage is:[30]

$$\frac{w_j}{\left(\frac{1}{1-\mu_j}\right)^{1-\mu_j}\left(\frac{P_j}{\mu_j}\right)^{\mu_j}}. \tag{6.1}$$

On the supply side, after paying the sunk cost of entry f_{ii}^E, differentiated goods firms draw productivity φ from a Pareto distribution with support $[1, \infty)$, i.e., $G(\varphi) = 1 - \varphi^{-k}$. Wages are set exogenously in the homogeneous goods sector. Of M_i^e potential entrants in each country, M_i firms with productivity greater than or equal to the cutoff productivity φ_{ii}^H end up producing domestically, and a fraction of those firms also export to the rest of the world. This is determined by a free entry condition which states the probability of successful entry multiplied by the average profits conditional on successful entry are equal to the (nominal) sunk entry cost:

$$(1 - G(\varphi_{ii}^H))\bar{\pi}_i = R_i w_i f_{ii}^E, \tag{6.2}$$

where

$$\bar{\pi}_i = \frac{1}{1 - G(\varphi_{ii}^H)}\Big[\int_{\varphi_{ii}^H}^{\infty} \pi_{ii}^H(\varphi) dG(\varphi) + \int_{\varphi_{ij}^I}^{\widehat{\varphi}_{ij}} \pi_{ij}^I(\varphi) dG(\varphi) + \int_{\widehat{\varphi}_{ij}}^{\infty} \pi_{ij}^D(\varphi) dG(\varphi)\Big],$$

and R_i captures the country-level financial frictions as reflected by the cost of capital, and simply magnifies the wage rate. Thus, $\bar{\pi}_i$ includes profits from domestic sales as well as exports;

[29] The calibration strategy mainly follows the earlier unpublished version of Breinlich and Cuñat (forthcoming).

[30] For CES utility functions, welfare can be equivalently defined as the real wage or the value of the indirect utility function.

Table 9: Matched Moments

Variable	Matched Moment	Data
f_{ii}^H	$\mu_i Y_i - X_{ji}$	Consumption of domestic production
f_{ij}^I	X_{ij}	Exports
f_{ij}^D	X_{ij}^I / X_{ij}^D	Indirect-to-direct exports
f_{uu}^E	$\mu_u Y_u + X_{uc} - X_{cu}$	US firms' revenue
M_c^e	$w_c f_{cc}^E$	Cost of starting business in China
M_u^e	$\widehat{M}_c / M_c$	Share of directly exporting firms

Note: Subscript c (u) denote China (US).

$\pi_{ii}^H(\varphi), \pi_{ij}^I(\varphi)$, and $\pi_{ij}^D(\varphi)$, are analogs of Equations (2.5a) to (2.5c).

Recall (the reciprocal of) the strength of financial institutions as captured by λ_i multiplies all fixed costs (f_{ii}^H, f_{ij}^I, and f_{ij}^D). Thus, the calibration essentially gives measures of f_{ii}^H/λ_i, etc. The analysis proceeds by examining proportional changes to λ_i. The cost of capital is proxied by the lending interest rate (from World Bank World Development Indicators). The lending rate has a mean of 15% and standard deviation of 20.1% across 152 countries. The interest rate in China (US) is 5.8% (6.1%). Not surprisingly, the correlation with private credit is negative (-0.254).

The calibration recovers the fixed costs of domestic production, indirect exporting, and direct exporting. Table 9 summarizes the one-to-one mapping between fixed costs and observed aggregate variables or moments after solving the system of equations that describes the two-country economy and its stationary equilibrium (see Appendix A). Subscripts c and u denote China and the US respectively. The sunk cost of entry for China (f_{cc}^E) is retrieved directly from the data.

With a homogeneous goods sector, trade in the manufacturing goods sector can be unbalanced. Table 10 gives a sense of the amount of trade between the two countries. $\mu_i Y_i$ represents the market size, while X_{dom}^I and X_{HK}^I are the values of indirect exports through domestic and Hong Kong intermediaries respectively.[31]

Additional parameter estimates and data are required to perform the calibration. For variable costs, it is assumed that $\tau^D = \tilde{\tau}^I = 1.7$, the estimate in Anderson and van Wincoop (2004).Since the share of trade through domestic intermediaries is not small, and Hong Kong is located close to China, the assumption that iceberg transportation costs are equal for direct and indirect exporting is not too unreasonable. The intermediary markup γ is 1.09, which implies $\tau^I \equiv \tilde{\tau}^I \gamma^{\sigma/(\sigma-1)} = 1.91$. Bai et al. (2015) use a 2 percent commission in their dynamic estimation, while the Hong Kong Trade Development Council (2012) report that the rate of re-export margin was 15.9%, so the average between these two values is used here.[32]

I calculate manufacturing absorption from data to obtain the preference parameter μ_i, the

[31] As in Section 4, GDP and trade flow data are drawn from the IMF and UN Comtrade respectively, and X_{HK}^I from the data on Hong Kong re-exports. Estimates of the amount of domestically intermediated trade for China and the US are drawn from Ahn et al. (2011) and Bernard et al. (2010) respectively.

[32] This is weighted by the respective shares of indirect exports through Chinese domestic intermediaries and Hong Kong intermediaries. Using US indirect export shares for weights instead, the markup would be 1.10.

Table 10: China and US Data

Variable		Values (billions USD) China	US
Market size	$\mu_i Y_i$	484	2358
Indirect exports through domestic intermediaries	X^I_{dom}	36	3
Indirect exports through Hong Kong intermediaries	X^I_{HK}	37	6
Total indirect exports	X^I_{ij}	73	9
Direct exports	X^D_{ij}	126	27
Total exports	X_{ij}	199	36

Table 11: Calibrated Costs

	China	US
$w_i f^H_{ii}$ (M$)	0.117	0.348
$w_i f^I_{ij}$ (M$)	0.061	0.579
$w_i f^D_{ij}$ (M$)	0.158	1.138
$w_i f^E_{ii}$ ($)	616.5	0.392
f^I_{ij}/f^H_{ii}	0.523	1.663
f^D_{ij}/f^I_{ij}	2.574	1.967

Note: $w_i f^H_{ii}$, $w_i f^I_{ij}$, and $w_i f^D_{ij}$ in millions of 2005 USD.

manufacturing share of consumption. Absorption is output minus net exports, and output is measured with value added of manufacturing as a percentage of GDP (from the World Bank World Development Indicators).[33] Absorption is then divided by GDP to obtain shares. For China, $\mu_c = 0.21$, and for the US, $\mu_u = 0.18$.

Following Melitz and Redding (2015), the elasticity of substitution across varieties (σ) is 4 and the Pareto distribution shape parameter (k) is 4.25.[34] Data on manufacturing wages w_i and the number of firms are drawn from the UNIDO Industrial Statistics Databases INDSTAT.Lastly, an estimate of the share of Chinese firms that directly export, $\widehat{M_c}/M_c$, is provided by Ahn et al. (2011) as well as Enterprise Surveys conducted in China in 2002, 2003, and 2012; the value used is 0.1.

Table 11 presents the calibrated parameters. The fixed cost of production for the domestic market is around $117 thousand in China and $348 thousand in the US; it is higher in the US because of its larger market size (relative to the number of firms).[35] This is also the reason

[33]Net exports are computed for manufacturing product codes 15 to 37 with the ISIC Rev. 3 classification.

[34]For tractability, I impose symmetry in the model calibration for parameters k and σ. Head et al. (2014) choose $k = 4.854$ for Chinese exporters and $k = 3.849$ for French exporters, both of which are not great departures from the value of 4.25 from Melitz and Redding (2015). Broda and Weinstein (2006) show large variation in the elasticity of substitution between varieties across sectors, so using a single parameter for the broad sector of manufacturing is certainly imperfect. However, due to data constraints and the necessity of assuming $k > \sigma - 1$, I simply follow Melitz and Redding (2015) in choosing σ as 4.

[35]The magnitudes of these fixed cost is roughly the same as those in Das et al. (2007) and Castro et al. (2016).

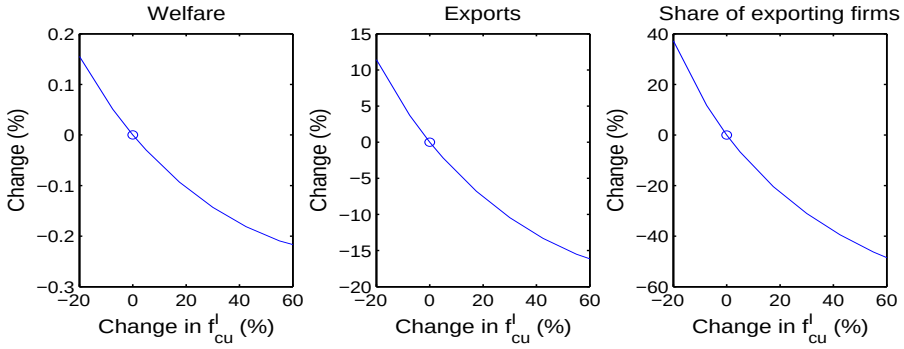

Figure 5: Changes in Chinese welfare, exports, and share of exporting firms from varying the fixed cost of indirect exporting f^I_{cu}.

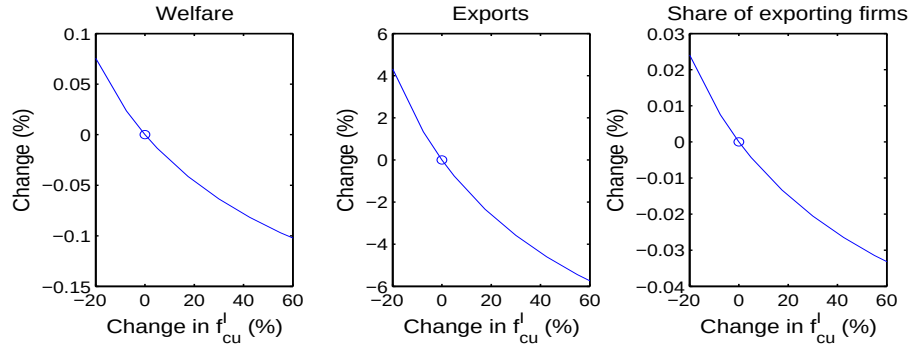

Figure 6: Changes in Chinese welfare, exports, and share of exporting firms from varying the fixed cost of direct exporting f^D_{cu}.

why it is relatively cheaper in terms of fixed costs for Chinese firms to export instead of selling at home; f^I_{ij}/f^H_{ii} is around 0.5 for China. Meanwhile, f^D_{ij}/f^I_{ij} is close to 2 for both countries; this ratio is determined by the ratio of indirect to direct exports and parameters γ, k, and σ. astly, from the World Bank Doing Business Report's cost of starting a business (originally as a percentage of income per capita), the (nominal) sunk entry cost in China is \$617 USD. As expected, the calibrated entry cost in the US is smaller than in China, though much lower than what should be observed. Note that the sunk cost of entry for US could be chosen for the calibration instead, in which case, the levels of parameters will be affected, but the relative changes from the counterfactual exercises will not.

6.1 Counterfactual exercise: varying fixed costs

Making adjustments to the calibrated parameters, I perform counterfactuals by solving the model for the new stationary equilibria. Since both the level of exports and share of trade intermediation for China are both much greater than the US, China is the country of interest. First, Figures 5 and 6 show experiments where I vary the fixed cost of indirect exporting f^I_{cu} and of direct exporting f^D_{cu} respectively. The contrast between changing indirect and direct trade costs is stark.[36] When f^I_{cu} falls by 20%, Chinese welfare increases by around 0.15%,

[36]Varying τ^I gives similar magnitudes as Figure 5. These figures are available upon request.

Table 12: Eliminating Export Modes in China

	Percentage change				
				Share of exporting firms	
	Welfare				
	China	US	World	China	US
Indirect	-0.236	0.003	-0.113	-59.3	4.88
Direct	-0.400	0.006	-0.192	-7.76	8.42
Both	-1.793	0.030	-0.857	-100	44.2
				Average productivity of exporters	
	Exports				
	China	US	World	China	US
Indirect	-18.2	6.64	-14.4	22.2	-1.10
Direct	-21.7	10.6	-16.8	0.031	-1.85
Both	-100	57.5	-76.1		-8.10

Note: World welfare weighted by market size Y_c/w_c and Y_u/w_u.

exports increase by over 20%, and the share of exporting firms is larger by almost 40%. The numbers for the same exercise with f_{cu}^D are roughly half as large for welfare and exports, and the fraction of exporting firms only increases marginally. These counterfactuals demonstrate that intermediaries and the option of indirect exporting are extremely important for the extensive margin of firms' entry into the export market.

When either f_{ij}^I or f_{ij}^D fall, home consumers in i benefit at the expense of foreign consumers in j. This is a comparison between two stationary equilibria. The intuition for this result can be shown through the free entry condition of Equation (6.2). When either fixed cost of exporting decreases, average profits conditional on entry increase. This implies that the probability of entry $(\varphi_{ii}^H)^{-k}$ must be lower for the free entry condition to hold. The cutoff productivity φ_{ii}^H, and hence average productivity of all producers, must rise; this in turn lowers the price index P_i. In foreign country j, the opposite effect takes place as firms find it less profitable to enter the home market and so P_j rises.

6.2 Counterfactual exercise: eliminating export modes

To gauge the relative importance of trade intermediaries on welfare and firm performance, I perform counterfactual exercises by eliminating export modes entirely. This sets a standard of comparison to determine the quantitative significance of indirect versus direct trade. They are not meant to policy experiments, and should be likened to a thought experiment to enhance our understanding of the gains from trade in models with trade intermediaries.[37]

[37]Another approach one might to obtain a quantitative answer for these experiments is to use the Arkolakis et al. (2012) framework. However, it is well known that their key formula $\widehat{W} = \widehat{\theta}^{1/\varepsilon}$ is an ex post result that is not useful for forecasting future welfare changes unless the economy is moving to autarky. Integrating $\widehat{W}$ we would arrive at a formula for welfare itself, $W = C\theta^{1/\varepsilon}$, where C is some constant and θ is the share of domestic expenditure. When performing the exercise of removing the intermediary, θ changes, but so does C, which means one cannot predict welfare changes with this equation. Moreover, one of the assumptions in deriving this general formula is trade balance, which is not observed in the data.

Table 12 presents the results and reveals that the gains from trade intermediation are sizable. In the first row of each panel, the option of indirect for Chinese firms is eliminated. Less productive firms can no longer afford to export, but some more productive firms switch to direct exporting. As the first panel in Table 12 indicates, Chinese welfare declines by 0.24%. Weighting each country by their respective market sizes, the world economy loses as a whole.The other panels show the effects on the supply side. Exports from China to the US decrease by 18%. When the relatively cheaper option of indirect exporting is not available, the share of exporting firms falls dramatically by 59%. Note that the diminished value of exports is almost exclusively due to the change in the extensive margin. The export value of indirect exporters that become direct exporters increases because variable costs are lower, but their profits are actually reduced. Lastly, since only the most productive firms directly export now, the average productivity of exporters correspondingly increases by 22%.[38]

In the second row of each panel, the option of direct exporting is removed. China loses -0.4% of per capita consumption. Thus, the loss in welfare for China from disallowing indirect exporting is around 60% of the loss in welfare from removing direct exporting. The relative importance of trade intermediaries is gauged by comparing the results from these two experiments. The welfare loss is relatively large, as is the loss in trade. Moreover, with indirect exporting still available, the share of exporting firms only falls by less than 8%. Many firms can still benefit from trade intermediaries providing the lower fixed costs of exporting. The last row in Table 12 presents the results from removing all Chinese exports as a reference point. The welfare loss is around 1.8%.

The magnitudes are similar when trade in both directions are eliminated for indirect, direct, and all exports. These results are available upon request. In unreported results, I have also confirmed that the ratios of the relative changes are similar in magnitude when parameters are varied. Sensitivity analysis is conducted with respect to the Pareto shape parameter k, elasticity of substitution σ, and the variable cost of indirect exporting τ^I.

6.3 Counterfactual exercise: higher cost of capital

The key theoretical and empirical results found that more firms benefit from trade intermediation when financial frictions are high, and subsequently the share of intermediary trade increases. I now perform counterfactuals with regards to financial development at the country-level.

Solving the model when the interest rate in China is half a standard deviation higher (i.e., at 15.9%), welfare in China falls by 2.53%, exports decrease by 44.0%, and the share of exporting firm is lower by 40.5%. As expected, financial frictions are detrimental to the country, for both producers and consumer alike.

The more interesting comparative static is how trade intermediation is affected under different levels of financial development. Table 13 shows the impact of eliminating export modes under two regimes. The top panel shows results using the original calibrated parameters. Note

[38] If instead export modes are eliminated for trade from US to China, the ratio of the decline in welfare, exports, and share of exporting firm for indirect versus direct trade are 0.21, 0.38, and 72 respectively.

Table 13: Outcomes in China

		Original cost of capital ($R = 5.8\%$)		
		Welfare	Exports	Share of exporting firms
Eliminating	Indirect	-0.236	-18.2	-59.3
	Direct	-0.400	-21.7	-7.76
Ratio of changes (indirect/direct)		0.590	0.836	7.64
		Cost of capital doubled ($R = 11.6\%$)		
		Welfare	Exports	Share of exporting firms
Eliminating	Indirect	-0.142	-16.7	-58.5
	Direct	-0.242	-19.3	-4.82
Ratio of changes (indirect/direct)		0.586	0.864	12.1

Note: First two rows in each panel in percentage points.

the first two rows under the original cost of capital are exactly the same as Table 12; the last row merely computes the ratio of the two changes for convenience. The bottom panel raises the cost of capital in China by one standard deviation as explained above, and then performs the same counterfactual exercises of eliminating export modes. In the bottom panel where the cost of capital is higher, the magnitudes of the changes in all outcome variables are smaller. This is to be expected as the overall level of trade has fallen. Since the amount of trade is not the same under each regime, comparing the levels of each variable can be misleading. Comparison is instead made between the last row of the two panels to determine the relative importance of trade intermediation.

First, welfare loss from eliminating indirect exporting relative to direct exporting in China is larger with lower financial frictions. Since US firms fill the void in the Chinese market left by Chinese firms, the difference for consumers is very minimal. However, the opposite is true for producers: trade intermediation is more important for firms when financial frictions increase. As the last rows in the second and third columns show, total exports fall relatively more when borrowing costs increase (the ratio is 0.864 versus 0.836). Furthermore, the decline in the share of exporting firms is relatively greater in the bottom panel: the ratio of relative changes is 12.1 versus 7.64. Thus, the proportion of exporting firms relying on indirect exporting through trade intermediaries relative to direct exporting rises by 58% when the cost of capital (proxied by the lending rate) is doubled. This calibration exercise provides some corroborating evidence to the regression analysis, demonstrating the importance of trade intermediaries for exporters as financial development weakens.

The quantitative exercises presented have compared stationary equilibria and did not incorporate any dynamics into the model. Evidence from Bai et al. (2015) suggests that firms also learn from exporting by selling indirectly through intermediaries. Since the less productive firms that rely on trade intermediaries to provide them with a cheaper alternative of selling abroad may realize productivity gains over time, one might expect that the gains from trade intermediation may be even larger.

7 Conclusion

This paper has shown the prevalence of intermediary trade using both firm and country-level data. Using a model of heterogeneous firms with trade intermediaries and market frictions, I derive testable implications regarding the characteristics of firms and countries that engage in indirect exporting. The empirical analysis exploits sectoral variation in financial vulnerability. Financially more constrained exporting firms are more likely to be indirect exporters, and correspondingly, in the aggregate, exporting countries with weaker financial institutions have larger indirect export shares. Both effects are stronger in sectors characterized by high external finance dependence and low asset tangibility. The role of geography is also critical in determining indirect export shares through Hong Kong. Institution strength in the contracting environment is associated with larger indirect export trade as well.

The calibration exercise provides quantitative analysis of the importance of trade intermediaries for welfare and global trade. I find that eliminating the option of indirect exporting leads to a 0.24% welfare loss in China, while removing direct exporting lowers Chinese welfare by 0.40%. There are considerable gains from trade due to the presence of intermediaries. Exports fall by 18% when trade intermediaries disappear. Moreover, when financial frictions become larger, the option of indirect exporting is even more valued by firms. Although the counterfactuals here focus on country-level financial frictions, incorporating firm-level financial constraints or distortions with intermediary trade will certainly help us understand quantitatively the role of intermediaries in alleviating credit constraints. This is left for future research.

The role of trade intermediaries appears to be declining as barriers to trade are being reduced and information is more readily available and accessible. For entrepôt economies like Hong Kong, they must diversify and find their new comparative advantage. The networks they have developed over the years are still extremely valuable however, and they must find new ways to facilitate international trade. Establishments operating in Hong Kong now engage heavily in offshore trade like merchanting and merchandising for offshore transactions. Research in these areas will help achieve a more complete understanding of the patterns of global trade.

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A Theoretical appendix

A.1 Proof of Proposition 2

Proof. The cutoff productivities for producing domestically, exporting indirectly, and exporting directly from Equations (2.5a) to (2.5c) are:

$$\varphi_{iis}^{H}(\theta) = \left[\frac{\left(\frac{\theta\eta_s}{\lambda_i}\right)^{\sigma} w_i^{\sigma} f_{ii}^{H} \sigma^{\sigma}}{\mu_s Y_i P_{is}^{\sigma-1}(\sigma-1)^{\sigma-1}}\right]^{\frac{1}{\sigma-1}} \tag{A.1}$$

$$\varphi_{ijs}^{I}(\theta) = \left[\frac{\left(\frac{\theta\eta_s}{\lambda_i}\right)^{\sigma} w_i^{\sigma} f_{ij}^{I} \sigma^{\sigma} (\tau^I)^{\sigma-1}}{\mu_s Y_j P_{js}^{\sigma-1}(\sigma-1)^{\sigma-1}}\right]^{\frac{1}{\sigma-1}}, \tag{A.2}$$

$$\widehat{\varphi}_{ijs}(\theta) = \left[\frac{\left(\frac{\theta\eta_s}{\lambda_i}\right)^{\sigma} w_i^{\sigma} (f_{ij}^{D} - f_{ij}^{I}) \sigma^{\sigma}}{\mu_s Y_j P_{js}^{\sigma-1}(\sigma-1)^{\sigma-1}[(\tau^D)^{1-\sigma} - (\tau^I)^{1-\sigma}]}\right]^{\frac{1}{\sigma-1}}. \tag{A.3}$$

Hence, with the productivity distribution assumed to be bounded Pareto:

$$\Pr(\text{indirect}|\text{exporting}) = \frac{(\varphi_{ijs}^{I})^{-k} - (\widehat{\varphi}_{ijs})^{-k}}{(\varphi_{ijs}^{I})^{-k} - \varphi_{H}^{-k}}$$

$$\frac{\partial \Pr(\text{indirect}|\text{exporting})}{\partial\theta} = \frac{\frac{\sigma k}{\sigma-1}\frac{1}{\theta}[(\varphi_{ijs}^{I})^{-k} - (\widehat{\varphi}_{ijs})^{-k}]\varphi_{H}^{-k}}{[(\varphi_{ijs}^{I})^{-k} - \varphi_{H}^{-k}]^2} > 0$$

$$\frac{\partial^2 \Pr(\text{indirect}|\text{exporting})}{\partial\theta\partial\eta_s} \propto \frac{\sigma k}{\sigma-1}\frac{[(\varphi_{ijs}^{I})^{-k} - (\widehat{\varphi}_{ijs})^{-k}]}{\eta_s}[(\varphi_{ijs}^{I})^{-k} + \varphi_{H}^{-k}] > 0$$

□

A.2 Proof of Proposition 3

Proof. The indirect export share can be written as

$$\Psi_{ijs} = \frac{B_{ij}\left[(\varphi_{ijs}^{I})^{-k+\sigma-1} - \widehat{\varphi}_{ijs}^{-k+\sigma-1}\right]}{B_{ij}\left[(\varphi_{ijs}^{I})^{-k+\sigma-1} - \widehat{\varphi}_{ijs}^{-k+\sigma-1}\right] + \widehat{\varphi}_{ijs}^{-k+\sigma-1} - \varphi_{H}^{-k+\sigma-1}} = \frac{B_{ij}\left[(\varphi_{ijs}^{I})^{-k+\sigma-1} - \widehat{\varphi}_{ijs}^{-k+\sigma-1}\right]}{\tilde{X}_{ijs}},$$

where $\tilde{X}_{ijs} = (\tau^D)^{\sigma-1}X_{ijs}$ and $B_{ij} \equiv (\tau^D/\tau^I)^{\sigma-1}$. Comparative statics of Ψ_{ijs} are:

$$\frac{\partial\Psi_{ijs}}{\partial\lambda_i} = \frac{-k+\sigma-1}{\sigma-1}\frac{B_{ij}}{\lambda_i}\frac{\varphi_{H}^{-k+\sigma-1}\left[(\varphi_{ijs}^{I})^{-k+\sigma-1} - \widehat{\varphi}_{ijs}^{-k+\sigma-1}\right]}{\tilde{X}_{ijs}^2} < 0$$

$$\frac{\partial^2\Psi_{ijs}}{\partial\lambda_i\partial\eta_s} \propto \frac{-k+\sigma-1}{\sigma-1}\frac{B_{ij}}{\eta_s}\left[(\varphi_{ijs}^{I})^{-k+\sigma-1} - \widehat{\varphi}_{ijs}^{-k+\sigma-1}\right]\tilde{X}_{ijs} < 0$$

□

We also have:

$$\frac{\partial \Psi_{ijs}}{\partial Y_j} \propto \frac{-k+\sigma-1}{\sigma-1}\frac{B_{ij}}{Y_j}\varphi_H^{-k+\sigma-1}\left[(\varphi_{ijs}^I)^{-k+\sigma-1} - \widehat{\varphi}_{ijs}^{-k+\sigma-1}\right] < 0$$

$$\frac{\partial \Psi_{ijs}}{\partial \tau^D} \propto B_{ij}\left[\frac{\sigma-1}{\tau^D}\left((\varphi_{ijs}^I)^{-k+\sigma-1} - \widehat{\varphi}_{ijs}^{-k+\sigma-1}\right)\left(\widehat{\varphi}_{ijs}^{-k+\sigma-1} - \varphi_H^{-k+\sigma-1}\right)\right.$$
$$\left. -\frac{(-k+\sigma-1)\widehat{\varphi}_{ijs}^{-k+\sigma-1}(\tau^D)^{-\sigma}}{(\tau^D)^{1-\sigma}-(\tau^I)^{1-\sigma}}\left((\varphi_{ijs}^I)^{-k+\sigma-1} - \varphi_H^{-k+\sigma-1}\right)\right] > 0$$

$$\frac{\partial \Psi_{ijs}}{\partial \tau^I} \propto B_{ij}\left[-\frac{\sigma-1}{\tau^I}\left((\varphi_{ijs}^I)^{-k+\sigma-1} - \widehat{\varphi}_{ijs}^{-k+\sigma-1}\right)\right.$$
$$\left. +\frac{(-k+\sigma-1)\widehat{\varphi}_{ijs}^{-k+\sigma-1}(\tau^I)^{-\sigma}}{(\tau^D)^{1-\sigma}-(\tau^I)^{1-\sigma}}\left((\varphi_{ijs}^I)^{-k+\sigma-1} - \varphi_H^{-k+\sigma-1}\right)\right] < 0$$

$$\frac{\partial \Psi_{ijs}}{\partial f_{ij}^D} \propto \frac{k-\sigma+1}{\sigma-1}\frac{B_{ij}}{f_{ij}^D - f_{ij}^I}\widehat{\varphi}_{ijs}^{-k+\sigma-1}\left[(\varphi_{ijs}^I)^{-k+\sigma-1} - \varphi_H^{-k+\sigma-1}\right] > 0.$$

A.3 Extension of Manova (2013) with trade intermediaries

Given that this model is a straightforward extension of Chaney (2008), we keep the description of the model set up to a minimum and devote more space to the construction of the theoretical moments.

In this section, I solve an extension of the model in Manova (2013) with trade intermediaries and show that both key theoretical predictions, i.e., Propositions 2 and 3, hold. The two models share similar features and I refer the reader to Manova (2013) for details. Consumer preferences still follow Equation (2.1), but domestic firms now solve the following problem:

$$\max_{p,q} \pi_{iis}^H(\varphi,\theta) = p_{iis}(\varphi)q_{iis}(\varphi) - q_{iis}(\varphi)\frac{w_i}{\varphi} - (1-\theta d_s)w_i f_{ii}^H - \lambda_i F(\varphi) - (1-\lambda_i)t_s w_i f_{ii}^H$$
$$s.t. \quad q_{iis}(\varphi) = \frac{(p_{iis}(\varphi))^{-\sigma}\mu_s Y_i}{P_{is}^{1-\sigma}}.$$
$$A_{iis}^H(\varphi,\theta) \equiv p_{iis}(\varphi)q_{iis}(\varphi) - q_{iis}(\varphi)\frac{w_i}{\varphi} - (1-\theta d_s)w_i f_{ii}^H \geq F(\varphi)$$
$$B_{iis}^H(\varphi,\theta) \equiv -\theta d_s w_i f_{ii}^H + \lambda_i F(\varphi) + (1-\lambda_i)t_s w_i f_{ii}^H \geq 0.$$

The parameter η_s from Section 2 is now separated into two components: $d_s \in (0,1)$ for external finance dependence and $t_s \in (0,1)$ for asset tangibility. A fraction d_s of the fixed costs must be financed from an outside risk-neutral investor, while remaining costs are paid for internally. To raise funds, the firm pledges collateral to the lender and offers to pay $F(\varphi)$ as a return. With probability $\lambda_i \in (0,1)$, the contract is enforced and the investor is paid; if the firm defaults, the investor seizes the collaterizable assets $t_s w_i f_{ii}^H$. As discussed in Section 4.1, firms may face greater obstacles in access to financing if there is less credit available, or higher costs, for example, in the form of collateral requirements. Although modeling the stringency of collateral requirements could deliver the same results, it requires an additional assumption on

the parameters, so the former approach is chosen. Because there is an infinite mass of investors, the lack of credit availability is instead modeled as an increase in *demand* for outside funds by the firm-specific factor $\theta \geq 1$ for each firm. Ultimately, this translates to an increase in the cots of capital that firms face. Note that firms would rather fund their fixed costs internally, but are forced to borrow because of inherent technological reasons. Thus, an increase in the costs funded by firms' cash flows would not represent a lack of credit availability. Hence, as in Section 2, firm-level financial frictions are still captured by $\theta \geq 1$.

In Manova (2013), the same qualitative results are derived if either the sunk entry cost is collaterizable or the fixed production cost. For simplicity, I assume that the fixed costs of production or exporting are collaterizable here. With competitive credit markets, the lender's participation constraint binds (i.e., $B^H_{iis}(\varphi) = 0$), and for some cutoff productivity level $A^H_{iis} = F(\varphi^H_{iis}(\theta))$. Indirect and direct exporters solve similar problems, and the three cutoff productivities are:

$$\varphi^H_{iis}(\theta) = \left[\frac{\left(1 - \theta d_s + \frac{\theta d_s}{\lambda_i} - \frac{(1-\lambda_i)t_s}{\lambda_i}\right) w_i^\sigma f^H_{ii} \sigma^\sigma}{\mu_s Y_i P_{is}^{\sigma-1}(\sigma-1)^{\sigma-1}}\right]^{\frac{1}{\sigma-1}},$$

$$\varphi^I_{ijs}(\theta) = \left[\frac{\left(1 - \theta d_s + \frac{\theta d_s}{\lambda_i} - \frac{(1-\lambda_i)t_s}{\lambda_i}\right) w_i^\sigma f^I_{ij} \sigma^\sigma (\tau^I)^{\sigma-1}}{\mu_s Y_j P_{js}^{\sigma-1}(\sigma-1)^{\sigma-1}}\right]^{\frac{1}{\sigma-1}},$$

$$\widehat{\varphi}_{ijs}(\theta) = \left[\frac{\left(1 - \theta d_s + \frac{\theta d_s}{\lambda_i} - \frac{(1-\lambda_i)t_s}{\lambda_i}\right) (f^D_{ij} - f^I_{ij}) \sigma^\sigma}{\mu_s Y_j P_{js}^{\sigma-1}(\sigma-1)^{\sigma-1}[(\tau^D)^{1-\sigma} - (\tau^I)^{1-\sigma}]}\right]^{\frac{1}{\sigma-1}}.$$

In Equations (A.1) to (A.3), the cost of capital is $R = (\theta\eta_s/\lambda_i)^\sigma$. In this model, $R = 1 - \theta d_s + \frac{\theta d_s}{\lambda_i} - \frac{(1-\lambda_i)t_s}{\lambda_i}$, and is increasing in θ and d_s and decreasing in t_s and λ_i. The same qualitative predictions as Propositions 2 and 3 can be derived:

$$\frac{\partial \Pr(\text{ind}|\text{exp})}{\partial \theta} = \frac{\frac{k(-d_s + d_s/\lambda_i)}{(\sigma-1)\left(1-\theta d_s + \frac{\theta d_s}{\lambda_i} - \frac{(1-\lambda_i)t_s}{\lambda_i}\right)}[(\varphi^I_{ijs})^{-k} - (\widehat{\varphi}_{ijs})^{-k}]\varphi_H^{-k}}{[(\varphi^I_{ijs})^{-k} - \varphi_H^{-k}]^2} > 0$$

$$\frac{\partial^2 \Pr(\text{ind}|\text{exp})}{\partial\theta\partial d_s} \propto \frac{\theta d_s(-1 + \frac{1}{\lambda_i})}{R}\left[\frac{k-\sigma+1}{\sigma-1}(\varphi^I_{ijs})^{-k} + \frac{k+\sigma+1}{\sigma-1}\varphi_H^{-k}\right] + (\varphi^I_{ijs})^{-k} - \varphi_H^{-k} > 0$$

$$\frac{\partial^2 \Pr(\text{ind}|\text{exp})}{\partial\theta\partial t_s} \propto -\left[\frac{k-\sigma+1}{\sigma-1}(\varphi^I_{ijs})^{-k} + \frac{k+\sigma+1}{\sigma-1}\varphi_H^{-k}\right] < 0$$

$$\frac{\partial \Psi_{ijs}}{\partial \lambda_i} = \frac{k-\sigma+1}{\sigma-1}\frac{B_{ij}}{\lambda_i^2}\frac{-\theta d_s + t_s}{1 - \theta d_s + \frac{\theta d_s}{\lambda_i} - \frac{(1-\lambda_i)t_s}{\lambda_i}}\frac{\varphi_H^{-k+\sigma-1}\left[(\varphi^I_{ijs})^{-k+\sigma-1} - \widehat{\varphi}_{ijs}^{-k+\sigma-1}\right]}{\tilde{X}^2_{ijs}} < 0$$

$$\frac{\partial^2 \Psi_{ijs}}{\partial\lambda_i\partial d_s} \propto \frac{(-\theta d_s + t_s)(-1 + \frac{1}{\lambda_i})}{R}\left[\frac{k}{\sigma-1}X_{ijs} + \frac{2(k-\sigma+1)}{\sigma-1}\varphi_H^{-k}\right] - \theta X_{ijs} < 0$$

$$\frac{\partial^2 \Psi_{ijs}}{\partial\lambda_i\partial t_s} \propto \frac{(-\theta d_s + t_s)(-\frac{1-\lambda_i}{\lambda_i})}{R}\left[\frac{k}{\sigma-1}X_{ijs} + \frac{2(k-\sigma+1)}{\sigma-1}\varphi_H^{-k}\right] + X_{ijs} > 0.$$

A.4 Calibration

Note $M_i = M_i^e(\varphi_{ii}^H)^{-k}$ and $\tilde{\tau}^I = \tau^D = \tau$. The following equations can be derived for $i = c, u$:

$$w_i f_{ii}^H = \frac{k-\sigma+1}{\sigma k}\frac{\mu Y_i - X_{ji}}{M_i},$$

$$f_{ij}^I = \left[\frac{1}{X_{ij}}\frac{\sigma k}{k-\sigma+1}\tau^{-k} w_i \left(\frac{w_i}{w_j}\right)^{-\frac{\sigma k}{\sigma-1}} \frac{M_j}{M_j^e} M_i^e \gamma^{-\frac{\sigma k}{\sigma-1}} \left(\frac{X_{ij}^I}{X_{ij}^D}+1\right)\left(\frac{X_{ij}^I}{\gamma X_{ij}^D}+\gamma^{-\sigma}\right)^{-1} f_{jj}^H\right]^{\frac{\sigma-1}{k-\sigma+1}} f_{jj}^H,$$

$$f_{ij}^D = \left[\left(\frac{X_{ij}^I}{\gamma X_{ij}^D}+\gamma^{-\sigma}\right)^{\frac{\sigma-1}{k-\sigma+1}}(1-\gamma^{-\sigma})\gamma^{\frac{\sigma k}{k-\sigma+1}}+1\right] f_{ij}^I,$$

$$M_i^e = \frac{\sigma-1}{\sigma k}\frac{\mu Y_i + X_{ij}^I/\gamma + X_{ij}^D - X_{ji}}{w_i f_{ii}^E}.$$

The calibration will also use the following equation:

$$M_u^e = \left(\frac{1}{X_{cu}^D}\right)^{\frac{k}{\sigma-1}}\left(\frac{\sigma k}{k-\sigma+1}\right)^{\frac{k}{\sigma-1}} \tau^{-k} w_c^{-k} M_c^{\frac{k}{\sigma-1}} M_u \left(\frac{\widehat{M_c}}{M_c}\right)^{\frac{k-\sigma+1}{\sigma-1}} \frac{M_c^e}{M_c} w_u^{\frac{\sigma k}{\sigma-1}} (f_{uu}^H)^{\frac{k}{\sigma-1}},$$

where $\frac{\widehat{M_c}}{M_c}$ is the fraction of directly exporting firms in China.

B Empirical appendix

B.1 Fractional probit model

The standard Chamberlain-Mundlak device is used to handle unobserved heterogeneity from c_i, c_j, and c_s (Mundlak, 1980; Chamberlain, 1980; Wooldridge, 2002). The unobserved effects in each group are assumed to be normally distributed with linear expectation and constant variance conditional on the explanatory variables. Specifically, let the vector $\boldsymbol{x}_{ijst}$ contain all of the explanatory variables in Equation (3.3) ($FinDev_{it}, FinDev_{it} \times ExtFin_s, FinDev_{it} \times Tang_s, Z_{ijst}$), and exploit the normal distribution by assuming:

$$\Psi_{ijst} = \Phi(\boldsymbol{x}_{ijst}\boldsymbol{\beta} + c_i + c_j + c_s),\ t = 1, ..., T, \tag{A.1}$$

where $\Phi(\cdot)$ is the standard normal cumulative distribution. As I will not be relying on an instrumental variables approach, but rather the general difference-in-difference approach which exploits exogenous variation in sector financial vulnerability, the framework in Papke and Wooldridge (2008) under the assumption of exogeneity is adopted. Exogeneity implies that $E(\Psi_{ijst}|\boldsymbol{x}_{ijs}, c_i, c_j, c_s) = E(\Psi_{ijst}|\boldsymbol{x}_{ijst}, c_i, c_j, c_s)$, where $\boldsymbol{x}_{ijs} \equiv (\boldsymbol{x}_{ijs1}, ..., \boldsymbol{x}_{ijsT})$ is the set of covariates in all time periods. While there are concerns for potential endogeneity, since intermediated trade through Hong Kong represents a small portion of global economic activity (see Section 4), at least reverse causality is unlikely.

The Mundlak (1980) version of Chamberlain's assumption is imposed for each unobserved group effect. The conditional normality assumptions are:

$$c_i|(\boldsymbol{x}_{ijs1}, \boldsymbol{x}_{ijs2}, ..., \boldsymbol{x}_{ijsT}) \sim \text{Normal}(A_1 + \bar{\boldsymbol{x}}_i \boldsymbol{B}_1, \sigma^2_{v1}),$$
$$c_j|(\boldsymbol{x}_{ijs1}, \boldsymbol{x}_{ijs2}, ..., \boldsymbol{x}_{ijsT}) \sim \text{Normal}(A_2 + \bar{\boldsymbol{x}}_j \boldsymbol{B}_2, \sigma^2_{v2}),$$
$$c_s|(\boldsymbol{x}_{ijs1}, \boldsymbol{x}_{ijs2}, ..., \boldsymbol{x}_{ijsT}) \sim \text{Normal}(A_3 + \bar{\boldsymbol{x}}_s \boldsymbol{B}_3, \sigma^2_{v3}),$$

where $\bar{\boldsymbol{x}}_i \equiv (N_j ST)^{-1} \sum_{j=1}^{N_j} \sum_{s=1}^{S} \sum_{t=1}^{T} \boldsymbol{x}_{ijst}$ is the vector of regressors averaged across all importers, sectors, and time; $\bar{\boldsymbol{x}}_j$ and $\bar{\boldsymbol{x}}_s$ are analogously defined. We could alternatively write $c_i = A_1 + \bar{\boldsymbol{x}}_i \boldsymbol{B}_1 + v_{1i}$, where $v_{1i}|\bar{\boldsymbol{x}}_i \sim \text{Normal}(0, \sigma^2_{v1})$, and likewise for c_j and c_s. As an example, recall the vector $\bar{\boldsymbol{x}}_i$ consists of not only exporter financial development, but also gravity model variables like origin market size, therefore correlation between c_i and $\bar{\boldsymbol{x}}_i$ is expected. Thus,

$$E(\Psi_{ijst}|\boldsymbol{x}_{ijs}, v_{1i}, v_{2j}, v_{3s}) = \Phi(A + \boldsymbol{x}_{ijst}\boldsymbol{\beta} + \bar{\boldsymbol{x}}_i \boldsymbol{B}_1 + \bar{\boldsymbol{x}}_j \boldsymbol{B}_2 + \bar{\boldsymbol{x}}_s \boldsymbol{B}_3 + v_{ijs}),$$

where $A = A_1 + A_2 + A_3$ and $v_{ijs} = v_{1i} + v_{2j} + v_{3s}$. Note $v_{ijs}|(\bar{\boldsymbol{x}}_i, \bar{\boldsymbol{x}}_j, \bar{\boldsymbol{x}}_s) \sim \text{Normal}(0, \sigma^2_{v1} + \sigma^2_{v2} + \sigma^2_{v3})$. We can further simplify this to:

$$E(\Psi_{ijst}|\boldsymbol{x}_{ijs}) = \Phi(A_v + \boldsymbol{x}_{ijst}\boldsymbol{\beta}_v + \bar{\boldsymbol{x}}_i \boldsymbol{B}_{1v} + \bar{\boldsymbol{x}}_j \boldsymbol{B}_{2v} + \bar{\boldsymbol{x}}_s \boldsymbol{B}_{3v}), \tag{A.3}$$

where the subscript v denotes division of the original coefficient by $(1 + \sigma^2_{v1} + \sigma^2_{v2} + \sigma^2_{v3})^{1/2}$. Equation (A.3) is estimated using the pooled Bernoulli QMLE, or as it is referred to in Papke and Wooldridge (2008), the "pooled fractional probit" estimator. Note that not all of the coefficients in A_v and the vectors $\boldsymbol{B}_{1v}, \boldsymbol{B}_{2v}$, and $\boldsymbol{B}_{3v}$ can be separately identified. For instance, the average of financial development (i.e., private credit) over exporters, importers, and time ($(N_i N_j T)^{-1} \sum_{i=1}^{N_i} \sum_{j=1}^{N_j} \sum_{t=1}^{T} FinDev_{it}$) has no variation over industries and is a constant; therefore it is absorbed in the estimation of A_v. However, as long as the linear combination of $\bar{\boldsymbol{x}}_i \boldsymbol{B}_{1v} + \bar{\boldsymbol{x}}_j \boldsymbol{B}_{2v} + \bar{\boldsymbol{x}}_s \boldsymbol{B}_{3v}$ can be computed, the APEs are identified.

B.2 Data

Table B.1: World Bank Enterprise Surveys, Summary Statistics

	(1) Mean	(2) Median	(3) Std. dev.	(4) Min.	(5) Max.
Fraction of sales exported	29.5	26.3	20.8	0	97.9
Indirect/Total exports	21.1	13.3	21.3	0	96.6
Direct/Total exports	78.9	86.7	21.3	3.39	100
Indirect/Direct exports	76.9	15.4	311	0	2847
Fraction of exporting firms	28.8	24.2	17.6	0	86.8
Indirect/Total exporting firms	27.4	25.5	17.1	0	89.6
Direct/Total of exporting firms	72.6	74.5	17.1	10.4	100

Notes: $N = 202$ country-years. Statistics are computed for manufacturing establishments. All statistics in percentage points.

Table B.2: Largest Values of Hong Kong Re-exports by Origin and Destination (2010)

	Origin	Value (% of total)		Destination	Value (% of total)	
1	China	143	(51.2)	China	110	(39.5)
2	Japan	27.4	(9.82)	United States	40.8	(14.6)
3	Taiwan	24.9	(8.92)	Japan	15.6	(5.59)
4	Korea	13.9	(4.98)	Germany	10.2	(3.65)
5	United States	11.6	(4.16)	United Kingdom	7.46	(2.67)
6	Malaysia	9.34	(3.34)	Taiwan	7.30	(2.61)
7	Thailand	7.34	(2.63)	Korea	6.33	(2.27)
8	Philippines	4.37	(1.56)	Singapore	6.10	(2.18)
9	Germany	4.27	(1.53)	Netherlands	5.33	(1.91)
10	Singapore	3.50	(1.25)	India	4.99	(1.79)

Notes: Values exclude re-exports that return to their origin country, in billions of 2010 USD; values as percentages of total re-exports through Hong Kong in parentheses.

Table B.3: Composition of Hong Kong Re-exports (2010)

	Destination Region					Origin Region				
Country	Chn	Asia	Eur.	Am.	Afr.	Chn	Asia	Eur.	Am.	Afr.
China		37.1	29.4	32.0	1.46		77.0	11.3	10.7	0.97
Japan	86.7	8.28	2.42	2.41	0.16	92.7	3.76	2.12	1.27	0.14
India	43.0	31.6	13.7	11.7	0.14	81.7	8.37	5.56	2.18	2.13
Australia	74.5	22.3	2.00	1.03	0.18	75.4	5.28	17.9	1.37	0.09
Israel	31.8	16.1	7.53	44.6	0.01	78.0	16.8	2.59	0.78	1.85
Germany	80.2	18.1	0.71	0.87	0.11	93.3	4.52	0.45	1.65	0.05
United States	74.3	22.2	3.29	0.17	0.07	92.2	6.19	1.12	0.26	0.19
Nigeria	88.7	9.12	2.22	0.01	0	90.5	8.33	0.93	0.16	<0.01

Notes: Rows in each panel sum to 100%. Abbreviations: Chn- China, Asia- Asia excluding China, Eur.- Europe, Am.- Americas, and Afr.- Africa.

Table B.4: Re-export Shares by Destination and Origin Regions (2010)

	Destination Region					Origin Region				
Country	Chn	Asia	Eur.	Am.	Afr.	Chn	Asia	Eur.	Am.	Afr.
China		8.57	9.82	9.98	2.52		9.82	6.23	5.50	4.58
Japan	12.7	0.74	0.63	0.38	0.42	10.1	0.20	0.43	0.21	0.24
India	6.76	1.28	1.09	1.15	0.03	8.86	0.37	0.52	0.36	0.62
Australia	0.88	0.13	0.07	0.06	0.01	9.91	0.36	2.18	0.23	0.17
Israel	23.4	2.57	0.69	3.10	0.01	9.53	0.81	0.09	0.04	1.05
Germany	4.46	0.51	<0.01	0.02	0.02	11.8	0.31	0.01	0.23	0.02
United States	8.19	0.81	0.14	<0.01	0.03	11.4	0.61	0.13	0.01	0.16
Nigeria	1.03	0.01	<0.01	<0.01	0	1.27	0.29	0.02	0.01	<0.01

Notes: Abbreviations: Chn- China, Asia- Asia excluding China, Eur.- Europe, Am.- Americas, and Afr.- Africa. Total re-exports and direct exports are first separately aggregated by region, then the re-export share for each region is calculated.