# Financial Frictions and Sourcing Decisions

Entian Zhang*

November 18, 2023

Please click here for the most recent version.

**Abstract**

This paper studies the impact of financial frictions on firms' sourcing decisions of intermediate inputs. I set up a general equilibrium Baumol-Tobin inventory management model where heterogeneous firms pay for inputs before production and are subject to borrowing limits. The model implies that financial frictions distort firms' sourcing decisions by inducing firms to source from countries where they can make small and frequent orders. The impact of financial frictions on the gains from trade are two-fold: they reduce total imports, and distort the sourcing decisions of importers. I then use Chinese firm-level data to validate the model. I find that the import orders from neighboring countries of China are small and frequent comparing to those from other countries, and that firms tend to source from neighboring countries when financially constrained. Financial reforms aimed at improving firms' access to external finance and policies that reduce the fixed costs of importing can mitigate the distortion in sourcing decisions and facilitate the access to imported inputs, thereby increase the gains from trade.

***Keywords***— Financial frictions, foreign sourcing, international trade, inventory, (S,s) policies

*Department of Economics, University of Minnesota, zhan6300@umn.edu. I would like to thank my advisors, Timothy Kehoe, Manuel Amador, and Doireann Fitzgerald for their valuable guidance and incredible support. I would also like to thank Samuel Bailey, Maria-Jose Carreras-Valle, V. V. Chari, Loukas Karabarbounis, Illenin Kondo, Simeng Zeng, and all the participants of the Trade workshop at the University of Minnesota and the UMN-UW Graduate Workshop for their comments and suggestions.

# 1 Introduction

A key channel through which openness to international trade promotes growth and economic development is cheaper intermediate inputs (Amiti and Konings 2007). Recent work has shown that financial frictions limit the access to imported intermediate inputs. For example, financial frictions reduce the extensive and the intensive margins of imports at the firm level (Muûls 2015), and reduce the total imports of inputs at the aggregate level (Kohn et al. 2022). However, not only the level, but also the sources of imported inputs matter. The seminal Eaton and Kortum (2002) model suggests firms source from countries with the lowest prices. Can firms always import from their optimal sources of supply? In this paper, I investigate the role that financial frictions play in firms' sourcing decisions of intermediate inputs.

How can financial frictions distort firms' sourcing decisions? Intermediate inputs are often purchased before the realization of sales, and hence are associated with up-front costs (Manova 2010). Controlling for the value of the total purchase, the up-front costs are high when firms make large and infrequent orders. Firms then need to finance the up-front costs with retained earnings and external borrowings. On the other hand, as documented by previous research, import orders are lumpy—importers make large and infrequent orders and hold inventories (Alessandria, Kaboski, and Midrigan 2010); and the lumpiness of import orders varies depending on the sources (Blum, Claro, Dasgupta, and Horstmann 2019). This suggests that sourcing from a country where import orders are large and infrequent is associated with high up-front costs. In the presence of financial frictions, credit-constrained firms that are not able to afford the up-front costs are precluded from sourcing from such countries. For example, if a Chinese firm finds that the import orders from Germany are large and cannot afford the up-front costs, then the firm may choose to purchase the product from a trade intermediary in Hong Kong. By doing so the firm pays higher unit price, but makes a smaller order.

To investigate, I extend a general equilibrium Baumol-Tobin inventory management model to include financial frictions in the form of borrowing limits. In the model, firms are heterogeneous in a demand shifter parameter, and face per-shipment fixed costs of purchasing a storable input. The input can be purchased from different countries. These inputs from different countries are perfect substitutes but have different prices and per-shipment fixed costs. The per-shipment fixed costs give rise to economies of scale in purchasing: orders from countries with higher fixed costs are larger and less frequent, implying a higher inventory of the input. I further assume that inputs are purchased before sales take place. Therefore large and infrequent orders cause high up-front costs. Firms can finance the up-front costs via two channels:

internal accumulation of assets and external borrowing. When borrowing externally, firms face borrowing limits: the amount that firms can borrow is at most an exogenous proportion of their net worth. Firms with low net worth will tend to source from countries with low per-shipment costs, which may deviate from their optimal sourcing decision. This is because those firms are financially constrained and cannot afford the high up-front costs of large orders from countries with high per-shipment fixed costs. Thus financial frictions distort firms' sourcing decisions. The impact of financial frictions on the gains from trade are two-fold: they reduce the total imports, and distort the sourcing decisions of importers.

I validate the implications of the model by studying the relationship between firms' sourcing decisions of imported inputs and their financial conditions. To do so, I need to first identify the set of countries from which the import orders are small and frequent. Following Manova and Yu (2016), I match two proprietary data sets on Chinese firms from 2000 to 2006: the Annual Survey of Industrial Firms (ASIF), which provides the balance sheet information, and the Chinese Customs Trade Statistics (CCTS) collected by the Chinese Customs Office, which provides shipment level import orders. Following Blum, Claro, Dasgupta, and Horstmann (2019), I find that the import orders from neighboring countries of China are small and frequent compared to those from other countries. The neighbor countries are Japan, South Korea, Taiwan, Hong Kong and Singapore. On the other hand, to gauge firms' financial condition, I construct two standard balance sheet measures: the liquidity ratio and the leverage ratio. A higher liquidity ratio, or a lower leverage ratio implies better financial conditions.

First, I find that when firms have low liquidity ratios or high leverage ratios, suggesting that they are in bad financial condition, they tend to source from neighboring countries; after the improvements of financial conditions, i.e. firms have higher liquidity ratios or lower leverage ratios, they may switch to other countries. This is consistent with the model that financially constrained firms tend to source from countries where they can make small and frequent orders. As a second test, by tracking continuing firm-product-country observations, I find that increases in liquidity ratios or decreases in leverage ratios, i.e. improvements in financial conditions, are followed by larger and more infrequent import orders. Finally, I show that sourcing from neighboring countries is associated with lower inventory holdings, suggesting that orders from neighboring countries are indeed small and frequent.

To study the quantitative impact of financial frictions on import and other aggregate variables, I estimate the parameters of the model to match key moments from the Chinese firm-level data. Then I use the estimated economy as a laboratory to study two counterfactuals. First, I contrast the stationary equilibrium of the estimated model with the one in an economy with perfect credit market. By eliminating the financial frictions, total imports as a fraction of gross output increases, and conditional on importing firms always choose their optimal sources. This increases the gross output and consumption by $\Delta Y/Y = 7.2\%$, and $\Delta C/C = 7.4\%$. Second, I reduce the per-shipment fixed costs from all sources by 10% uniformly. Alessandria, Kaboski, and Midrigan (2010) documents that the monetary and time costs of bureaucratic procedures of importing that are not proportional to a shipment's size is an important component of the per-shipment fixed costs. With lower per-shipment fixed costs, firms can make smaller orders, and hence are less financially constrained. Of course lower fixed costs increase profits. Hence when considering the change in consumption, I still assume a same total expenditure on fixed costs as the baseline model. With lower fixed costs, $\Delta Y/Y = 1.5\%$, and $\Delta C/C = 1.5\%$.

The counterfactual analysis suggests that financial reforms aimed at improving firms' access to external finance, and policies that simplify the procedures of importing and reduce the per-shipment fixed costs mitigate the distortion in sourcing decisions and facilitate the access to imported inputs, and hence increase the gains from trade.

**Related Literature** This paper contributes to several strands of literature in international trade and macroeconomics. First, I build on the seminal contribution of Melitz (2003) and subsequent work, such as Alessandria and Choi (2014), who analyze the gains from trade in a model with heterogeneous firms. Chaney (2016) and Manova (2013) introduce credit market frictions into a Melitz (2003) framework. Both papers consider a static environment, and do not address how credit frictions affect the gains from trade. Caggese and Cuñat (2013) study the gains from trade reform with collateral constraints and show that gains are limited due to the extensive margin. Recent papers by Brooks and Dovis (2020), Leibovici (2021) study dynamic trade models with financial frictions. These previous studies focus on the impact of financial frictions on the export side. This paper investigate how financial frictions affect the import side. Most closely related to this work is that of Kohn et al. (2022), which shows that financially constrained firms have limited access to imported inputs and hence low financial development causes welfare loss. I confirm their findings and contrast them by focusing on the impact of financial frictions on firms' sourcing decisions of imported inputs. Welfare loss is not only due to lower imports as a fraction of gross output, but also because financially constrained firms are not be able to import from the best sources.

Second, the notion that trade frictions have an important per-shipment component is in line with a literature that documents systematic patterns in the size and frequency of international shipments (Alessandria, Kaboski, and Midrigan 2010; Kropf and Sauré 2014; Hornok and Koren 2015; Bekes et al. 2017; Blum, Claro, Dasgupta, and Horstmann 2019). The key feature is that the per-shipment fixed costs give rise to economies of scale in transportation, and hence the import shipments are lumpy and associated with high inventories; and that the lumpiness of import shipment varies across source countries, documented by Alessandria, Kaboski, and Midrigan (2010), Blum, Claro, Dasgupta, and Horstmann (2019) and Carreras Valle (2022). This paper contributes to this literature by linking these findings to financial frictions. This is closely related to Khan and Thomas (2013) which studies the cyclical implications of credit market imperfections when firms' capital accumulation follows (s,S) policy due to investment irreversibilities. In particular this paper assumes that inputs are purchased before the realization of revenues, and cause up-front costs. Large and infrequent orders can cause high up-front costs. Financially constrained firms will avoid such orders due to lack of liquidity. Given the different lumpiness of import shipment across countries, this paper studies how financial frictions distort the sourcing decisions.

Finally, this paper adds to a large body of work on foreign sourcing. A number of papers provide reduced form evidence on the determinants of foreign sourcing (Fort 2017), as well as its impact on firm performance and aggregate productivity (Amiti and Konings 2007; Goldberg et al. 2010; De Loecker et al. 2016). A related set of papers uses a more structural approach to quantify the effect of importing on firm productivity and prices (Halpern et al. 2015; Gopinath and Neiman 2014; Blaum et al. 2017). Previous works studies how financial frictions affect foreign sourcing. Aristei and Franco (2014) and Muûls (2015) finds financial frictions reduce the extensive and the intensive margins of imports at firm level; Kohn et al. (2022) finds that financial frictions reduce the total imports of inputs at aggregate level. This paper extends these framework to study the impact of financial frictions on the sourcing decisions.

The rest of the paper is structured as follows. Section 2 details the assumptions of the model and summarizes with testable predictions. Section 3 introduces the data and validate the model by examining the predictions. Section 4 explains the calibration strategies and shows the main quantitative results. Lastly section 5 concludes the paper.

## 2 Model

This section presents the general equilibrium model I use to study the role financial frictions play in firms' sourcing decisions. In the model, firms faces per-shipment fixed costs of purchasing a storable input. The input can be purchased from different countries. The inputs from different countries are perfect substitutes, but have different prices and per-shipment fixed costs. The per-shipment fixed costs give rise to economies of scale in purchasing—orders from countries with higher fixed costs are larger and hence, given import values, less frequent, implying higher inventory of the input. I further assume that inputs are purchased before they are used in production and the output is sold. Therefore large and infrequent orders cause high up-front costs. Firms can finance the up-front costs in two ways: internal accumulation of assets and external borrowing. When borrowing, firms face borrowing limits: the amount that firms can borrow is at most a given proportion of their net worth. Under this setting, firms with low net worth tend to source from countries with low per-shipment costs, which may deviate from their optimal sourcing decisions.

### 2.1 Environment

Time is discrete and indexed by $t = 0, 1, \ldots$ There are $N$ countries in the world, home and $N-1$ foreign countries. The home country is composed of a representative household, competitive final good producers and a unit continuum of monopolistic competitive firms each producing an intermediate differentiated product. The home final good is set as the numeraire. I assume that the home country is a small open economy. The interest rate and prices of imported goods are exogeneously given. The foreign countries are simple: they each export their final goods at exogenous prices $\{\omega^i\}_{i=1}^{N-1}$.

#### Household

The representative household in the home country inelastically supplies $L$ unit of labor each period. The household does not borrow or save, and hence spends all income on the consumption of the home final good:

$$C_t = w_t L_t + D_t + T_t \quad \forall t \geq 0 \tag{1}$$

where $w_t$ is wage, $D_t$ is the sum of profits from the operation of firms, and $T_t$ is the sum of transfers to the firms, which will be specified later.

**Final Good Producers**

The final good in the home country is produced using the following Cobb-Douglas technology with intermediate goods and labor:

$$Y_t = \left[ \left( \int_0^1 e^{\frac{z_i}{\sigma}} y_{i,t}^{\frac{\sigma-1}{\sigma}} di \right)^{\frac{\sigma}{\sigma-1}} \right]^{\alpha} L_t^{1-\alpha} \tag{2}$$

where $y_{i,t}$ refers to the intermediate good $i \in [0,1]$, and $z_i$ is a demand shifter for $y_{i,t}$.

Final goods producers are competitive. A representative firm solves:

$$\max_{y_{i,t}, L_t} \quad Y_t - \int_0^1 p_{i,t} y_{i,t} di - w_t L_t \tag{3}$$

subject to (2), taking $\{p_{i,t}\}_{i \in [0,1]}$ and $w_t$ as given.

**Intermediate Good Producers**

The unit continuum of intermediate good firms, $i \in [0,1]$, behaves monopolistically and each produces a unique variety of an intermediate good. Each firm faces a demand from the final good producers:

$$y_{i,t} = e^{z_i} (p_{jt}/P_{m,t})^{-\sigma} Y_{m,t} \tag{4}$$

where $z_i$ is the firm-specific demand shifter, which is drawn from a distribution $\Gamma_z$ when a firm enters, and remains constant through time; $P_{m,t}$ and $Y_{m,t}$ are the price index and demand for the CES aggregator of intermediate goods respectively.

Firms have access to a technology which produces one unit of the intermediate variety with one unit of an input. Let $q_t$ denote the quantity of input used. Then

$$y_t = q_t \tag{5}$$

Firms can use the home final good, or the final goods from the $N-1$ foreign countries as their inputs. For firm $i \in [0,1]$, the inputs from different countries are perfect substitutes, but have different prices and per-shipment fixed costs given by $\{\omega^k, f_i^k\}_{k \in \{1,\ldots,N\}}$. Each time firm $i$ makes a order from country $k$, it pays $\omega^k$ for each unit of input, and a fixed cost $f_i^k$ in addition. The per-shipment fixed cost vector,

$\{f_i^k\}_{k\in\{1,\ldots,N\}}$, is firm-specific, drawn from a distribution $\Gamma_f$ when a firm enters and remains constant through time. Further I assume the input is storable, with a depreciation rate $\delta$. Due to the per-shipment fixed costs, firms will find it optimal to purchase infrequently and carry non-zero holdings of inventories from one period to the next.

I assume there is a one-period lag between firms' orders and the delivery of the input. That is, the quantity sold by firm $i$, $y_{i,t}$ , is constrained to not exceed firm $i$'s beginning-of-period stock of inventory, $s_{i,t}$:

$$y_{i,t} = \min\left[e^{z_i}(p_{jt}/P_{m,t})^{-\sigma}Y_{m,t}, s_{i,t}\right] \tag{6}$$

That is, production uses inputs in the inventory.

The amount of input firm $i$ orders today, $m_{i,t}$, cannot be used for sales until next period. The law of motion for the firm $i$'s beginning-of-period inventories is:

$$s_{i,t+1} = (1-\delta)\left[s_{i,t} - y_{i,t} + m_{i,t}\right] \tag{7}$$

where $\delta$ is the depreciation rate. Note that I assume that inventories in transit, $m_{i,t}$, depreciates at the same rate as inventories in the importer's warehouse, $s_{i,t} - y_{i,t}$. Note if the firm chooses not to make an order, then $m_{i,t} = 0$.

So far, the firms' problem is a standard Baumol-Tobin inventory management problem. In each period the firm decides: (i) whether to make an order and refill its inventory; (ii) if it decides to make an order, choose the country to import from. Implicit in this formulation is the assumption that inventory investment is irreversible, i.e. firms can only use their inventories to produce, but cannot sell their inventories.[1]

I assume that firms needs to pay for the input before sales. Indeed as Manova (2010) documents, intermediate input purchase is a substantial up-front cost for firms, which can be recovered only after firms sell the outputs. Firm $i \in [0,1]$ has two sources of finance for purchasing its input. First, firm $i$ can use its internal accumulation of assets, but cannot raise new equity. In the model, the asset holdings are denoted by $a_{i,t}$. Second, firm $i$ can borrow externally via an one-period bond with interest rate $r_t$, but

[1]Understand this assumption as once a firm makes an order, the firm makes it customized and other firms cannot use it. This assumption implies that there's no market for the transaction of inventories.

this borrowing is subject to a borrowing constraint: firm $i$ can borrow up to a fraction of its net worth:

$$b_{i,t+1}/(1+r_t) \leq \theta(a_{i,t} - b_{i,t}) \tag{8}$$

Define net worth $n_{i,t} = a_{i,t} - b_{i,t}$, equation (8) can be rewritten as

$$b_{i,t+1}/(1+r_t) \leq \theta n_{i,t} \tag{9}$$

I assume the net worth must be non-negative.

I further assume that if the firm changes its supplier from country $j$ to $k$, the firm pays a sunk costs $f_{jk}^{\text{sunk}}$. Models in which heterogeneous firms face sunk entry costs and fixed costs of importing have become important tools for studying international trade patterns[2]. In my model, I define the previous sources of supply for new entrants are the home country. Thus, per-shipment fixed costs and the sunk costs of switching sources of supply will jointly determine the fraction of firms that import and the shares of import values from different sources. As will be explained later in the Quantitative Analysis, the per-shipment fixed costs will be disciplined by data moments on the frequencies of import orders from different sources. Hence I introduce the sunk costs of switching sources of supply to match moments of fraction of firms that import and the import shares from different countries. If firm $i$, previously sourcing from country $j$, now decides to make an order from country $k$, all the costs need to be paid before sales. Hence

$$\omega^k m_{i,t} + f_i^k + f_{jk}^{\text{sunk}} * 1_{j \neq k} \leq n_{i,t} + \frac{b_{i,t+1}}{(1+r_t)}, \quad \text{where } \frac{b_{i,t+1}}{(1+r_t)} \leq \theta n_{i,t} \tag{10}$$

Left hand side is the variable and fixed cost of the order, plus the sunk cost if the firm changes source of supply. The firm cannot raise new equity, the dividend must be non-negative:

$$d_{i,t} = p_{i,t} y_{i,t} + n_{i,t} - \omega^k m_{i,t} - f_i^k - f_{jk}^{\text{sunk}} * 1_{j \neq k} - \frac{n_{i,t+1}}{1+r_t} \geq 0, \quad n_{i,t+1} \geq 0 \tag{11}$$

Finally, net worth must be non-negative.

At the beginning of each period a firm exits exogenously with probability $\delta^e$. Law of large number suggests that each period a measure of $\delta^e$ firms exit. At the same time, a measure of $\delta^e$ new firms enter, with an initial net worth $n_0$ received from the households and zero inventory holdings. It is defined

[2] Notable papers in this expansive literature include: Melitz (2003), Helpman et al. (2008), Eaton et al. (2011) and Ruhl and Willis (2017).

that for a new entrant the previous source of supply is home. I assume that net assets of exiting firms are transferred to the household, while the inventory holdings of those firms are gone[3]. A firm that operates for long time will eventually accumulate enough assets to become financially unconstrained. With exogenous exit, firms may exit before accumulating enough assets and hence financial frictions remain in the stationary equilibrium.

Recall the total transfer term in the household's budget constraint (1). The household receives the net worth of all the exiting firms, and makes transfers to all the new entrants. Let $NW_t$ denote the total net worth of all firms at the beginning of period $t$:

$$T_t = \delta^e (NW_t - n_0) \tag{12}$$

**Recursive formulation**

The firms' problem in a stationary equilibrium can be concisely summarized by the following system of two functional Bellman equations. Let $V^A(s, n, c; \Theta)$ denote a firm's value of making an new order, where $s$ refers to inventory holding, $n$ refers to net worth, $c$ refers to the previous source of supply, and $\Theta = (z, \{f^k\}_{k=1}^N)$ refers to the firm's demand shifter and per-shipment fixed costs. Let $V^N(s, n, c; \Theta)$ denote the value of inaction. Let $V(s, n, c; \Theta) = \max\{V^A(s, n, c; \Theta), V^N(s, n, c; \Theta)\}$ denote the firm's value. Then the firm's problem is:

$$\begin{aligned} V^A(s, n, c; \Theta) = & \max_{p,d,m,c',b',n'} d + \beta(1-\delta^e) V(s', n', c'; \Theta) \\ \text{s.t.} \quad & d = py + n - (\omega^{c'} m + f^{c'} + f^{\text{sunk}}_{c,c'} * 1_{c' \neq c} + n'/(1+r)) \geq 0 \\ & \omega^{c'} m + f^{c'} + f^{\text{sunk}}_{c,c'} * 1_{c' \neq c} \leq n + b'/(1+r) \\ & b'/(1+r) \leq \theta n \\ & y \leq s \\ & s' = (1-\delta)(s + m - y) \\ & y \geq 0, \ m \geq 0, \ n' \geq 0 \end{aligned}$$

[3] Remember that I assume there's no market for the transaction of inventories. A firm's inventories can only be used for its own production.

and

$$
\begin{aligned}
V^N(s,n,c;\Theta) = \max_{p,d,n'} \; & d + \beta(1-\delta^e)V(s',n',c;\Theta) \\
\text{s.t.} \quad & py + n \geq d + n'/(1+r) \\
& y \leq s \\
& s' = (1-\delta)\,(s-y) \\
& y \geq 0, \;\; n' \geq 0
\end{aligned}
$$

**Stationary Competitive Equilibrium**

Consider a fixed interest rate $r$. Let $\mathbf{S}$ denote the state space of intermediate good producers, and let $s \in \mathbf{S}$ denote an element of the state space. Let $\phi$ denote a measure over $\mathbf{S}$. Given the prices of final goods, $\{\omega^k\}_{k=1}^N$, a recursive stationary competitive equilibrium of this economy consists of wage $w$, policy functions $\{p, d, m, c', b', n'\}$, value functions $\{V, V^A, V^N\}$, and a measure $\phi : \mathbf{S} \to [0,1]$ such that (i) labor market clears; (ii) goods market clears[4]; (iii) policy and value functions solve the intermediate good producers' problem; (iv) measure $\phi$ is stationary.

## 2.2 Mechanism of the Model

I next characterize the optimal decision rules for the intermediate good firms' problem. In particular, I study how financial frictions distort firms' sourcing decisions.

I use a numerical example to illustrate the mechanism. Consider an intermediate good firm which can source from $N = 3$ countries, facing different prices: $\omega^1 > \omega^2 > \omega^3$ and different per-shipment fixed costs: $f^1 < f^2 < f^3$. Without loss of generality, I assume the sunk costs of switching suppliers equal zero. This will not affect the mechanism through which financial frictions distort the firm's sourcing decision. In addition, under this assumption the firm's sourcing decision will be independent on last period's decision. Thus the firm is characterized by its inventory holding $s$, net worth $n$ and demand shifter $z$.

[4] Since the interest rate is exogeneously given, in each period, the total export should be equal to the sum of the total import and net borrowing.

### 2.2.1 Sourcing Decisions

**Without Financial Frictions** If there are no financial frictions, the firm' problem is a standard Baumol-Tobin inventory management problem[5]. When sourcing from countries with higher fixed cost, due to scale of economies, the firm tends to make larger and less frequent orders, and hence holds more inventories. Holding inventories is costly—because inventory is depreciating, and also due to the opportunity cost since the inventory does not have a return as assets. Holding the same amount of inventory, it is more costly if the firm's demand shifter is low, as the result of a low inventory turnover rate. In the numerical example, countries with low prices have high per-shipment fixed costs. Hence the firm needs to trade-off prices and per-shipment fixed costs together with the associated inventory costs.

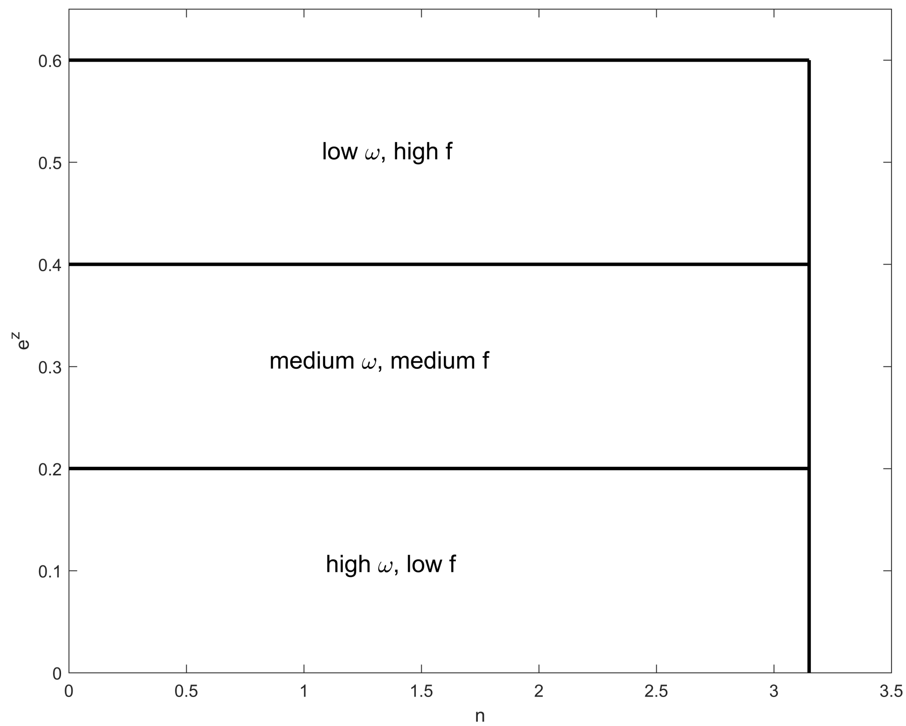
Figure 1 depicts the firm's sourcing decision in the $(n, z)$ space, with inventory holding $s = 0$, i.e. the firm will make an order to refill its inventory holdings. Without financial frictions, net worth does not affect the sourcing decision. The sourcing decision is only a function of the firm's demand shifter. With a low demand shifter, the firm sources from countries with low per-shipment fixed costs, even though the inputs from those countries are more expensive; while with a high demand shifter, the firm sources from the country with low price and high per-shipment fixed costs, because the benefit from the low price covers the high fixed costs and the associated inventory costs.

**With Financial Frictions** In the case of financial frictions, Figure 2 depicts the firm's sourcing decision in the $(n, z)$ space, with inventory holding $s = 0$. Different from the case without financial frictions, the sourcing decision now depends on the firm's net worth. With a high demand shifter, the firm still tends to source from countries with low prices and high per-shipment fixed costs, but only when the firm has enough net worth. For example, when there's no financial frictions, with demand shifter $e^z = 0.5$, Figure 1 suggests that the firm will source from country 3 which has low price and high fixed cost. However, with financial frictions and demand shifter $e^z = 0.5$, Figure 2 suggests that the firm will source from country 3 only if it has enough net worth. With low net worth, instead the firm sources from country 2 or country 1, which have lower per-shipment fixed costs.

Why do financial frictions distort the firm's sourcing decision? Remember in the model, the firm pays for the input before the realization of its sales. This up-front costs can be financed by the firm's

[5] In the model, firms are financially constrained due to two reasons: the borrowing limit and that the net worth must be non-negative. Here no financial frictions implies that, first there's no borrowing limit; second, net worth can be negative, but no Ponzi scheme.

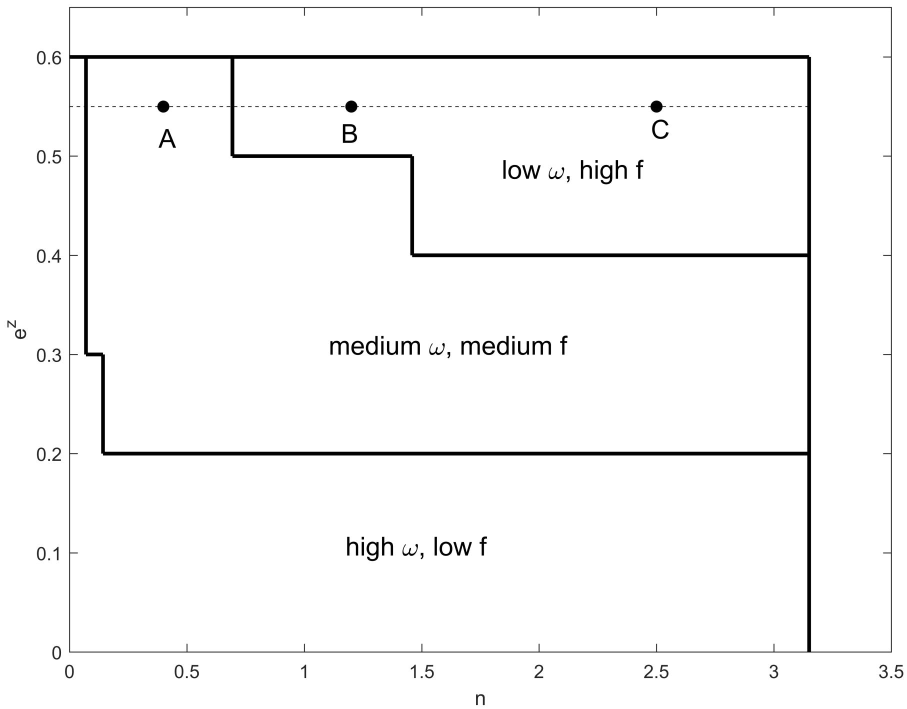
Figure 1: Sourcing Decision, Without Financial Frictions




Note: Consider an intermediate good firm which can source from $N = 3$ countries, facing different prices: $\omega^1 > \omega^2 > \omega^3$ and different per-shipment fixed costs: $f^1 < f^2 < f^3$. This figure depicts the firm's sourcing decision in the $(n, z)$ space, with inventory holding $s = 0$ and with a perfect credit market. I assume the sunk costs of switching suppliers equal zero. The x-axis represents the firm's net worth and the y-axis represents the firm's demand shifter. The sourcing decision does not depend on the net worth.

net worth, or external borrowing, up to a fraction of its net worth. As mentioned before, sourcing from countries with high per-shipment fixed costs is associated with larger and less frequent orders, implying a higher up-front cost. Low-networth firms may not be able to afford large orders and hence will not source from countries with high per-shipment fixed costs. To see this more clearly, consider three points A, B and C in Figure 2. The demand shifters are the same at the three points, but the net worth are different. The sourcing decisions are also different: at point B and C, the firm sources from country 3 which has low price and high fixed cost; while at point A, the firm sources from country 2, which has medium price and medium fixed cost. This is because at point A with low net worth the firm cannot afford the large and infrequent orders from country 3. I will next show the sizes of orders at the three points by studying the firm's inventory decisions.

Figure 2: Sourcing Decision, With Financial Frictions




Note: Consider an intermediate good firm which can source from $N = 3$ countries, facing different prices: $\omega^1 > \omega^2 > \omega^3$ and different per-shipment fixed costs: $f^1 < f^2 < f^3$. This figure depicts the firm's sourcing decision in the $(n, z)$ space, with inventory holding $s = 0$ and in the case of financial frictions. I assume the sunk costs of switching suppliers equal zero. The x-axis represents the firm's net worth and the y-axis represents the firm's demand shifter. The sourcing decision now depends on the net worth.

### 2.2.2 Inventory Decisions

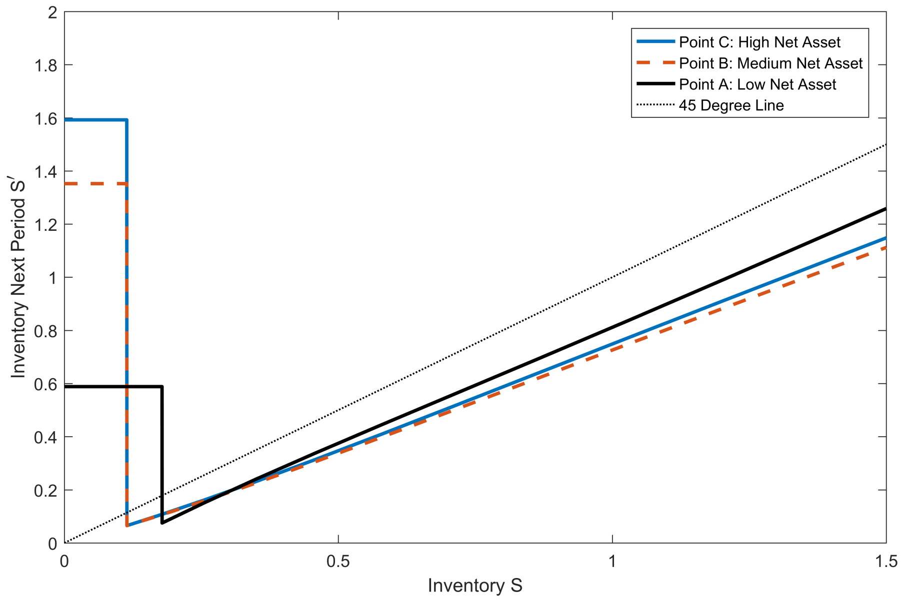
Figure 3 depicts the firm's inventory decisions under different values of net worth, given the demand shifter $e^z = 0.5$. The inventory decision follows a $(s, S)$ policy: make a new order when the inventory stock is lower a threshold, and do not make an order when the stock is high than that threshold.

At point C, the firm has enough net worth and is financially unconstrained. When making an order, the firm will refill its inventory stock to an optimal level $s'$ such that:

$$\omega^3 = \beta(1 - \delta^e)(1 - \delta)V_s(s', n'; z) \tag{13}$$

where $n'$ is the net asset after the up-front cost and the realization of revenue. Equation 13 shows that

Figure 3: Inventory Decision




Note: this figure depicts the inventory decisions of firms with different net worth. The x-axis represents current inventory holdings and the y-axis represents the inventory holdings of the next period. The blue solid line represents the inventory decision of the firm with high net worth, corresponding to point C in Figure 2. The orange dash line represents the firm with medium level of net worth, corresponding to point B. And the black solid line represents the firm with low net worth, corresponding to point A.

the marginal costs of input should be equal to the marginal benefit of holding it to the next period.

At point B, the firm has a medium level of net worth. Figure 2 suggests that the firm is still sourcing from country 3. However as Figure 3 shows, at point B, when making an new order, the firm refills it inventory to a level lower than that at point C, the optimal level. This is because at point B, the firm does not have enough net worth to afford the up-front cost of refilling the inventory to the optimal level. In other words, at point B, the firm will refill its inventory stock to $s'$ such that:

$$\omega^3 < \beta(1-\delta^e)(1-\delta)V_s(s', n'; z) \tag{14}$$

where $n'$ is the net worth after the up-front cost and the realization of revenue. The marginal cost of input is less than the marginal benefit of holding it to the next period. The firm wishes to purchase more but financially constrained. This suggests that sourcing from a same country, everything else the same, financially constrained firms make smaller orders.

At point A, the firm has a low net worth. Figure 2 suggests that the firm is sourcing from country 2. The per-shipment fixed costs give rise to increasing returns to scale in purchasing. The fixed cost of sourcing from country 3 is high, and hence it is profitable to source from country 3 only if the firm makes large orders. But due to the low net worth, the firm cannot afford such a large order. As a result, the firm chooses to source from country 2, which has a lower per-shipment fixed cost and hence the firm can make small orders. Indeed as Figure 3 shows, at point A, when making an new order, the firm refills it inventory to the level lower than that at point B and C. This suggests that when sourcing from a country with lower per-shipment fixed cost and hence from which import orders are smaller and more frequent, everything else the same, firms hold lower inventory stocks.

### 2.3 Predictions of the Model

To conclude, I summarize the implications of the model with the following three predictions:

- **Prediction 1:** Financially constrained firms tend to source from countries where they can make small and frequent orders.
- **Prediction 2:** When sourcing from the same country, more financially constrained firms will make smaller orders to avoid high up-front costs.
- **Prediction 3:** Sourcing from countries where import orders are small and frequent is associated with lower inventory holdings.

## 3 Empirical Analysis

In this sector, I support the implications of the model with suggestive evidence using two proprietary data sets on the activities of Chinese firms for 2000-2006: the Annual Survey of Industrial Firms (ASIF), and the Chinese Customs Trade Statistics (CCTS) collected by the Chinese Customs Office.

### 3.1 Data

The Annual Survey of Industrial Firms (ASIF) is conducted by China's National Bureau of Statistics. It provides standard balance sheet data for all state-owned enterprises (SOEs) and all private companies with sales above 5 million Chinese Yuan. The main variables of interest are measures of firm financial conditions, which I discuss in greater detail below. I also use information on total sales, employment, capital, and material inputs to construct proxies for firm size and productivity.

The Chinese Customs Trade Statistics (CCTS) is collected by the Chinese Customs Office, which contains detailed information about the universe of trade transactions. It reports the value of firm exports (free on board) and imports (cost, insurance, and freight included) in U.S. dollars by country and product for 243 destination/source countries and 7526 products in the 8-digit Harmonized System. The records indicate whether each cross-border transaction occurs under ordinary trade, processing with imports or pure assembly. Since I'm interested in firms' import decisions for production, I restrict the sample to firms' import transactions of intermediate inputs[6]. Following Manova and Yu (2016), I drop import transactions made by trade intermediaries[7], and also import transactions for pure assembly[8].

The empirical analysis relies on combining data from both sources. I therefore merge the census files to the customs records based on an algorithm that matches firm names and contact information[9]. While imperfect, this procedure generates a large and representative sample. More details about the data will be shown in the Appendix.

Note that the transaction level data is only for import, but not for domestic purchases. Therefore when examining the predictions, I focus on firms' sourcing and inventory decisions for imports.

### 3.2 Measure of Financial Conditions

Following Manova and Yu (2016), I construct two standard balance sheet measures of firms' financial conditions. Liquidity ratio is the difference between current assets and current liabilities, scaled by total assets. It signals firms' availability of liquid capital. Leverage ratio is the ratio of current liabilities to current assets. Firms with higher leverage have more financial obligations outstanding in the short run and less freedom in managing cash flows or raising additional external capital.

Is it safe to expect firms with high liquidity ratio and low leverage ratio to be financially healthier

[6]Definition of intermediate input is from Broad Economic Categories Rev.5

[7]Since the data do not directly flag trade intermediaries, I follow standard practice and use keywords in firm names to identify them (Ahn et al. 2011).

[8]As Manova and Yu (2016) documents, pure assembly is also known as processing with foreign-client supplied materials. It refers to business activities in which the operating enterprise receives materials/parts from a foreign enterprise without needing to pay foreign exchange for the import, and carries out processing or assembling with the materials/parts as per the requirements of the foreign enterprise, only charging for the processing or assembling. Hence import for pure assembly is not necessarily associated with up-front costs for inputs.

[9]See Wang and Yu (2013) for a detailed description of the matching procedure.

and less constrained? With cross-sectional data, the answer is no. Because a firm with low debt may be financially constrained; while a firm with high debt ratio may have a strong borrowing capacity and hence not financially constrained. However using panel data and studying the time series of changes within a firm mitigates the problem. Improving liquidity ratio or declining leverage ratio for a firm is a signal for an improving financial condition, by assuming that the firm's borrowing capacity does not change dramatically, which is fair in a short panel.

### 3.3 Size and Frequency of Import Orders

In order to examining the predictions, it's important to find out from which countries firms can make small and frequent orders. Following Blum, Claro, Dasgupta, and Horstmann (2019), I run the regression below:

$$\#\text{Order}_{fvct} = \alpha + \gamma_c + \beta * \text{import}_{fvct} + \gamma_{fv} + \gamma_{ft} + \gamma_{vt} + \epsilon_{fvct} \tag{15}$$

The idea is that the number of orders a firm makes to import a product from a country is determined by (i) the import value; (ii) firm characteristics; (iii) product characteristics; (iv) sourcing country characteristics. The sourcing country characteristics reflects the average frequencies of import orders for all firms importing from that country, which is of interest. Therefore I control for other factors to isolate the effects of the sourcing country characteristics.

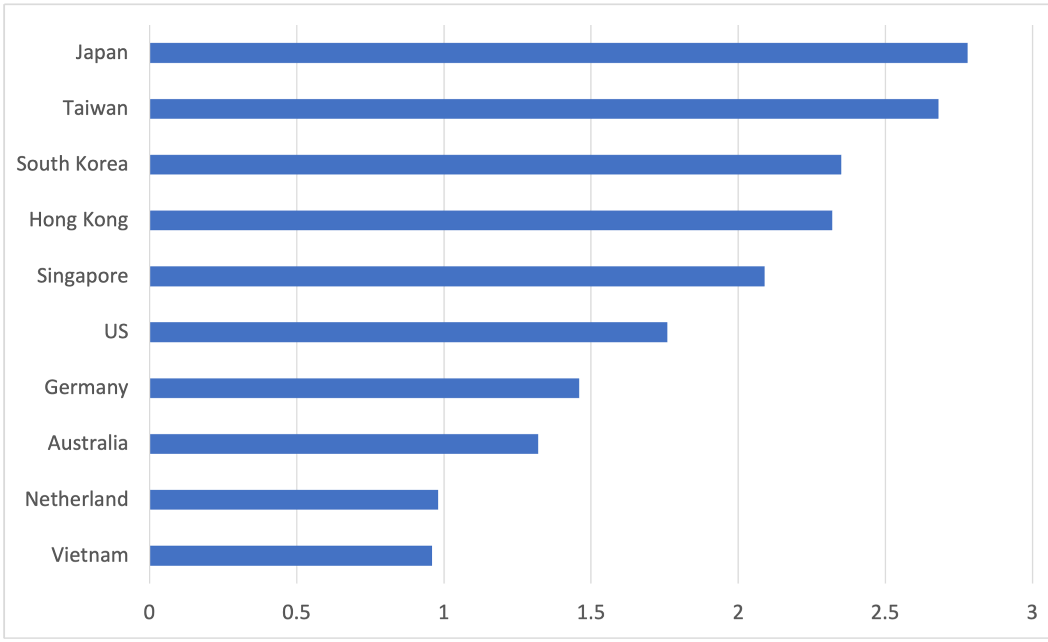
The dependent variable is the number of orders firm $f$ makes to import product $v$ from country $c$ in year $t$. The number of orders is measured by number of months in a year that the firm imports. On the right hand side I control for country fixed effect $\gamma_c$, which absorbs the sourcing country characteristics, reflecting the average number of orders from country $c$. Controlling for other factors, large values of $\gamma_c$ suggest that Chinese firms can make small and frequent orders from the country; $\text{import}_{fvct}$ refers to the import value in year $t$, since the more a firm imports, the higher the number of orders will be. I also control for firm-product fixed effect $\gamma_{fv}$, firm-year fixed effect $\gamma_{ft}$ and product-year fixed effect $\gamma_{vt}$, which absorb the firm and product characteristics[10]. The variable of interest is $\gamma_c$, the country fixed effect.

Figure 4 shows the ten highest values of country fixed effect in a descending order, among major trade partners of China. Japan, Taiwan, South Korea, Hong Kong and Singapore are the five countries with highest average number of orders, suggesting these countries have lower per-shipment fixed cost comparing to other countries and that Chinese firms make small and frequent orders from these coun-

[10] During the time windows of 2000-2006 China joined WTO. Fixed effects are needed to absorb the aggregate shocks.

tries. These five countries are all neighboring countries of China. I use neighboring countries to refer to these five countries hereforth.

Figure 4: Value of Country Fixed Effect




Note: this figure shows the ten highest values of country fixed effect in regression 15 in a descending order, among major trade partners of China. The x-axis represents the value of the country fixed effect and the y-axis lists the countries.

To confirm that the import orders from the neighboring countries are smaller and more frequent, next I compare the frequency and concentration of orders from neighboring and other countries with the following regression specification:

$$X_{fvct} = \alpha + \beta_1 * \text{Neighbor}_c + \beta_2 * \text{import}_{fvct} + \gamma_{fv} + \gamma_{ft} + \gamma_{vt} + \epsilon_{fvct} \tag{16}$$

The idea is similar to that of regression (15): controlling for other factors, I compared the difference in the average frequency and concentration of orders from neighboring and other countries. The dependent variable, $X_{fvct}$, is either (i) the number of orders firm $f$ imports variety $v$ from country $c$ in year $t$, measured by number of months in a year that the firm imports; or (ii) the concentration measured by

Herfindahl-Hirschman (HH) index. The HH index is defined as:

$$\mathrm{HH}_{fvct} = 100 * \sum_{i=1}^{12} s_i^2 \tag{17}$$

where $s_i$ is the share of annual import accounted for by the i-th month. The higher HH index is, the more concentrated the imports are, which means that firms make large and infrequent orders, and vice versa.

On the right hand side $\text{Neighbor}_c$ is a dummy variable which equals to one if the sourcing country is a neighboring country of China. It represents the differences in the average frequency and concentration of orders from neighboring and other countries. The variable $\text{import}_{fvct}$ refers to the import value in year $t$. I also control for firm-variety, firm-time and variety-time fixed effects.

Table 1 reports the results. Column (1) is the result for frequency. The number of orders from neighboring countries are significantly more than that from the rest of the world. Column (2) is the result for HH index, or the concentration of import. Same as the result for frequency, imports from neighbor countries are less concentrated. Together with column (1), the results suggest that **controlling for import values, when importing the same product, Chinese firms can make smaller and more frequent orders from neighboring countries, compared to the rest of the world.**

Why are the import orders from the neighboring countries smaller and more frequent comparing to those from other countries? Alessandria, Kaboski, and Midrigan (2010) documents that (i) trade costs that are not proportional to a shipment's size, including fixed transportation costs and the time and monetary costs of bureaucratic procedures of trade, and (ii) uncertainty caused by delivery lags explain the lumpiness of imports. Blum, Claro, Dasgupta, and Horstmann (2019) shows that the fixed costs of importing are positively correlated with distance between the two countries. Indeed the cost of shipping a standard container from the neighboring countries to China is much cheaper than that from other major trade partners of China, such as the US or European countries. Carreras Valle (2022) finds that longer delivery times are associated with higher delivery lags, causing higher uncertainty, and hence inducing larger and less frequent orders. The shipments from neighboring countries to China take just a few days by ocean, much faster than those from other major trade partners of China, such as the US or European countries, which on average take one month. As a result, Chinese firms face lower uncertainty due to delivery lags when importing from neighboring countries. Therefore the lower fixed transportation costs and uncertainty explain why the import orders from neighboring countries of China are smaller and more frequent.

Table 1: Frequency and Concentration of Import Orders and Import Sources

| | (1) Frequency | (2) HH Index |
|---|---|---|
| $\text{Neighbor}_c$ | 1.022*** | -1.1*** |
| $\text{Log}(\text{import}_{fcvt})$ | 2.325*** | -8.5*** |
| Observations | 11,821,158 | 11,821,158 |
| R-squared | 0.8046 | 0.8653 |
| Firm*Product FE | Y | Y |
| Firm*Time FE | Y | Y |
| Product*Time FE | Y | Y |

This table examines the differences in the average frequency and concentration of orders from neighboring countries and other countries of China. The unit of observation the firm-product-country-time. The dependent variable is the number of import orders measured by number of months of importing, or the concentration of import measured by the HH index, of firm f importing product v from country c in year t. Neighbor is a dummy variable which equals to 1 when importing from neighbor countries of China. Logarithm of import values is also controlled. All regressions include firm-product, firm-time and product-time fixed effects. Standard errors are clustered by firm.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

## 3.4 Suggestive Evidence

Next I support the three implications of the model with some suggestive evidence using the dataset described earlier.

**Suggestive Evidence 1: financially constrained firms tend to source from countries where they can make small and frequent orders.** Since import orders are small and frequent from the neighboring countries, I'm actually testing if financially constrained firms tend to source from neighboring countries. Consider a product whose optimal source of supply is the rest of the world. The model suggests that a financially constrained firm would first import from neighboring countries; but as the financial condition improves, the firm would switch to the optimal source, which is the rest of the world. Hence the identification strategy is to see if firms switch their sources of supply from neighboring countries to the rest of the world as their financial conditions improve[11]. I study the following regression specification:

[11] Of course if the optimal source of supply is neighbor countries, or the firm is financially unconstrained, the firm will not

$$\text{NB\_Share}_{fvt} = \alpha + \sigma_{fv} + \sigma_{vt} + \beta * Z_{f,t} + \gamma * \text{Financial}_{f,t-1} + \epsilon_{fvt} \tag{18}$$

where $f$ denotes for firm, $v$ for variety at HS 8-digit level and $t$ for year. The dependent variable, $NB\_share_{fvt}$, refers to the value share of variety $v$ imported from neighboring countries by firm $f$ in year $t$.

On the right hand size, I include firm-variety and variety-time fixed effects, and hence I study whether change in the characteristics lead continuing importing to switch their sources. Also note that China joined WTO during the period, the fixed effects can absorb the aggregate shocks. As for the independent variables, $Z_{f,t}$ refers to firm characteristics including capital, TFP[12] and experiences in importing. Following Manova and Yu (2016), financial condition of firms is proxied by two standard balance sheet measures: liquidity ratio and leverage ratio. By focusing on changes within a firm, higher liquidity ratio or lower leverage ratio implies better financial condition. I lag financial conditions with one year to alleviate concerns with reverse causality.

Table 2 reports the results. Column (1) and (2) suggest that firms that improve their financial conditions, i.e. with higher liquidity ratio or lower leverage ratio, tend to decrease their import share from neighbor countries, and switch to import from the rest of the world. Besides, as firms increase their import values of a variety, accumulate more capital, improve productivity or become more experienced in importing, they are more likely to import from the rest of the world. This suggests fixed costs associated with importing from the rest of the world and only large firms can do so.

Therefore, the regression results suggest that financial condition affects firms' sourcing decisions. Financially constrained firms tend to source from neighboring countries.

**Suggestive Evidence 2: When sourcing from the same country, more financially constrained firms make smaller orders.** Similarly the strategy is to check that importing a same product from a same country, controlling for import values, as financial conditions improve, if a firm would make larger and less frequent orders. I study the question with the following regression specification:

$$X_{fvct} = \alpha + \sigma_{fvc} + \sigma_{vct} + \beta * Z_{f,t} + \gamma * \text{Financial}_{f,t-1} + \epsilon_{fvct} \tag{19}$$

switch. These observations are like the noise in the data which may weaken the correlation between financial conditions and import share from neighbor countries.

[12] I use the Levinsohn and Petrin (2003) approach to construct measures of Chinese firm-level TFP.

Table 2: Financial Conditions and Neighbor Share

| | (1) | (2) |
|---|---|---|
| $\text{Liquidity}_{f,t-1}$ | -0.015** | |
| $\text{Leverage}_{f,t-1}$ | | 0.0040*** |
| $\text{Log}(\text{import}_{fcvt})$ | -0.0027*** | -0.0027*** |
| $\text{Log}(\text{capital}_{f,t})$ | -0.0073*** | -0.0072*** |
| $\text{TFP}_{f,t}$ | -0.0054** | -0.0054** |
| $\text{Experience}_{f,t}$ | -0.0011* | -0.0012* |
| Observations | 1,471,758 | 1,471,758 |
| R-squared | 0.915 | 0.915 |
| Firm*Product FE | Y | Y |
| Product*Time FE | Y | Y |

This table examines the relationship between firms' import shares from neighboring countries and financial conditions in the panel. The unit of observation the firm-product-time. The dependent variable is the value share of firm f's import of product v from neighboring countries in year t. Financial conditions are measured by liquidity ratio or leverage ratio. One period lag is taken to mitigate reversal causality. Other control variables include import value, capital, TPF and experiences in importing. All regressions include firm-product and product-time fixed effects. Standard errors are clustered by firm.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

The dependent variable, $X_{fvct}$, refers to the number of orders firm $f$ imports variety $v$ from country $c$ in year $t$, measured by number of months in a year that the firm imports; or is the concentration of import orders measured by Herfindahl-Hirschman (HH) index.

On the right hand size, I control for firm-variety-country and variety-country-time fixed effects. Hence I'm studying whether a change within firms lead to change in frequency and concentration of orders. The variable $Z_{f,t}$ refers to firm characteristics including import values, capital, TFP and experiences in importing. Financial health of firms is again proxied by the liquidity and leverage ratios.

Table 3 reports the results. Column (1) and (2) shows that when firms have worse financial conditions, i.e. higher leverage ratio or lower liquidity ratio, controlling for the import value, they make more frequent orders. I also find that as firms accumulate more capital, improve their productivity or become more experienced in importing, they import with fewer orders. Column (3) and (4) shows the results for concentration of import. Consistent with the frequency results, I find that when firms are in bad financial conditions, their concentration is low. Hence these results suggest that financially constrained firms make small and frequent import orders.

Table 3: Financial Conditions, Frequency and Concentration of Import Orders

| | (1) Frequency | (2) Frequency | (3) HH Index | (4) HH Index |
|---|---|---|---|---|
| $\text{Liquidity}_{f,t-1}$ | -0.390** | | 0.312*** | |
| $\text{Leverage}_{f,t-1}$ | | 0.092*** | | -0.028** |
| $\text{Log}(\text{import}_{fcvt})$ | 1.325*** | 1.325*** | -5.76*** | -5.76*** |
| $\text{Log}(\text{capital}_{f,t})$ | -0.317*** | -0.314*** | 0.331*** | 0.330*** |
| $\text{TFP}_{f,t}$ | 0.089** | 0.089** | -0.147* | -0.147* |
| $\text{Experience}_{f,t}$ | -0.045* | -0.051* | 0.334*** | 0.332*** |
| Observations | 2,494,514 | 2,494,514 | 2,494,514 | 2,494,514 |
| R-squared | 0.881 | 0.881 | 0.899 | 0.899 |
| Firm*Product*Country FE | Y | Y | Y | Y |
| Product*Country*Time FE | Y | Y | Y | Y |

This table examines the relationship between the frequency and concentration of import orders and the firms' financial conditions in the panel. The unit of observation the firm-product-country-time. The dependent variable is the number of import orders measured by number of months of importing, or the concentration of import measured by the HH index, of firm f importing product v from country c in year t. Financial conditions are measured by liquidity ratio or leverage ratio. One period lag is taken to mitigate reversal causality. Other control variables includes import value, capital, TPF and experiences in import. All regressions include firm-product-country and product-country-time fixed effects. Standard errors are clustered by firm.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

**Suggestive Evidence 3: Sourcing from countries where import orders are small and frequent is associated with lower inventory holdings.** Next I study the relationship between inventory holdings and the import share from neighboring countries. The ASIF dataset provides information on firms' inventory holdings of intermediate inputs. Since import orders from neighboring countries are small and frequent, higher import share from neighboring countries should be associated with lower inventory holdings. Following Alessandria, Kaboski, and Midrigan (2010), I study the following regression specification:

$$\begin{aligned}\text{Inv\_Ratio}_{f,t} = \alpha + \sigma_f + \sigma_t + \beta * Z_{f,t} + \gamma_1 * \text{Imp\_Share}_{f,t} \\ + \gamma_2 * \text{Imp\_Share}_{f,t} * \text{Imp\_Share\_NB}_{f,t} + \epsilon_{fvt}\end{aligned} \tag{20}$$

where $f$ denotes for firm, $t$ for year. The dependent variable is the inventory holding of intermediate inputs as a share total expenditure on intermediate inputs:

$$\text{Inv\_Ratio}_{f,t} = \frac{\text{Inventory}_{f,t}}{\text{Total Input}_{f,t}}$$

On the right hand side I control for firm and time fixed effect. The variable $Z_{f,t}$ refers to firm characteristics. I also control for the values of imported inputs as a share of total expenditure on intermediate inputs, and its cross-term with the value of imported inputs from neighbor countries as a share of total value of imported inputs:

$$\text{Imp\_Share}_{f,t} = \frac{\text{Imported Inputs}_{f,t}}{\text{Total Input}_{f,t}}, \qquad \text{Imp\_Share\_NB}_{f,t} = \frac{\text{Imported Inputs from Neighbor}_{f,t}}{\text{Imported Inputs}_{f,t}}$$

The cross term is the term of the interest. If importing from neighboring countries is associated with lower up-front costs, controlling for total import share, the more a firm imports from neighboring countries, the lower its inventory holdings will be. Hence we expect $\gamma_2$ to be negative.

Table 4 reports the results. I find a strong positive relationship between import share and inventory holdings, suggesting that firms using foreign inputs hold more inventories, which confirms the findings by Alessandria, Kaboski, and Midrigan (2010). While the cross term of import share and share from neighboring countries, is negative, implying that controlling for import share, the more a firm imports from neighboring countries, the lower inventory holdings will be. This is what the model predicts: import orders from neighboring countries are frequent and small, and hence firms hold lower inventory.

Table 4: Inventory and Neighbor Share

| | (1) |
|---|---|
| Import Share$_{f,t}$ | 0.205*** |
| $*$ Neighbor Share$_{f,t}$ | -0.054*** |
| Log(sale$_{f,t}$) | 1.1*** |
| Log(capital$_{f,t}$) | 1.09*** |
| TFP$_{f,t}$ | 0.74** |
| Age$_{f,t}$ | 0.017* |
| Export$_{f,t}$/Sale$_{f,t}$ | 0.416*** |
| Observations | 1,864,485 |
| R-squared | 0.830 |
| Firm FE | Y |
| Time FE | Y |

This table examines the relationship between the firms' inventory holdings as a fraction of total expenditure on intermediate inputs and the import share from neighboring countries in the panel. The unit of observation the firm-time. The dependent variable is the ratio of inventory holdings of inputs to total expenditure on the intermediate inputs. Import share refers to the share of inputs imported. Neighbor share refers to share of imported inputs from neighboring countries. Other control variables includes sale, capital, TFP, age and ratio of export to sale. All regressions include firm and time fixed effects. Standard errors are clustered by firm.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

# 4 Quantitative Analysis

In this section, I quantify the impact of financial frictions on this economy. To do so, I begin by estimating the parameters of the model to match key features of firm-level data. I then use the estimated model as a laboratory to study the impact of financial frictions on firms' sourcing decisions and aggregate variables.

## 4.1 Calibration

I consider a world with three countries and ($N = 3$): home, neighbor and the rest of the world (henceforth RoW). I interpret the length of the period as one month. To choose the parameters of the model, I begin by partitioning the parameter space into two groups. The first group consists of predetermined parameters set to standard values from the literature. The second group of parameters is estimated jointly following a simulated method of moments (SMM) approach to match key features of Chinese firms.

#### 4.1.1 Predetermined parameters

The set of standard predetermined parameters consists of $\alpha$ (the Cobb-Douglas parameter), $\beta$ (the discount parameter), $\sigma$ (the elasticity of substitution), $\delta$ (inventory depreciation), $\delta^e$ (firm exit rate) and $r$ (real interest rate). The Cobb-Douglas parameter $\alpha$ is set to 0.5, and the elasticity of substitution $\sigma$ is set to 5, as standard value in literature. Real interest rate $r$ is set to 0.2% to match the the average annual real interest rate in China over the period 2000-2006. The discount factor is thus set to 0.998. Following Alessandria, Kaboski, and Midrigan (2010), I choose the depreciation rate of inventory $\delta = 0.025$. The firm exit rate is set to 0.012 following Brandt et al. (2012). The predetermined parameter values are presented in Table 5.

Table 5: Predetermined Parameters

| Predetermined Parameters | | |
|---|---|---|
| Discount Factor | $\beta$ | 0.998 |
| Substitution Elasticity | $\sigma$ | 5 |
| Depreciation Rate | $\delta$ | 0.025 |
| Firm Exit Rate | $\delta^e$ | 0.01 |
| Cobb-Douglas Parameter | $\alpha$ | 0.5 |
| Interest Rate | $r$ | 0.2% |

#### 4.1.2 Parameters estimated via SMM

First I specify the distributions in the model. I assume the distribution of the demand shifter, $\Gamma_z$ is normal distribution $(0, s)$. I assume the sunk costs of switching sources of supply from country $j$ to country $k$, $\{f_{jk}^{\text{sunk}}\}$, has the following specification:

$$f_{jk}^{\text{sunk}} = \begin{bmatrix} f_{hh}^{\text{sunk}} & f_{hn}^{\text{sunk}} & f_{hr}^{\text{sunk}} \\ f_{nh}^{\text{sunk}} & f_{nn}^{\text{sunk}} & f_{nr}^{\text{sunk}} \\ f_{rh}^{\text{sunk}} & f_{rn}^{\text{sunk}} & f_{rr}^{\text{sunk}} \end{bmatrix} = \begin{bmatrix} 0 & \hat{f}_n^{\text{sunk}} & \hat{f}_r^{\text{sunk}} \\ 0 & 0 & \hat{f}_r^{\text{sunk}} \\ 0 & 0 & 0 \end{bmatrix}$$

where h, n and r refer to home, neighbor and RoW respectively. In the model I assume for new entrants the previous sources of supply are home. Since the only uncertainty is an exogenous exit shock, firms accumulates wealth. Once a firm switches to its optimal source of supply, it will never change. That's why I assume a zero cost for switching back because no firm will do so in equilibrium. I also assume that the sunk cost of switching from home to RoW is equal to that of switching from neighbor country to RoW.

The distribution of the per-shipment fixed costs, $\Gamma_f$, is discrete. I assume there are three types of firms in terms of per-shipment fixed costs:

| | Weight | Home | Neighbor | RoW |
|---|---|---|---|---|
| Type 1 | $\widehat{\omega}_1$ | 0 | $\infty$ | $\infty$ |
| Type 2 | $\widehat{\omega}_2$ | 0 | $\hat{f}_n$ | $\infty$ |
| Type 3 | $1-\widehat{\omega}_1-\widehat{\omega}_2$ | 0 | $\hat{f}_n$ | $\hat{f}_r$ |

Type 1 firm does not import and uses only the home input. I assume the per-shipment fixed cost from home is zero. This is in part because the data I have are only for international shipped products. Type 2 firms can use final goods from home or neighbor countries, and type 3 firms can use final goods from all three countries. The per-shipment fixed costs of importing from neighbor country and RoW are $\hat{f}_n$ and $\hat{f}_r$, and are the same for all the firms that import from the two countries. In the model I assume that the final goods from different sources are perfect substitutes. Hence without heterogeneous per-shipment fixed costs across firms, unconstrained firms will all source from the country that has the best price. This is not true in data as countries have comparative advantages in different products. Heterogeneous per-shipment costs can match this feature. For example, a Type 2 firm in the model that only imports from neighbor country, can be understood as a firm in the data that finds neighbor countries have comparative advantages in the products it imports and hence it will not import from RoW[13].

The set of parameters estimated via SMM consists of $s$ (standard deviation of the demand shifter), $\theta$ (borrowing limit), $a_0$ (initial asset), $P_N$ (price of final good from neighbor country), $P_R$ (price of final good from the rest of the world), $\{\hat{f}_n^{\text{sunk}}, \hat{f}_r^{\text{sunk}}\}$ (sunk costs of switching sources of supply) and $\{\hat{f}_n, \hat{f}_r, \hat{\omega}_1, \hat{\omega}_2\}$ (distribution of per-shipment fixed costs). I estimate them jointly, following the simulated method of

[13] I assume if a firm can source from RoW, it can also source from neighbor country. Under this assumption, if a firm cannot source from RoW, it may source from the neighbor country instead. This tend to lower estimate the welfare loss from financial frictions

moments, to minimize the objective function $MWM'$, where $W$ is the identity matrix and $M$ is a row vector whose elements are given by the squared difference between each target moment and its model counterpart.

I target the following moments of the data in 2005: [1] the ratio of the 75th to the 50th percentile from the distribution of sales; [2] the ratio between the average sales at age three and the average sales at age one, among new firms that survive for at least three years; [3] the ratio of import of inputs to gross output; [4] the ratio of import of inputs by firms above the 75th percentile from the distribution of sales to gross output; [5] the ratio of import of inputs from neighbor country to gross output; [6] the ratio of import of inputs from neighbor country by firms above the 75th percentile from the distribution of sales to gross output; [7] the fraction of firms that import; [8] the fraction of firms above the 75th percentile from the distribution of sales that import; [9] the regression coefficient $\beta_1$ in regression specification (16) (number of orders with respect to the dummy variable that if the import shipment is from neighbor countries); [10] the regression coefficient $\gamma_1$ in regression specification (20) (inventory holdings with respect to import share); and [11] the regression coefficient $\gamma_2$ in regression specification (20) (inventory holdings with respect to the cross-term of import share and fraction of import from neighbor country)[14].

While all the estimated parameters simultaneously affect all the target moments, I now provide a heuristic argument to map them to each other. The standard deviation $s$ shapes the distribution of the demand shifter, and hence determines the distribution of firms' revenue. The initial asset $a_0$ determines the speed of wealth accumulation and thus the ratio between the average sales at age three and one.

The prices of foreign final goods, $P_N$ and $P_R$, the sunk costs of switching sources of supply $\{f_{jk}^{\text{sunk}}\}$, and the distribution of per-shipment fixed cost $\Gamma_f$, jointly determine the trade moments. Especially the sunk costs of switching and the per-shipment fixed costs affect the difference between small and large firms directly. As will be explained later, the values of per-shipment fixed costs will be calibrated to match the regression coefficients on number of import orders and inventory holdings. Hence the sunk costs of switching will play a key role in matching those trade moments. In order to calibrate the borrowing limit $\theta$, I do not directly match moments like total credit. Instead I compare moments between small firms and large firms. The idea is that large firms are in general less financially constrained. Net of the effects of per-shipment fixed costs and the sunk costs of switching, the difference between small and large firms

[14]In the model, I assume that the per-shipment fixed costs from home country is zero, and hence the firms that do not import hold a quite low level of inventories, which is not consistent with data. Therefore, by targeting the regression coefficient on inventory holding, I am actually matching the difference in inventory holding between importers and non-importers.

reflects the impact of financial frictions.

In many ways the most important set of parameters to be specified are the per-shipment fixed costs, $\{\hat{f}_n, \hat{f}_r\}$. The per-shipment costs determine the frequency and size of import orders. Remember that large import orders are associated with high inventory holding. Therefore I use the model as a data generating process to replicate regressions specification (16) which compares number of orders from different sources by controlling for import values, and (20) which studies the relationship between inventory holdings, import share and fraction of import from neighbor countries. To do so, I simulate 1,000,000 firms for 84 periods at stationary equilibrium[15]. This generates an unbalanced panel data due to exit and entry. Details about the numerical algorithms will be shown in the Appendix.

To replicate regression specification (16), I study the following regression with simulated data:

$$X_{fct} = \alpha + \beta_1 * \text{Neighbor}_c + \beta_2 * \text{import}_{fct} + \beta_3 * \text{NetAsset}_{ft} + \gamma_f + \epsilon_{fct} \tag{21}$$

The dependent variable, $X_{fct}$, is the number of orders firm $f$ imports from country $c$ in year $t$. Note in the model each firm import only one product, and hence I drop the subscription $v$ for imported variety. On the right hand side $\text{Neighbor}_c$ is a dummy variable which equals to one if the source is neighbor country. $\text{import}_{fct}$ refers to the import value in year $t$. $\text{NetAsset}_{ft}$ is the average net worth in year $t$. I also control for firm fixed effects. At a stationary equilibrium there's no aggregate shock. As a result I do not include firm-time fixed effect like regression specification (16). However the firm-time fixed effect absorb a firm's financial condition. Hence here I control for the net worth, which is the measure for financial condition in the model. The coefficient $\beta_1$ is the target moment.

To replicate regression specification (20), I study the following regression with simulated data:

$$\begin{aligned} \text{Inv\_Ratio}_{f,t} = \alpha + \sigma_f + \beta * \text{NetAsset}_{ft} + \gamma_1 * \text{Imp\_Share}_{f,t} \\ + \gamma_2 * \text{Imp\_Share}_{f,t} * \text{Imp\_Share\_NB}_{f,t} + \epsilon_{fvt} \end{aligned} \tag{22}$$

The dependent variable is the yearly average inventory holding of intermediate inputs as a share of total expenditure on intermediate inputs. On the right hand side I control for firm and time fixed effects, and the annually average net worth. I also control for the values of imported inputs as a share of total expenditure on intermediate inputs, and its cross-term with the value of imported inputs from neighbor

[15] The data covers 2000-2006. One period in the model is interpreted as one month. Therefore I simulate 84 periods which is 7 years.

countries as a share of total value of imported inputs. The coefficient $\gamma_1$ and $\gamma_2$ are the target moment.

The values of parameters estimated via SMM are presented in Table 6. The values of moments in the model and data are given in Table 7. As observed in the table, the model can match the target moments closely.

Table 6: Parameters Estimated via SMM

| Parameters | | Value |
|---|---|---|
| Std of demand shifter | s | 1.35 |
| Borrowing limit | $\theta$ | 0.27 |
| Initial asset | $a_0$ | 0.08 |
| Price, Neighbor | $P_N$ | 0.91 |
| Price, ROW | $P_R$ | 0.85 |
| Sunk cost of Switching | $\{\hat{f}_n^{\text{sunk}}, \hat{f}_r^{\text{sunk}}\}$ | $\{0.42, 0.78\}$ |
| Per-shipment fixed cost | $\{\hat{f}_n, \hat{f}_r, \hat{\omega}_1, \hat{\omega}_2\}$ | $\{0.08, 0.19, 0.8, 0.07\}$ |

Table 7: Moments

| Moment | Data | Model |
|---|---|---|
| Sales p75/p50 | 2.5 | 2.5 |
| Average Sales (age 3/age 1) | 1.85 | 1.72 |
| Import/GO | 10.6% | 10.3% |
| Import (sale>p75)/GO | 9.3% | 8.5% |
| Import from Neighbor/GO | 5.1% | 5.0% |
| Import from Neighbor (sale > p75)/GO | 4.0% | 3.7% |
| Fraction of firms that import | 10% | 10.1% |
| Fraction of firms that import, sale>p75 | 19% | 20.2% |
| Regression: #orders on dummy neighbor | 1.022 | 1.4 |
| Regression: Inventory on import share | 0.205 | 0.31 |
| Regression: Inventory on import share cross neighbor share | -0.054 | -0.10 |

### 4.2 Counterfactual Analysis

Next I compare the baseline economy to counterfactual economies with either perfect credit market or with lower per-shipment fixed costs.

**Perfect Credit Market** In the model there are two frictions in the credit market: (1) firms can borrow up to a fraction $\theta$ of their net assets and (2) the net worth cannot be negative. Therefore with a perfect credit market, there's no borrowing limit and the net asset is constrained by the natural borrowing limit.

The model becomes a standard Baumol-Tobin inventory management model: given the per-shipment fixed costs and prices, firms choose their sources of supply just considering their demand shifter. The level of net worth no longer affects the sourcing decisions. This is an efficient equilibrium in that the sourcing decisions are no longer distorted by financial frictions. Given the interest in comparing the welfare implications between the economies, I keep all the other parameters unchanged.

Table 8: Counterfactual Analysis

| | (1) $\frac{Import}{Y}$ | (2) $\frac{Import_N}{Y}$ | (3) $\frac{Import_R}{Y}$ | (4) $\frac{\Delta Y}{Y}$ | (5) $\frac{\Delta C}{C}$ |
|---|---|---|---|---|---|
| Baseline | 10.3% | 5.0% | 5.3% | N/A | N/A |
| Perfect Credit Market | 16.0% | 6.4% | 9.6% | 7.2% | 7.4% |
| Lower Per-shipment Fixed Costs | 11.6% | 5.4% | 6.2% | 1.5% | 1.7% |

This table shows the results of the two counterfactual analysis. The variables of interest are the ratio of total imports to total output, the ratio of imports from neighboring countries to total outputs, the ratio of imports from RoW to total outputs, the percent change in total output and consumption. The first row shows the results of the baseline economy. The second row for the counterfactual economy with a perfect credit market, and the third row are an economy with lower per-shipment fixed costs from both neighbor and RoW.

Table 8 reports statistics for the counterfactual scenario where the credit market is perfect. By removing financial frictions, firms that do not import due to financial frictions will now source from foreign countries, and hence total imports as a fraction of gross output increases; financially constrained importers that were induced to source from neighbor country now can source from RoW, since the sourcing decisions are no longer distorted. The total imports as a fraction of gross output increases from 10.3% to 16.0%. The import from neighbor countries as a fraction of gross output increases from 5.0% to 6.4%, and the import from RoW as a fraction of gross output increases from 5.3% to 9.6%. The response of import from RoW is stronger because of the more severe distortion in the sourcing decisions of firms whose optimal sources of supply are RoW. Comparing to the baseline economy, the gross output increases by 7.2%, and consumption increases by 7.4%. The results confirm the findings in previous work that low financial development limits the gains from trade by reducing total imports, and highlight the effects of distortions on the sourcing decisions due to financial frictions.

The model suggests that by eliminating the financial frictions: (i) if a firm sources from the same country as the baseline economy with financial frictions, the firms now will make larger and less frequent orders; (ii) financially constrained firms that source from countries with low per-shipment fixed costs in the baseline economy will now source from their optimal sources of supply, and hence they will make larger and less frequent orders. These two points together imply a higher level of inventory holdings in an economy with perfect credit market. Indeed, the total inventory holdings of all firms increases by 5.2%.

**Lower Per-Shipment Fixed Costs** High per-shipment fixed costs are associated with large and infrequent import orders, causing high up-front costs, which impedes the access to imported inputs for firms with low demand shifter, and distorts the sourcing decisions of firms with low net asset. I consider a scenario where the per-shipment fixed costs from neighbor country and RoW both decrease by 10%. Table 8 reports statistics. The import from neighbor countries as a fraction of gross output increases from 5.0% to 5.4%, and the import from RoW as a fraction of gross output increases from 5.3% to 6.2%. Comparing to the baseline economy, the gross output increases by 1.5%, and consumption increases by 1.7%. Part of the increase in consumption is because the reduction in the per-shipment fixed costs increases firms' profit. The consumption increases by 1.5% if the total expenditure on per-shipment fixed costs were remain to the same as the baseline scenario.

The results suggest that lower per-shipment fixed costs allow access to imported inputs and mitigate the distortion in sourcing decisions. What is the nature of the per-shipment fixed costs? Alessandria, Kaboski, and Midrigan (2010) documents that the monetary and time cost of bureaucratic procedures that are not proportional to a shipment's size is an important component of the per-shipment fixed costs. According to the World Bank Doing Business Database, the costs of bureaucratic procedures of importing vary across countries, and are higher in developing countries. Hence policies that simplify the procedures and reduce the associated costs can increase the gains the trade.

## 5 Conclusion

Recent studies have documented that low financial development impedes the access to imported inputs and hence limits the gain from trade. However not only the level, but also the sources of imported inputs matters. In this paper, I investigate how financial frictions affect sourcing decisions of imported inputs. I set up a general equilibrium Baumol-Tobin inventory management model where heterogeneous firms pay for inputs before production and are subject to borrowing limits. The model implies that financial frictions distort firms' sourcing decisions by inducing firms to source from countries where they can make small and frequent orders. The impact of financial frictions on the gains from trade are two-fold: they reduce the total imports, and distort the sourcing decisions of importers. I then use Chinese firm-level data to validate the model. I find that the import orders from neighbor countries of China are small and frequent comparing to other countries, and that firms tend to source from neighbor countries when financially constrained. The counterfactual analysis show that a perfect credit market, or lower per-shipment fixed costs would significantly mitigate the distortion in sourcing decisions and facilitate the access to imported inputs. Therefore the results suggest that reforms aimed at improving firms' access to external finance, and policies aimed at simplifying import process and reducing fixed costs of importing, can increase the gains from trade.

## References


JaeBin Ahn, Amit K Khandelwal, and Shang-Jin Wei. The role of intermediaries in facilitating trade. *Journal of International Economics*, 84(1):73–85, 2011.

George Alessandria and Horag Choi. Establishment heterogeneity, exporter dynamics, and the effects of trade liberalization. *Journal of International Economics*, 94(2):207–223, 2014.

George Alessandria, Joseph P Kaboski, and Virgiliu Midrigan. Inventories, lumpy trade, and large devaluations. *American Economic Review*, 100(5):2304–2339, 2010.

Mary Amiti and Jozef Konings. Trade liberalization, intermediate inputs, and productivity: Evidence from indonesia. *American Economic Review*, 97(5):1611–1638, 2007.

Pol Antras, Teresa C Fort, and Felix Tintelnot. The margins of global sourcing: Theory and evidence from us firms. *American Economic Review*, 107(9):2514–2564, 2017.

David Aristei and Chiara Franco. The role of credit constraints on firms' exporting and importing activities. *Industrial and Corporate Change*, 23(6):1493–1522, 2014.

Gabor Bekes, Lionel Fontagné, Balázs Muraközy, and Vincent Vicard. Shipment frequency of exporters and demand uncertainty. *Review of World Economics*, 153:779–807, 2017.

Joaquin Blaum et al. Importing, exporting and aggregate productivity in large devaluations. *Unpublished Manuscript, Brown University*, 2017.

Bernardo S Blum, Sebastian Claro, Kunal Dasgupta, and Ignatius J Horstmann. Inventory management, product quality, and cross-country income differences. *American Economic Journal: Macroeconomics*, 11(1):338–388, 2019.

Loren Brandt, Johannes Van Biesebroeck, and Yifan Zhang. Creative accounting or creative destruction? firm-level productivity growth in chinese manufacturing. *Journal of development economics*, 97(2): 339–351, 2012.

Wyatt Brooks and Alessandro Dovis. Credit market frictions and trade liberalizations. *Journal of Monetary Economics*, 111:32–47, 2020.

Francisco J Buera and Benjamin Moll. Aggregate implications of a credit crunch: The importance of heterogeneity. *American Economic Journal: Macroeconomics*, 7(3):1–42, 2015.

Francisco J Buera and Yongseok Shin. Self-insurance vs. self-financing: A welfare analysis of the persistence of shocks. *Journal of Economic Theory*, 146(3):845–862, 2011.

Francisco J Buera, Joseph P Kaboski, and Yongseok Shin. Finance and development: A tale of two sectors. *American economic review*, 101(5):1964–2002, 2011.

Andrea Caggese and Vicente Cuñat. Financing constraints, firm dynamics, export decisions, and aggregate productivity. *Review of Economic Dynamics*, 16(1):177–193, 2013.

Maria Jose Carreras Valle. Essays on trade under uncertainty. 2022.

Thomas Chaney. Liquidity constrained exporters. *Journal of Economic Dynamics and Control*, 72: 141–154, 2016.

Jan De Loecker, Pinelopi K Goldberg, Amit K Khandelwal, and Nina Pavcnik. Prices, markups, and trade reform. *Econometrica*, 84(2):445–510, 2016.

Quy-Toan Do and Andrei A Levchenko. Comparative advantage, demand for external finance, and financial development. *Journal of Financial Economics*, 86(3):796–834, 2007.

Jonathan Eaton and Samuel Kortum. Technology, geography, and trade. *Econometrica*, 70(5):1741–1779, 2002.

Jonathan Eaton, Samuel Kortum, and Francis Kramarz. An anatomy of international trade: Evidence from french firms. *Econometrica*, 79(5):1453–1498, 2011.

Robert C Feenstra, Zhiyuan Li, and Miaojie Yu. Exports and credit constraints under incomplete information: Theory and evidence from china. *Review of Economics and Statistics*, 96(4):729–744, 2014.

Teresa C Fort. Technology and production fragmentation: Domestic versus foreign sourcing. *The Review of Economic Studies*, 84(2):650–687, 2017.

Pinelopi Koujianou Goldberg, Amit Kumar Khandelwal, Nina Pavcnik, and Petia Topalova. Imported intermediate inputs and domestic product growth: Evidence from india. *The Quarterly journal of economics*, 125(4):1727–1767, 2010.

Gita Gopinath and Brent Neiman. Trade adjustment and productivity in large crises. *American Economic Review*, 104(3):793–831, 2014.

László Halpern, Miklós Koren, and Adam Szeidl. Imported inputs and productivity. *American Economic Review*, 105(12):3660–3703, 2015.

Elhanan Helpman, Marc Melitz, and Yona Rubinstein. Estimating trade flows: Trading partners and trading volumes. *The quarterly journal of economics*, 123(2):441–487, 2008.

Cecília Hornok and Miklós Koren. Per-shipment costs and the lumpiness of international trade. *Review of Economics and Statistics*, 97(2):525–530, 2015.

Aubhik Khan and Julia K Thomas. Credit shocks and aggregate fluctuations in an economy with production heterogeneity. *Journal of Political Economy*, 121(6):1055–1107, 2013.

David Kohn, Fernando Leibovici, and Michal Szkup. Financial frictions and international trade: A review. *Oxford Research Encyclopedia of Economics and Finance*, 2022.

David Kohn, Fernando Leibovici, and Michal Szkup. No credit, no gain: Trade liberalization dynamics, production inputs, and financial development. *International Economic Review*, 2023.

Andreas Kropf and Philip Sauré. Fixed costs per shipment. *Journal of International Economics*, 92(1): 166–184, 2014.

Fernando Leibovici. Financial development and international trade. *Journal of Political Economy*, 129 (12):3405–3446, 2021.

James Levinsohn and Amil Petrin. Estimating production functions using inputs to control for unobservables. *The review of economic studies*, 70(2):317–341, 2003.

Kalina Manova. Credit constraints, equity market liberalizations and international trade. *Journal of International Economics*, 76(1):33–47, 2008.

Kalina Manova. Credit constraints and the adjustment to trade reform. *Trade adjustment costs in developing countries: Impacts, determinants, and policy responses*, pages 315–329, 2010.

Kalina Manova. Credit constraints, heterogeneous firms, and international trade. *Review of Economic Studies*, 80(2):711–744, 2013.

Kalina Manova and Zhihong Yu. How firms export: Processing vs. ordinary trade with financial frictions. *Journal of International Economics*, 100:120–137, 2016.

Marc J Melitz. The impact of trade on intra-industry reallocations and aggregate industry productivity. *econometrica*, 71(6):1695–1725, 2003.

Virgiliu Midrigan and Daniel Yi Xu. Finance and misallocation: Evidence from plant-level data. *American economic review*, 104(2):422–458, 2014.

Benjamin Moll. Productivity losses from financial frictions: Can self-financing undo capital misallocation? *American Economic Review*, 104(10):3186–3221, 2014.

Mirabelle Muûls. Exporters, importers and credit constraints. *Journal of International Economics*, 95 (2):333–343, 2015.

Nina Pavcnik. Trade liberalization, exit, and productivity improvements: Evidence from chilean plants. *The Review of economic studies*, 69(1):245–276, 2002.

B Ravikumar, Ana Maria Santacreu, and Michael Sposi. Capital accumulation and dynamic gains from trade. *Journal of International Economics*, 119:93–110, 2019.

Kim J Ruhl and Jonathan L Willis. New exporter dynamics. *International Economic Review*, 58(3): 703–726, 2017.

Petia Topalova and Amit Khandelwal. Trade liberalization and firm productivity: The case of india. *Review of economics and statistics*, 93(3):995–1009, 2011.

Zheng Wang and Zhihong Yu. Trading partners, traded products and firm performances of china's exporterimporters: Does processing trade make a difference? *The World Economy*, pages 165–193, 2013.

Miaojie Yu. Processing trade, tariff reductions and firm productivity: Evidence from chinese firms. *The Economic Journal*, 125(585):943–988, 2015.

# Appendices

## Appendix A: Data

### Firm-level Production Data: the Annual Survey of Industrial Firms

The sample is derived from a rich firm-level panel data set that covers between 162,885 firms (in 2000) and 301,961 firms (in 2006). The data are collected and maintained by China's National Bureau of Statistics (NBS) in an annual survey of manufacturing enterprises. Complete information on the three major accounting statements (i.e. balance sheet, profit and loss account, and cash flow statement) is available. In brief, the data set covers two types of manufacturing firms – all state-owned enterprises (SOEs) and non-SOEs whose annual sales exceed RMB 5 million ($770,000). The data set includes more than 100 financial variables listed in the main accounting statements of these firms.

Following Yu (2015), I clean the sample and omit outliers by using the following criteria. First, observations with missing key financial variables (such as total assets, net value of fixed assets, sales and gross value of the firm's output productivity) are excluded. Second, I drop firms with fewer than eight workers as they fall under a different legal regime, as mentioned in Brandt et al. (2012).

Following Feenstra et al. (2014), I delete observations according to the basic rules of the Generally Accepted Accounting Principles (GAAP) if any of the following are true: (i) liquid assets are greater than total assets; (ii) total fixed assets are greater than total assets; (iii) the net value of fixed assets is greater than total assets; (iv) the firm's identification number is missing; (v) an invalid established time exists (e.g. the opening month is later than December or earlier than January).

### Shipment Level Trade Data: the Chinese Customs Trade Statistics

The HS 8-digit product level trade transaction data are obtained from China's General Administration of Customs. It records a variety of information for each trading firm's product list, including trading price, quantity and value at the HS eight-digit level. More importantly, this rich data set not only includes both import and export data but also breaks down the data into several specific types of processing trade, such as processing with assembly and processing with inputs. This is important for the empirical analysis. As Manova and Yu (2016) documents, pure assembly is also known as processing with foreign-client supplied materials. It refers to business activities in which the operating enterprise receives materials/parts from a foreign enterprise without needing to pay foreign exchange for the import, and carries out processing or assembling with the materials/parts as per the requirements of the foreign enterprise, only charging for the processing or assembling. Hence import for pure assembly is not necessarily associated with up-front costs for inputs. To study firms' financial conditions and imports, I need to exclude imports for pure assembly.

Table 9 reports a simple statistical summary for Chinese product-level trade data by shipment and year for 2000–2006. Overall, when focusing on the highly disaggregated HS eight-digit level, process imports for pure assembly takes a small fraction in terms of both number of observations and import value.

Table 9: Chinese Transaction-level Trade Data Statistics

| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | Total |
|---|---|---|---|---|---|---|---|---|
| *Percentage of number of observations (HS eight-digit)* | | | | | | | | |
| Ordinary imports | 2.57 | 3.54 | 3.77 | 5.17 | 6.04 | 6.8 | 7.3 | 35.19 |
| Processing imports with assembly | 2.46 | 2.72 | 2.37 | 2.59 | 2.77 | 2.79 | 2.77 | 18.47 |
| Processing imports with inputs | 3.9 | 4.14 | 3.57 | 4.67 | 5.33 | 5.74 | 5.61 | 32.95 |
| Other types of processing imports | 1.42 | 1.55 | 1.7 | 1.71 | 2.03 | 2.24 | 2.77 | 13.4 |
| Total | 10.34 | 11.95 | 11.41 | 14.13 | 16.16 | 17.57 | 18.44 | 100 |
| *Percentage of import value* | | | | | | | | |
| Ordinary imports | 3.12 | 3.87 | 3.71 | 5.87 | 7.74 | 8.86 | 10.46 | 43.64 |
| Processing imports with assembly | 0.87 | 0.98 | 0.98 | 1.22 | 1.68 | 2.11 | 2.31 | 10.16 |
| Processing imports with inputs | 2.02 | 2.21 | 2.39 | 3.87 | 5.24 | 6.52 | 7.15 | 29.4 |
| Other types of processing imports | 1.01 | 1.24 | 1.43 | 1.93 | 2.85 | 3.35 | 4.99 | 16.8 |
| Total | 7.02 | 8.3 | 8.52 | 12.89 | 17.51 | 20.85 | 24.91 | 100 |

### Merged Data Set

Following Wang and Yu (2013), I use two methods to match the two data sets by using other common variables. First, I match the two data sets by using each firm's Chinese name and year. That is, if a firm has an exact Chinese name in both data sets in a particular year, it should be the same firm. To increase the number of qualified matching firms as much as possible, I then use two other common variables to identify the firms: postal code and the last seven digits of the firm's phone number.

However, some of the observations need to be excluded. Since I'm interested in firms' import decisions for production, I restrict the sample to firms' import transactions of intermediate inputs. The definition of intermediate input is from Broad Economic Categories Rev.5. In the customs data set, some Chinese firms do not have their own production activity but only export goods collected from other domestic firms or import goods from abroad and then sell them to other domestic companies. To ensure the preciseness of the estimates, I exclude such trading companies from the sample in all the estimates. In particular, firms with names including any Chinese characters for Trading Company or Importing and Exporting Company are excluded from the sample. I also exclude import transactions for pure assembly.

## Appendix B: Numerical Algorithm

The firms' problem in a stationary equilibrium can be concisely summarized by the following system of two functional Bellman equations: $V(s,n,c;\Theta) = \max\{V^A(s,n,c;\Theta), V^N(s,n,c;\Theta)\}$. The algorithm iterates on the value functions until converge. I discretize endogenous state variable, inventory holdings, $s$ and net worth $n$ into finite grid. I use 90-grid points for $s$, and 60-grid points for $n$. As mentioned in the Quantitative Analysis, the previous source of supply, $c$ takes three values: Home, Neighbor and RoW. The exogenous state variable, $\Theta$, includes demand shifter and vector of per-shipment fixed costs of sourcing from countries. The demand shifter is drawn from a normal distribution to $(0, s)$, which is discretized into 15 bins with equal probabilities. The vector of per-shipment fixed costs are drawn from the distribution specified in the Quantitative Analysis.

When solving for the firms' problem, I take all prices as given. In particular, I assume the demand function of the intermediate good firms are

$$y_{i,t} = e^{z_i}(p_{jt})^{-\sigma}$$

That is I normalize $P^{\sigma}_{m,t}Y_{m,t}$ to one. With this assumption, I can solve for each intermediate good firm's price, and then calculate the CES price index, $P_{m,t}$. Remember I set the home final good as numeraire. I just need to choose the total labor supply, $L$, which determines wage, to guarantee that the price of home final good equals to one.

When solving the value functions, first I set initial guess for $V(s,n,c;\Theta)$, $V^A(s,n,c;\Theta)$ and $V^N(s,n,c;\Theta)$. Then with given state variables I find the optimal solution for $V^A(s,n,c;\Theta)$ and $V^N(s,n,c;\Theta)$, and then update $V(s,n,c;\Theta)$. Iterate until converge.

Note that there are two assets in the state variables, inventory $s$ and net worth $n$. It is very costly to simply scan over the state space. I simplify the process with the following methods. First, remember that due to the borrowing limit, firms with low net worth always make small orders. Hence when sourcing from the same country, conditional on making a new order, with higher value of net worth, firms will always choose a higher level of inventory for next period. Second, conditional on not making a new order, with same level of inventory, firms with lower net worth will always set lower prices and sell more. This is because for financially constrained firms, the marginal value of net worth is higher. Third, as mentioned in the model, since the only uncertainty is exogenous exit, continuing firms are keeping accumulating net worth. Once a firm source from its optimal source of supply, it will never switch back. If in an iteration a firm with state variable $(s_0, n_0, c_0; \Theta_0)$ chooses to source from a country, then another firm with $(s_1, n_1, c_0; \Theta_0)$ where $s_1 \geq s_0$ and $n_1 \geq n_0$ will always choose to source from the same country, or a new country with even lower unit price but higher per-shipment fixed cost.

After solving the firms' problem, I do simulation with the policy functions. I simulate with 1,000,000 firms, with initial net worth equals to $a_0 = 0.08$, initial inventory equals to zero, initial source of supply defined as Home, and exogenous type drawn from the distribution. Then firms operate following the value functions. In each period a fraction $\delta^e$ of firms exit, with their inventories gone and net worth transferred to the households. Meanwhile same number of firms enters with the same initial setting. I keep iterating until I get a stationary distribution for the endogenous state variables, inventory $s$ and net worth $n$. Thus I get a stationary equilibrium.

However when doing counterfactual analysis, I cannot choose labor supply to normalize $P^{\sigma}_{m,t} Y_{m,t}$ to one. Instead I search for the values of $P^{\sigma}_{m,t} Y_{m,t}$ for given labor supply, which will be more complicated computationally.