Three Essays on Firms’ Behavior in International Trade

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Submitted in partial fulfillment of the Requirements for the degree of Doctor of Philosophy in the Graduate School of Arts and Sciences

COLUMBIA UNIVERSITY

2011
ABSTRACT

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Chapter 1 examines how trade finance may help explain the great trade collapse. The financial crisis of 2008-2009, the most severe world macroeconomic shock since the Great Depression, brought about a much more dramatic collapse in trade relative to GDP. This is called the "great trade collapse". I begin by exploring the differences between international and domestic trade finance. In particular, I endogenize the relative riskiness of international and domestic trade finance loans, and show why a letter of credit is used exclusively for international trade. The model explains the role of trade finance in the recent great trade collapse through two mechanisms: first, the riskiness of international transactions increases relative to domestic transactions during economic downturns, and second, international trade finance is more sensitive to adverse loan supply shocks than domestic trade finance. Both lead to larger drops in trade than domestic output during a recession. In addition, the exclusive use of a letter of credit in international transactions exacerbates a collapse in trade during a financial crisis. The basic model considers banks’ optimal screening decisions in the presence of counterparty default risks. In equilibrium, banks will maintain a higher precision screening test for domestic firms and a lower precision
screening test for foreign firms, which constitutes the main mechanism for the aforementioned results. In Chapter 2, I re-evaluate conventional wisdom in the literature that inward Foreign Direct Investment (FDI) benefits a host country, by increasing the competitive pressure and reducing inefficiency in the local industry. Such pro-competitive aspects of FDI are countered by the concern that the emergence of foreign firms crowds out local firms. This paper uses a heterogenous firms model to examine the pro-competitive channel through which FDI affects national welfare. Symmetric FDI liberalization improves net welfare across both participating countries. Breaking down the effects of FDI into source- and host-country, the country from which the FDI originates experiences a welfare gain following liberalization. However, a counterintuitive finding is that the welfare of the host country falls. This is explained by the production relocation process that leads to an increase in the mass of domestic firms in the source country and a decrease in the host country. In the long run, welfare losses from a decrease in the mass of domestic firms outweigh welfare gains from a price reduction from FDI goods in the host country. Chapter 3, joint work with Professor Amit Khandelwal and Professor Shang-Jin Wei from Columbia Business School, documents that intermediaries play an important role in facilitating international trade. We modify a heterogeneous firm model to allow for an intermediary sector. The model predicts that firms will endogenously select their mode of export—either directly or indirectly through an intermediary—based on productivity. The model also predicts that intermediaries will be relatively more important in markets that are more difficult to penetrate. We provide empirical confirmation for these predictions using the firm-level census of China’s trade, and generate new facts regarding the activity of intermediaries. We also provide evidence that firms begin to export directly after exporting through intermediaries.
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\(^1\)This chapter is joint work with Professor Amit Khandelwal and Professor Shang-Jin Wei from Columbia Business School. This chapter is published in *Journal of International Economics* 84(1), May 2011.
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Chapter 1

A Theory of Domestic and International Trade Finance

1.1 Introduction

Exchange takes time. For example, when a seller receives a purchase order that stipulates payment after delivery, the seller has to produce and ship a product before the buyer pays. This requires financing over short horizons because the seller may need to borrow working capital to complete the order or may purchase credit insurance to protect against counterparty defaults. That is the essence of trade finance.\(^\text{1}\) It is often described as the lifeline of business transactions because more than 90% of transactions involves some form of credit, insurance or guarantee (International Trade Center, 2009). It was, however, not until the recent financial crisis that trade finance came to the attention of academic researchers.

\(^\text{1}\)In general, trade finance refers to any type of financing that uses trade credit (i.e., accounts receivable) as collateral. This paper defines international trade finance only as a letter of credit and working capital financing for international transactions, opposed to domestic trade finance defined as working capital financing for domestic transactions. The main result of the model will be readily extended to other types of trade finance facilities (e.g., export credit insurance) by introducing risk averse agents.
since the Great Depression. During the crisis period, the collapse of international trade was much swifter and greater than the decline of GDP: world GDP fell by about 5%, while world trade contracted by about 30% (Baldwin, 2009). Similarly, while U.S. GDP in this period also contracted by 3.8%, U.S. trade contracted much more sharply, by around 20% (Levchenko, Lewis, and Tesar, 2010).

This "great trade collapse" has been the motivation for a variety of theoretical and empirical exercises seeking to account for the much more dramatic collapse in trade relative to GDP. These include product composition effects (Levchenko et al., forthcoming), inventory adjustment (Alessandria, Kaboski, and Midrigan, 2010), vertical integration effects (Bems, Johnson, and Yi, 2010), and other demand factors (Eaton, Kortum, Neiman, and Romalis, 2011). This asymmetric response of trade relative to GDP has also led economists to suspect that trade finance had a role. This paper presents the first theory model that answers the question, "What is the specific role of trade finance in explaining the great trade collapse?"

There are good reasons for thinking that trade finance may be an important part of the story. Growing evidence suggests that international trade finance experienced severe adverse effects in terms of price as well as availability during the same period. The IMF-BAFT survey reports that approximately 90% of the banks raised the price of international trade finance facilities at the onset of the great trade collapse (Dorsey, 2009), and in some cases the price of letters of credit jumped from 10~15 basis points to 250~500 basis points above LIBOR (Auboin, 2009). Banks in emerging markets also reported that international trade finance transactions declined by 6% on average during the period. Behind the evidence lies the hypothesis that international trade finance is more sensitive to economic fluctuation or financial crisis than domestic trade finance (e.g., Chauffour and Farole, 2009).

(2011) report that export price increased by 2.5~6% relative to domestic price in European Union countries, Japan and the U.S. These facts are strong evidence that supply shocks played an important role in the great trade collapse.

This view is supported by various empirical studies. For example, Amiti and Weinstein (forthcoming), using the uniquely matched database between Japanese listed firms and their main banks, find that firms contract export/domestic sales ratio when their main banks become unhealthier, and such a pattern is stronger for smaller firms, non-multinational firms, and industries that export primarily by sea. Iacovone and Zavacka (2009) provide the historical evidence that exports in financially vulnerable sectors were hit harder during banking crises. For the recent global recession period, Chor and Manova (2010) confirm that trade finance is indeed a critical factor for trade activity by showing that countries experiencing higher growth in inter-bank loan rates tend to decrease exports to the U.S. even more, and this is more pronounced in financially dependent sectors. Firm level studies also report that financially constrained firms had greater adverse impacts on exports during this period (Bricongne, Fontagné, Gaulier, Taglioni, and Vicard, 2010; Paravisini, Rappoport, Schnabl, and Wolfenzon, 2010), and U.S. inter-firm trade (i.e., trade with payment default risk) with Asian countries declined more sharply than intra-firm trade (i.e., trade with no payment default risk) during the Asian crisis period (Bernard, Jensen, Redding, and Schott, 2009).

Despite the ample empirical evidence, there is a lack of theoretical foundation for understanding the nature of trade finance. In particular, there is no theoretical model in which the asymmetric structure, domestic versus international, of trade finance has been derived from first principles. That is what the current paper achieves. This paper contributes to the literature by examining how international trade finance reacts differently than domestic trade finance during crisis periods. To answer the question, the paper begins with a more fundamental question of what makes interna-

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2 In contrast, Behrens, Corcos, and Mion (2010) find no such evidence from Belgian firms.
tional trade finance different from domestic trade finance, and then shows how such
difference leads to the great trade collapse.

The mechanics of this paper are very straightforward. International trade is
more costly than domestic trade, hence the volume of international transactions will
be smaller than domestic transactions. Firms borrow from local banks. Banks need
to gather information about whether loans will be repaid. They need not only worry
about the firm they loan to, but also any other firms on whose solvency repayment
depends. Banks invest more in learning about firms with which they have a larger
volume of transactions, which in turn makes them more knowledgeable about these
firms. Since banks have larger transactions with domestic than foreign firms, they
will also be more knowledgeable about them. This makes international trade finance
loans riskier than domestic finance loans. When a crisis hits, information becomes
more important because a crisis raises uncertainty about firms’ performance. Having
accumulated less information, banks become disproportionately more uncertain about
foreign than domestic firms. At the same time, having more information gives priority
to a domestic trade finance loan. When a crisis brings adverse loan supply shocks,
banks will cut international trade finance loans first. Thus, an international trade
finance loan is more sensitive to a crisis. As a result, the relative price of export
to domestic goods will rise, and the volume of international transactions will drop
more sharply than the volume of domestic transactions during a crisis. The following
describes this mechanism in more detail.

The basic model incorporates payment systems used for business transactions.
When payment is made by a buyer after delivery (i.e., open account system), a sup-
plier is exposed to non-payment risk from the buyer. As a result, if the supplier
borrowed working capital from a bank, the loan performance depends not only on the
supplier’s credit risk but also on the buyer’s credit risk. Likewise, when a buyer makes
advance payment to a supplier (i.e., cash-in-advance system), the buyer is subject to
non-delivery risk from the supplier. If a bank provided the advance payment, the
loan repayment is contingent on the successful performance of both the supplier and the buyer. From the banks’ perspective, therefore, it becomes a serious concern to evaluate such creditworthiness of both borrowers and their trading partners to insure loan repayment.

Banks assess this overall transaction risk through screening tests for the borrower’s trading partner as well as the borrower. By investing in information acquisition, banks can improve the precision levels of screening tests, and hence the loan repayment probability of the transactions that pass the screening tests. The optimal precision levels of screening tests are determined by comparing costs and benefits. When screening tests are domestic or foreign firm specific, marginal gains from improving the screening test for domestic firms is proportional to the volume of domestic transactions, and the same is true for the foreign screening. All else being equal, since costly trade results in a larger volume of domestic transactions than international transactions, banks will maintain a higher precision level of screening test for domestic firms than foreign firms. Accordingly, the screening of foreign firms yields a less accurate outcome than domestic screening, making international transactions a relatively higher risk with lower loan repayment probability. Therefore, costs of financing international transactions will be higher, i.e., trade finance premium.

To be more specific, suppose that there are two types of firms: good firms that never default and bad firms that are subject to default risk. Screening tests help banks distinguish good firms from bad firms. A higher precision screening will include a lower share of bad firms among the firms passing the screening test, and hence a lower average loan default rate. Since international transactions are typically smaller

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3The screening technology adopted in this paper follows closely the ones developed in banking literature. Broecker (1990) introduced this particular form of technology in the context of inter-bank competition in credit markets. Flannery (1996) also modeled an identical type of screening test to show the possibility of loan market failure due to an increase in uncertainty during a financial crisis. Freixas and Holthausen (2004) incorporate the screening test into the inter-bank loan market. Hauswald and Marquez (2003, 2006) use the framework to study banks competition through information acquisition. Unlike them, this paper explores the cyclical property of the screening test and endogenizes its precision level.
than domestic transactions, banks endogenously invest less in screening foreign firms. Therefore, international transactions are riskier, and as a result, the model generates a trade finance premium.

Moreover, the resulting trade finance premium features a counter-cyclical movement. Suppose further that the default risk of bad firms increases during a recession. Although an increase in the default risk will raise the average default rate of firms that passed either screening test, the default rate will rise relatively more for the less precisely screened foreign firms. This is simply because an inferior foreign screening is more sensitive to the changes in the default risk due to a larger share of bad firms among the firms passing the screening test. That is, during a recession, the average default rate for international transactions increases relatively more than the one for domestic transactions, as do the cost of financing international transactions. Once the costs of financing pass through to the final goods price, an elastic demand dictates that a fall in trade will dominate a fall in output through the price channel, generating pro-cyclical export to output ratio consistent with empirical patterns.\(^4\)

The asymmetric nature of the screening tests for domestic and foreign firms gives rise to a letter of credit system exclusively for international transactions.\(^5\) Under a letter of credit system, both a buyer’s bank and a supplier’s bank participate in the transaction as intermediaries. The buyer’s bank promises to pay the supplier’s bank on behalf of the buyer as long as the goods are delivered from the supplier, and the supplier’s bank guarantees to pay the supplier whether the buyer’s bank actually pays or not. From the view of the supplier’s bank, this essentially switches the non-payment risk from the buyer to the buyer’s bank, and thus can replace an inferior screening test for foreign firms by the supplier’s bank with a superior screening test.

\(^4\)The excess sensitivity of trade relative to domestic output has long been a well-established phenomenon (Engel and Wang, 2011). Most recently, Freund (2009) documents the historical evidence that trade is more responsive to GDP during global downturns.

\(^5\)According to the Society for Worldwide Interbank Financial Telecommunication (SWIFT), nearly 90% of letters of credit transactions are cross-border transactions (ICC, 2010).
for domestic firms by the buyer’s bank. This is the gain from using a letter of credit system for international transactions. At the same time, however, since the supplier’s bank has only limited, imperfect information on the credit risk of the buyer’s bank, it incurs additional inter-bank informational friction. As long as the gains from a letter of credit outweigh the costs, a letter of credit would be chosen as the optimal payment system for the international transaction. On the other hand, this will not be true for domestic transactions because it only incurs additional costs without any gains.

The inter-bank dimension inherent in a letter of credit system provides another channel that adversely affects international trade during a recession or financial crisis. An increase in the bank default risk worsens the informational friction between banks, leading to a higher price charged on a letter of credit. Since the model shows that a letter of credit can be used only for international transactions, such an additional adverse effect is thus unique to international transactions.

In addition to the price channel effect and a letter of credit effect just described, the model also incorporates the quantity channel effect, i.e., international trade finance is more sensitive to adverse loan supply shocks than domestic trade finance. When banks face a decline in the availability of funds, they set priorities for the lending activity, and the priority will be given to the loans with higher expected profits. Due to the asymmetric nature of the screening tests derived from the model, the loans for international transactions become less profitable than the loans for domestic transactions. As a result, when there occurs an adverse loan supply shock, banks will cut international trade finance loans first, leading to larger drops in international transactions than domestic transactions. To sum up, the price channel effect, a letter of credit effect, and the quantity channel effect lead to a great decline in international trade than in domestic sales.

This paper also contributes to the trade credit literature by providing a novel prediction on the optimal payment system. Based on firm heterogeneity in borrowing
costs, which is determined by the amount of collateral, the model predicts that firms choose the optimal payment system that minimizes overall financing costs of the transaction, and hence attains maximum profits. That is, when a buyer can afford to borrow at a relatively cheaper rate than a supplier, even the buyer prefers a cash-in-advance system to an open account system. Likewise, when the buyer faces a relatively higher borrowing rate, trade credit will be offered to the buyer by the supplier. This is consistent with empirical evidence that financially constrained firms tend to receive more credit and offer less credit (Petersen and Rajan, 1997; Love, Preve, and Sarria-Allende, 2007).  

In this aspect, this paper is closely related to a growing literature that considers the pattern of an optimal payment system for international trade (Schmidt-Eisenlohr, 2009; Olsen, 2010; Antràs and Foley, 2010). Schmidt-Eisenlohr (2009) shows that firms in a country with relatively lower financing costs or weaker enforcement of contracts offer trade credit to counterpart firms in a country with relatively higher financing costs or stronger enforcement of contracts. Olsen (2010) considers the optimal payment system in the presence of imperfect contract enforcement, and shows how bank intermediation mitigates such problems in international trade. Antràs and Foley (2010) also offer a prediction on the pattern of an optimal payment system based on an imperfect contract approach, and test the prediction using unique international transactions data from a single U.S. food exporter. In contrast to the exogenous assumption made in these papers, that international transactions are riskier than domestic transactions due to the imperfect contract enforcement, the current paper endogenizes the relative riskiness of international transactions through the asymmetric level of information, and derives the macroeconomic implications from its cyclical property.

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6 Alternative views on the determinants of trade credit include transaction costs motive (Ferris (1981)), suppliers’ informational advantage on buyers (Biais and Gollier, 1997; Smith, 1987) or better ability in monitoring buyers’ moral hazard (Burkart and Ellingsen, 2004)). For further reference, please refer to the references in Petersen and Rajan (1997).
This paper is also related to the literature that studies credit constraints and international trade. In the presence of fixed costs for exporting, credit constrained firms find it difficult to finance such fixed costs, and are discouraged from participating in exporting (Chaney, 2005). This can alter the patterns of trade, depending on industry level financial vulnerability as well as the financial development of the countries (Manova, 2006), and thus financial development can become a source of comparative advantage (Kletzer and Bardhan, 1987; Ju and Wei, forthcoming). Empirical studies find that financial development leads to a greater level of exports in manufactured goods (Beck, 2002), and credit constrained firms are less likely to become exporters (Mûuls, 2008). Although the literature focuses on the comparison between non-exporting and exporting firms in terms of long-term fixed costs financing, the current paper studies the difference between short-term domestic and export financing even for a single exporter.

The remainder of the paper proceeds as follows: Section 2 introduces the basic setup of the model, and discusses the optimal payment system. Section 3 describes a bank’s optimal investment decision in the precision level of each screening test, proves the existence of trade finance premium, and analyzes its cyclical property. Section 4 extends the analysis to a letter of credit system. Section 5 demonstrates the effects of adverse loan supply shocks, and Section 6 concludes.

1.2 A Baseline Model

There are two symmetric countries, each with consumers having CES preference over differentiated final goods that are nontradeable and sold to domestic consumers only:

\footnote{Greenaway, Guariglia, and Kneller (2007) find that the strong correlation between firms’ financial health and exporting status rather comes from the reverse causality, i.e., exporting improves firms’ financial health.}
\[ U(Q) = U \left( \left[ \int_{\omega \in \Omega} q(\omega)^{\sigma} d\omega \right]^{\frac{1}{\sigma}} \right), \]

where \( Q \) is the composite good and \( \Omega \) denotes the set of total available domestic varieties in the final goods sector. The corresponding price index is:

\[ P = \left[ \int_{\omega \in \Omega} p_b(\omega)^{1-\sigma} d\omega \right]^{\frac{1}{1-\sigma}}, \]

where \( \sigma = \frac{1}{1-\rho} > 1 \) is the constant elasticity of substitution across varieties and \( p_b \) is the price of final goods.

A final goods producer transforms a unit of intermediate goods into final goods without any additional cost. Accordingly, the demand for intermediate inputs \( (q_s) \) follows exactly the demand for final goods \( (q_b) \):

\[ q = q_s(\omega) = q_b(\omega) = Q \left( \frac{p_b(\omega)}{P} \right)^{-\sigma} = \frac{R}{P} \left( \frac{p_b(\omega)}{P} \right)^{-\sigma}, \]  

(1.1)

where \( R \) denotes aggregate expenditure in each country and \( PQ = R \) holds. Intermediate goods are produced with a unit working capital requirement technology such that one unit of working capital (with unit cost \( w \)) is required to produce one unit of intermediate goods.

A random matching process provides a unique supplier-buyer relationship between producers of intermediate goods and final goods. The relationship is so specific that only a uniquely matched variety can be used for a particular final goods production. Once a random match is made between a supplier and a buyer, the supplier has the exclusive right to provide the inputs to the corresponding buyer, who in turn produces and sells final goods to domestic consumers. It is assumed that suppliers set the price for intermediate goods from their own profit maximization problem, and similarly for final goods producers, generating double marginalization.\(^8\)

\(^8\)The model abstracts away from the hold-up problem that may arise between the matched partners. The main results of the model will not be affected by a consideration of the contract to resolve the hold-up problem \textit{a la} Grossman and Helpman (2002).
There is a $2N$ mass of supplier-buyer matches that is equally split\textsuperscript{9} into domestic ($D$) and international ($F$) transactions. International transactions incur variable trade costs that take the form of an iceberg-type cost ($\tau_F > 1$), whereas domestic transactions are free of such trade costs ($\tau_D = 1$). This reflects various sources of possible trade costs, e.g., transportation costs, time costs or tariff rates.\textsuperscript{10}

Firms are heterogeneous in the level of pledgeable collateral. We define $0 \leq \varphi \leq 1$ as the fraction of working capital that can be used as collateral. A supplier-buyer match is then characterized by their collateral parameters as $(\varphi_s; \varphi_b)$, where $s$ and $b$ denote supplier and buyer, respectively. A direct implication is that firms may have different values of collateralizable assets or use different technology in terms of tangible input usage, but this can be more broadly interpreted as any other firm characteristic that leads to different borrowing costs across firms.\textsuperscript{11}

### 1.2.1 Banks with Costly Screening Technology

The banking industry is assumed to be imperfectly competitive due only to spatial differentiation: banks are identical except for locale. When a firm borrows from a bank, it incurs per unit travel costs $t(z) \geq 1$ that are increasing with a

\textsuperscript{9}Together with a symmetric country setting, this assumption intends to highlight the main mechanism by shutting down any other factor. As will be discussed later, the key idea is that the presence of costly trade is sufficient to create the nature of trade finance consistent with empirics even between identical countries without any other cross-border risk factors.

\textsuperscript{10}Essentially, this can be more generalized to capture any other exogenous factors that makes international transactions more costly. For example, weaker contract enforcement across borders considered in Schmidt-Eisenlohr (2009), Olsen (2010), and Antràs and Foley (2010) can be collapsed into $\tau_F$. It is straightforward that adding country specific enforcement level to the current model will provide additional testable prediction across country that are consistent with evidence in Schmidt-Eisenlohr (2009) and Antràs and Foley (2010). Similarly, allowing market size to differ across country will yield richer empirical predictions, leaving the key idea of this paper untouched.

\textsuperscript{11}Bank borrowing is assumed to be the only source of working capital financing for simplicity. In reality, however, firms may prefer internal financing to external financing (i.e., pecking order hypothesis as in Myers and Majluf (1984)). To the extent that internal fund is not sufficient to fully finance the working capital, the marginal cost of production will then be determined by the bank borrowing rate as in this model.
distance $z$ between a firm and a bank. When borrowing from a local bank, distance between a firm and a local bank is 0, and travel costs are assumed to be 1. Each bank, therefore, has an exclusive relationship with a group of local borrowers, and exerts monopolistic control over lending rates that depend on the distance to the nearest neighbor bank.\footnote{This is to allow banks to make positive profits so that they can invest in information acquisition as discussed in section 3. Note that we do not consider the case in which potential borrowers apply for loans, learn the screening test outcomes, and apply again to other banks when they receive bad signals. This is implicitly imposed in the model in that a screening test yields an identical outcome conditional on the amount of information.} Whenever a bank makes a lending decision to support a transaction, it needs to evaluate the associated failure risk of the transaction that arises from either the buyer or the supplier; a supplier may default and fail to produce the intermediate goods or a buyer may default and fail to sell the final goods.\footnote{We treat the distance as an exogenous parameter. Champonnois (2009) considers market contestability and endogenizes the distance between banks.}

Specifically, there are two types of firms: good firms ($\Theta = G$) with a fraction $\mu_G \geq 1/2$ and bad firms ($\Theta = B$) with a fraction $(1 - \mu_G) \leq 1/2$.\footnote{This implies that a bank charges a transaction specific interest rate for each loan. In the real world, short-term financing uses trade credit from each transaction as collateral. Also, firms often sell trade credit to third parties (i.e., factoring), and get a transaction specific discount. In this sense, a bank in the model captures the roles of both a lender and a factor. On the contrary, Feenstra, Li, and Yu (2011) consider the case in which a bank cannot verify whether the loan is used to cover the costs of production for domestic sales or for exports.} A good firm never defaults (default probability $=0$), while a bad firm defaults with probability $0 < \lambda < 1$.\footnote{This is common to both suppliers and buyers: $\mu_G = \mu_{G,s} = \mu_{G,b}$} The information on a firm’s type is unknown to anyone, including the firm itself. To distinguish good firms from bad firms, banks use a screening test. The precision level of the test, in turn, depends on the amount of information that they have acquired. The information acquisition is market specific (domestic vs foreign).\footnote{Hence, $\lambda(1 - \mu_G)$ is the economy wide default rate. This may include both voluntary and involuntary default.} We assume that information acquisition is a costly investment such that

\[[12]\] This is to allow banks to make positive profits so that they can invest in information acquisition as discussed in section 3. Note that we do not consider the case in which potential borrowers apply for loans, learn the screening test outcomes, and apply again to other banks when they receive bad signals. This is implicitly imposed in the model in that a screening test yields an identical outcome conditional on the amount of information.

\[[13]\] We treat the distance as an exogenous parameter. Champonnois (2009) considers market contestability and endogenizes the distance between banks.

\[[14]\] This implies that a bank charges a transaction specific interest rate for each loan. In the real world, short-term financing uses trade credit from each transaction as collateral. Also, firms often sell trade credit to third parties (i.e., factoring), and get a transaction specific discount. In this sense, a bank in the model captures the roles of both a lender and a factor. On the contrary, Feenstra, Li, and Yu (2011) consider the case in which a bank cannot verify whether the loan is used to cover the costs of production for domestic sales or for exports.

\[[15]\] This is common to both suppliers and buyers: $\mu_G = \mu_{G,s} = \mu_{G,b}$

\[[16]\] Hence, $\lambda(1 - \mu_G)$ is the economy wide default rate. This may include both voluntary and involuntary default.

\[[17]\] There are two mutually exclusive groups: domestic ($D$) and foreign ($F$) firms. Instead, the information (and hence a screening test) can be modeled as firm specific. This will give a qualitatively
banks optimally choose the amount of information, and hence the precision level of screening test, for each group. This will be discussed in the next section.

The precision level of screening is defined as the probability of receiving a good signal \((S = G)\) conditional on firms’ being good, and symmetrically for bad signals:

**Definition 1** The precision level of screening is defined as

\[
\alpha_j \equiv \text{prob}(S_j = G \mid \Theta_j = G) = \text{prob}(S_j = B \mid \Theta_j = B)
\]

for \(j = D, F \) and \(1/2 \leq \alpha_j \leq 1\).

Accordingly, the share of the firms that receives a good signal in the economy is:

\[
\gamma_j \equiv \text{prob}(S_j = G) = \frac{\Theta_j = G}{\Theta_j = B} \mu_G \alpha_j + (1 - \mu_G)(1 - \alpha_j)
\]  

(1.2)

When a screening technology is imperfect \((\alpha_j < 1)\), the group of firms that receives good signals will be composed of both good and bad firms. The share of non-defaulting firms among this group can then be expressed as\(^{18}\):

\[
\chi_j^G \equiv \frac{\mu_G \alpha_j + (1 - \mu_G)(1 - \alpha_j)(1 - \lambda)}{\gamma_j}
\]

(1.3)

This represents the probability of firms not defaulting, conditional on observing a good signal. As long as a screening test is informative \((\alpha > 1/2)\), a firm with a good signal is less likely to default than a firm with a bad signal \((\chi_j^G > \chi_j^B)\) and, throughout the paper, we will assume that a screening is precise enough to ensure that there are identical result (Propositions 1-5) since we are interested in the outcomes conditional on transaction characteristics (i.e., \((\phi_b, \phi_s))\), as will be discussed clearly later.

\(^{18}\)Similarly, the share of non-defaulting firms among a group of firms with a bad signal is: \(\chi_j^B \equiv \frac{\mu_B (1 - \alpha_j) + (1 - \mu_B)(\alpha_j)(1 - \lambda)}{(1 - \gamma_j)}\)
too few good firms among a group of firms with a bad signal for a bank to make a profit from lending to this group:

**Assumption 1 (Credit Rationing)** Whenever either party of the transaction receives a bad signal, banks deny a loan for the transaction.

**Lemma 1** $\chi^j_G$ is an (i) increasing and (ii) weakly concave function of the precision level $\alpha_j$:

\[
\frac{\partial \chi^j_G}{\partial \alpha_j} = \frac{\lambda(1 - \mu_G)\mu_G}{[\mu_G\alpha_j + (1 - \mu_G)(1 - \alpha_j)]^2} > 0 \quad (1.4)
\]
\[
\frac{\partial^2 \chi^j_G}{\partial \alpha_j^2} = \frac{-2(2\mu_G - 1)}{[\mu_G\alpha_j + (1 - \mu_G)(1 - \alpha_j)]^3} \leq 0 \quad (1.5)
\]

**Lemma 2** The elasticity of $\chi^j_G$ with respect to $\lambda$ is (i) negative and (ii) increasing in the precision level $\alpha_j$:

\[
\frac{\partial \ln \chi^j_G}{\partial \ln \lambda} = \frac{-2\lambda(1 - \mu_G)(1 - \alpha_j)}{[\mu_G\alpha_j + (1 - \mu_G)(1 - \alpha_j)(1 - \lambda)]} < 0 \quad (1.6)
\]
\[
\frac{\partial}{\partial \alpha_j} \left( \frac{\partial \ln \chi^j_G}{\partial \ln \lambda} \right) = \frac{\lambda\mu_G(1 - \mu_G)(2 - \alpha_j)}{[\mu_G\alpha_j + (1 - \mu_G)(1 - \alpha_j)(1 - \lambda)]^2} > 0 \quad (1.7)
\]

The property of screening tests is summarized in Lemma 1 and 2 above and illustrated in <Figure 1.1>. Equation (1.4) in Lemma 1 implies that a higher precision screening test yields better loan performance, i.e., $\chi^j_G$ curve with a higher precision level $\alpha_h$ (solid line) lies above the curve with a lower precision level $\alpha_l$ (dotted line), where $\alpha_l < \alpha_h < 1$. When a screening is perfect, no bad firms can receive a good signal, and thus, $\chi^j_G = 1$ (dashed line). Equation (1.6) in Lemma 2 shows that an imperfect

\[\text{Footnote 24 discusses the condition for this assumption in detail.}\]
screening test yields better loan performance as the economy wide default rate ($\lambda$) decreases, and vice versa, i.e., $\chi^j_G$ curve is decreasing in $\lambda$. According to equation (1.7) in Lemma 2, this tendency is stronger as a screening test is less precise, i.e., $\chi^j_G$ curve with a higher precision level $\alpha_h$ (solid curve) is less steep than the curve with a lower precision level $\alpha_l$ (dotted curve). For example, as $\lambda$ approaches 0, there is no firm default in the economy, and thus the loan repayment probability for both high and low precision test converges to 1. On the contrary, the loan performance gap between tests widens as $\lambda$ increases. This is simply because a low precision screening test, relative to a high precision screening, allows a larger share of bad firms to be included in the bank’s loan portfolio, and hence is more sensitive to changes in $\lambda$.

### 1.2.2 Payment Systems

A novel feature of the model is the introduction of the payment system as a choice variable for each transaction. In this section, we will carefully go through each payment system step by step, and provide predictions on the optimal payment system that would be chosen by either party in the transaction. In the real world, there are three main modes of payment system: open account (OA), cash-in-advance (CA), and a letter of credit (L/C). In the following, we will focus only on the open account and cash-in-advance systems and defer discussion on the letter of credit system to Section 4.

The open account system refers to when suppliers extend credit to buyers such that the intermediate goods are produced and shipped to buyers first and the payment is made later. The exact opposite is true for the cash-in-advance system in that the payment by buyers is made to suppliers prior to the production or delivery of the intermediate goods. Therefore, it is necessary for the supplier to borrow from the bank in the open account system, and the supplier’s bank screens the supplier and the domestic buyer with the precision level $\alpha_D$, but screens the foreign buyer with the precision level $\alpha_F$. Likewise, it is the buyer that borrows from the bank in the
cash-in-advance system, and the buyer’s bank evaluates the creditworthiness of the buyer and the domestic supplier using a domestic screening test, but assesses the credit risk of the foreign supplier using a foreign screening test. This is illustrated in Figure 1.2. We begin with the open account system.

**Open Account (OA)**

**Buyer’s Problem** On receiving the intermediate goods from a supplier, a buyer transforms them into the final goods that are then sold to domestic consumers. As long as the transaction is financed (with probability $\gamma_D \gamma_j$), the buyer receives revenue from sales of final goods (with probability $\chi_G \chi_j$), and the payment to the supplier takes place at the end of the transaction cycle. Since the revenue from sales of final goods is enough to cover the inputs payment, the buyer does not need to borrow from a bank. Taking an input price $p_s$ as given, the buyer solves the simple expected profit maximization problem:

$$\max_{p_b} \chi_D \chi_j \left[ p_b q - p_s q \right]$$

to set the optimal price as a markup over marginal cost:

$$p_b = \frac{1}{\rho} p_s$$  \hspace{1cm} (1.8)

**Supplier’s Problem** Considering an iceberg-type trade cost such that $\tau_j$ units of goods are required for a unit of goods to reach the buyer, a supplier providing $q$ units of intermediate goods therefore needs $q \tau_j w$ value of working capital. Since the payment is made to the supplier only after the delivery (with probability $\chi_D \chi_j$), the

---

20 A transaction is financed only if both a buyer and a seller pass the screening test by a seller’s bank (Assumption 1). This occurs with probability $\gamma_D \gamma_j$. A buyer then earns the positive profit with probability $\chi_D \chi_j$: only when neither a seller nor a buyer defaults. The current profit maximization problem can be thought of as the expected profit conditional on passing the screening test. This applies to most of the profit maximization problems considered in this paper unless specified otherwise. Note that we ignore the discount factor for a period between the payment and the delivery.
supplier has to finance the working capital prior to the production. In particular, a supplier that can pledge $\varphi_s$ fraction of working capital as collateral borrows working capital from a bank at the interest rate $r(\varphi_s)$, and hence the cost function becomes $q\tau_j wr(\varphi_s)$. Consequently, taking the interest rate as a given, the supplier maximizes the following expected profit function:

$$\max_{p_s} \chi_D^j \left[ p_s q - q\tau_j wr_s \right]$$

(1.9)

The optimal price is, again, markup over marginal cost:

$$p_s = \frac{\tau_j w}{\rho} r_s$$

(1.10)

**Bank’s Problem**  
A bank lends working capital ($q\tau_j w$) to a supplier and gets gross repayment ($q\tau_j wr_s$) only if neither supplier nor buyer defaults during the transaction cycle. Otherwise, the bank ends up with recovering only $\varphi_s$ fraction of the loan from the collateral collection process. Whenever a bank receives a bad signal from either a supplier or a buyer, it refuses to lend, and the transaction is not viable from Assumption 1. This amounts to the loan repayment probability of $\chi_D^j \chi_G^j$ for each transaction because the transaction is financed only when both parties receive good signals (with probability $\gamma_D \gamma_j$).

The bank’s expected profit maximization is then:

$$\max_{\tau_s} \left[ \chi_D^j \chi_G^j q\tau_j wr_s + (1 - \chi_G^j \chi_G^j) q\tau_j w \varphi_s - q\tau_j w \right]$$

(1.11)

$^21$\(r_k\) and \(r(\varphi_k)\) are used interchangeably herein, where \(k = s\) or \(b\).

$^22$A bank lends to local domestic suppliers only and the corresponding buyers could be either domestic or foreign. This implies that the screening test used for suppliers has the precision level \(\alpha_D\), while the one for buyers is \(\alpha_j\) for \(j = D, F\).
and the optimal interest rate charged to a supplier with collateral parameter $\varphi_s$ is solved as:

$$r^j(\varphi_s) = \frac{1}{\rho} \left[ \frac{\lambda_D^j \lambda_G^j \varphi_s + (1 - \varphi_s)}{\lambda_G^j \lambda_G} \right] = \frac{1}{\rho} \left[ \varphi_s + \frac{(1 - \varphi_s)}{\lambda_G^j \lambda_G} \right]$$

(1.12)

It is intuitive that the borrowing cost is decreasing in the collateral parameter ($\frac{\partial r_s}{\partial \varphi_s} < 0$), and decreasing in the success probability of transaction ($\frac{\partial r_s}{\partial \Delta D_G^j \Delta G} < 0$) as well. Spatial competition in the banking sector, however, predicts that a bank in the neighbor region may approach the borrower with a lower lending rate. Therefore, the maximum interest rate that the bank can charge cannot be higher than the lowest possible interest rate that the nearest bank can offer. This is characterized as the distance cost on top of the zero profit lending rate, or:

$$t(z) \left[ \varphi_s + \frac{(1 - \varphi_s)}{\lambda_G^j \lambda_G} \right],$$

where $z$ is the minimum distance between banks. As a result, the equilibrium interest rate charged by the local bank to the supplier with collateral parameter $\varphi_s$ will be:

$$r^j(\varphi_s) = \min \left\{ \frac{1}{\rho}, t(z) \right\} \cdot \left[ \varphi_s + \frac{(1 - \varphi_s)}{\lambda_G^j \lambda_G} \right]$$

Weak competition implies longer distance between banks, and the optimal lending rate in equation (1.12) is likely to be the equilibrium rate. As the distance $z$ decreases,

---

23Equations (1.8) and (1.10) are combined to enter equation (1.1). In short, the bank takes into account the effect of the lending rate on final good demand.

24This is the rationale for Assumption 1. Bad signaled transactions (i.e., the supplier-buyer pairs in which at least one party receives a bad signal) face higher borrowing costs than good signaled transactions (i.e., the supplier-buyer pairs in which none receives a bad signal) due to a lower probability of loan repayment. This means that bad signaled transactions generate lower revenue, and hence lower profits due to a higher final goods price and elastic demand. We can introduce the fixed cost such that the bad signaled transactions end up with negative profits, and hence full repayment cannot occur. Knowing this is going to happen, a bank will not provide a loan for such transactions. Since we assumed that all the bad signaled transactions are credit rationed, but the opposite is true for the good signaled transactions, it should hold that the supplier-buyer match that incurs the lowest borrowing costs among the bad signaled transactions is still less profitable than the supplier-buyer match that incurs the highest borrowing costs among the good signaled transactions.
banks are forced to charge a lending rate below the optimal rate, reflecting fierce competition between banks. Henceforth, we will assume banking competition to be such (i.e., $\frac{1}{\rho} > t(z)$), and thus the equilibrium rate becomes:

$$r^j(\varphi_s) = t(z) \cdot \left[ \varphi_s + \frac{(1 - \varphi_s)}{\chi_G^j \chi_G} \right]$$  \quad (1.13)

To sum up, the borrowing cost in equation (1.13) enters the intermediate goods price in equation (1.10), which in turn determines the final goods price in equation (1.8):

$$p^{j,OA}_{s}(\varphi_s) = \frac{t(z)\tau_j w}{\rho^2} \left[ \frac{\chi_G^j \chi_G^j \varphi_s + (1 - \varphi_s)}{\chi_G^j \chi_G} \right] = \frac{t(z)\tau_j w}{\rho^2} \left[ \varphi_s + \frac{(1 - \varphi_s)}{\chi_G^j \chi_G} \right], \quad (1.14)$$

generating the complete pass-through of the borrowing cost into the final goods price.

Now, we turn to the cash-in-advance system.

**Cash-in-Advance (CA)**

**Buyer’s Problem** A buyer needs to pay a supplier before the intermediate goods are produced and delivered. To finance the advance payment, a buyer with collateral parameter $\varphi_b$ needs to borrow the advance payment from banks at the interest rate $r(\varphi_b)$. The cost function for the buyer is $p_s q r(\varphi_b)$, and taking the interest rate as a given, the buyer maximizes expected profit function:

$$\max_{p_b} \chi_G^j \chi_G \left[ p_b q - p_s q r_b \right]$$

to set the optimal price as markup over marginal cost:

$$p_b = \frac{1}{\rho} p_s r_b$$  \quad (1.15)

---

25 This assumption is not necessary for the model to deliver the main results.
Bank’s Problem  A bank supports the transaction by lending to a buyer so that the buyer can provide a supplier with advance payment. The bank will be able to collect the full loan repayment from the buyer only when the transaction is completed successfully (with probability $\chi_G^D\chi_G^j$). Otherwise, the bank recovers only $\varphi_b$ fraction of the loan from collateral. The bank solves the following expected profit maximization problem taking an input price as given:

$$\max_{r_b} \left[ \chi_G^D \chi_G^j p_s q r_b + (1 - \chi_G^D \chi_G^j) p_s q \varphi_b - p_s q \right]$$  \hspace{1cm} (1.16)

to find the optimal interest rate charged to a buyer with collateral parameter $\varphi_b$:

$$r^j(\varphi_b) = \frac{1}{\rho} \left[ \chi_G^D \chi_G^j \varphi_b + (1 - \varphi_b) \right] = \frac{1}{\rho} \left[ \varphi_b + \frac{(1 - \varphi_b)}{\chi_G^D \chi_G^j} \right]$$  \hspace{1cm} (1.17)

Again, it is clear that the borrowing cost for a buyer decreases under two circumstances: the buyer can pledge more collateral; the success probability of transaction increases. Considering the aforementioned spatial competition between banks, the equilibrium interest rate will be:

$$r^j(\varphi_b) = \min \left\{ \frac{1}{\rho}, t(\bar{z}) \right\} \cdot \left[ \varphi_b + \frac{(1 - \varphi_b)}{\chi_G^D \chi_G^j} \right]$$

and we assume strong enough banking competition to lead to the following equilibrium interest rate:

$$r^j(\varphi_b) = t(\bar{z}) \cdot \left[ \varphi_b + \frac{(1 - \varphi_b)}{\chi_G^D \chi_G^j} \right]$$  \hspace{1cm} (1.18)

Supplier’s Problem  Since the payment is made prior to the intermediate goods production and can be used for working capital financing by a supplier, a supplier does not need to borrow from a bank. More interestingly, a buyer’s default after the payment no longer affects the supplier’s profit, which depends only upon the supplier’s own default probability. Noting that the transaction will take place
only when a buyer’s bank receives good signals from the buyer and the supplier (with probability $\gamma_D \gamma_j$), and the supplier makes positive profit only if it does not default (with probability $\chi^j_G$), the corresponding expected profit becomes:

$$\max_{p_s} \chi^j_G [p_s q - q \tau_j w]$$

and yields the optimal price:

$$p_s = \frac{\tau_j w}{\rho}$$  \hspace{1cm} (1.19)

As is done for the open account system case, plugging the input price expressed in equation (1.19) and the borrowing cost expressed in equation (1.18) into the final goods price in equation (1.15), we get the final goods price as a function of the model parameter values:

$$p^{j,CA}_b (\varphi_b) = \frac{t(z) \tau_j w}{\rho^2} \left[ \frac{\chi^j_G \chi^j G \varphi_b + (1 - \varphi_b)}{\chi^j_G \chi^j G} \right] = \frac{t(z) \tau_j w}{\rho^2} \left[ \varphi_b + \frac{(1 - \varphi_b)}{\chi^j_G \chi^j G} \right]$$  \hspace{1cm} (1.20)

**Optimal Payment System**

For any given precision level, $\alpha_j$ (and hence $\chi^j_G$), depending on who has control over the choice of payment systems, the payment system that gives the highest expected profit will be chosen for a transaction between a given pair ($\varphi_s$, $\varphi_b$). Assuming that it is always a buyer who decides the payment system used for each transaction, the comparison between the buyer’s expected profits from the open account and the cash-in-advance system reduces to the comparison between the equation (1.14) and (1.20) because the buyer’s profit from each payment system is expressed as:

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26The case with a supplier having control over the payment system gives similar implications. A supplier considers the expected profits from an open account relative to the expected profits from a cash-in-advance: $\pi^{OA}_b (\varphi_s, \varphi_b) / \pi^{CA}_b (\varphi_s, \varphi_b) = \chi^j_G r_j (\varphi_s) \left[ (p^{OA}_b / p^{CA}_b)^\sigma \right]$.
\[ \pi^O_A(\varphi_s, \varphi_b) = \chi_D^j \chi_G \left[ A(1 - \rho) \left( \rho^O_A \right)^{1-\sigma} \right] \] (1.21)

for an open account and

\[ \pi^C_A(\varphi_s, \varphi_b) = \chi_D^j \chi_G \left[ A(1 - \rho) \left( \rho^C_A \right)^{1-\sigma} \right] \] (1.22)

for a cash-in-advance respectively, where \( A = RP^{\sigma-1} \).

It is straightforward that a buyer will choose the payment system that gives lower final good price for a given transaction characteristic (\( \varphi_s, \varphi_b \)): an open account for \( \varphi_b < \varphi_s \), a cash-in-advance for \( \varphi_b > \varphi_s \), and indifferent when \( \varphi_b = \varphi_s \)\(^{27}\). This is very intuitive in that all else being equal, a party in a better financial condition applies for a loan and provides working capital for a transaction so that the borrowing cost (and therefore, the final goods price) is minimized.

### 1.3 Trade Finance Premium

#### 1.3.1 Optimal Investment in Screening Tests

So far, we have treated the different precision levels of screening tests \( \alpha_j \) as exogenous parameters. In this section, we consider a bank’s optimal precision level of screening tests on each group of firms. Banks can improve the precision level of each screening test by acquiring the information on each group of firms (i.e., domestic and foreign firms). When it is costly to acquire the information, banks will optimally choose the precision level by considering the marginal gains and marginal costs of the information acquisition. Intuitively, banks will continue investing in the information acquisition until the marginal gains from additional information are no greater than the marginal costs. A possible discrepancy in marginal gains across groups will gen-

\(^{27}\)We will assign the open account system to the pairs \((\varphi_b = \varphi_s)\) without implication.
erate different precision levels of screening tests even when we assume an identical 
cost function for domestic and foreign information acquisition.

**Marginal costs curve** We assume that the information on firms is market 
specific (i.e., domestic and foreign firms), costly to obtain, and the marginal costs of 
the information acquisition are increasing with the precision level (and hence increasing 
in the amount of information obtained). This assumption implies that it is more 
difficult or expensive to improve the screening test as it gets closer to being perfect. 
Formally, we impose the following assumption on the information acquisition cost 
function $C(\alpha)$, and one example of marginal cost functions that satisfies the following 
assumption is a linear curve featured in Figure 1.3.$^{28}$

**Assumption 2** (i) $C(\alpha) > 0$, (ii) $C'(\alpha) > 0$, and (iii) $C'(\alpha = \alpha) = 0$.

**Marginal gains curve** A bank earns profits from financing domestic and 
international transactions:

$$\pi_{\text{bank}} = \pi_{\text{bank}}^{D} + \pi_{\text{bank}}^{F}$$

As described in Figure 1.2, a domestic screening test is used to evaluate the 
creditworthiness of borrowers and the borrowers’ domestic trading partners, whereas 
a foreign screening test is applied to the borrowers’ foreign trading partners. When 
a bank improves the precision level of the foreign screening test, the bank can assess 
the credit risks of the borrowers’ foreign trading partners more accurately, and thus 
will expect to earn greater profits from an international trade financing business:

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$^{28}$It is plausible to assume that marginal costs of acquiring local firms information is lower than 
marginal costs of acquiring foreign firms information, which will strengthen the results of this paper. 
However, this assumption is not made throughout the paper in order to highlight the endogenous 
nature of asymmetric screening tests.
On the other hand, improving the domestic screening test raises the bank’s profits not only from a domestic trade financing business but also from an international trade financing business:

\[
\frac{\partial \pi_{\text{bank}}}{\partial \alpha_F} = \frac{\partial \pi_{\text{bank}}^D}{\partial \alpha_D} + \frac{\partial \pi_{\text{bank}}^F}{\partial \alpha_D}
\]

because it allows the banks to screen the borrowers more precisely even in international transactions. The enhanced profits from a domestic trade financing business can be further broken down to the gains from better screening the borrowers and the gains from better screening their domestic trading partners. In general, because the benefits come from both domestic and international trade financing, the marginal gains from improving the domestic screening test are greater than the marginal gains from improving the foreign screening test. Combined with an increasing marginal cost curve, this leads to a relatively higher precision level for the domestic screening test than the foreign screening test.

Although this helps explain the result in an intuitive way, the result is not simply driven by the fact that the bank benefits from the domestic screening improvement via multiple channels. For example, even if we relax the specific assumption that banks screen local borrowers at the same precision level as their domestic trading partners, and assume instead that the information (and hence the screening precision level) is specific to local borrowers, other domestic firms, or foreign firms, we reach the same conclusion that the precision level of screening domestic firms is higher than that of screening foreign firms. In this case, the marginal gains from improving the domestic screening test will come solely from a domestic trade financing business because the bank is better able to screen the borrowers’ domestic trading partners but not the borrowers. This is similar to improving the foreign screening test discussed above. Nevertheless, these gains are shown to be still greater than
the marginal gains from improving the foreign screening test. The idea is that the marginal gains from improving each screening test are proportional to the volume of transactions affected by that specific screening test. In the presence of trade costs, all else being equal, the volume of domestic transactions is greater than the volume of international transactions, and thus the marginal gains from improving the domestic screening test are always greater than the marginal gains from improving the foreign screening test. Consequently, as shown in Figure 1.3, the marginal gains curve for domestic screening improvement lies above the one for foreign screening improvement, and therefore, the optimal precision level is determined at a higher level for the domestic screening test than the foreign screening test.

**Proposition 1** In equilibrium, the screening test for domestic firms has a higher precision level than the one for foreign firms ($\alpha_F^* < \alpha_D^*$).

**Proof.** In the appendix. □

A direct consequence of Proposition 1 is that international transactions are subject to higher default risks than domestic transactions because the screening test for foreign firms is more likely to misclassify bad firms as good. This results in higher borrowing costs for international transactions.

To see this clearly, let us consider transactions that take place between a trading partner pair $(\phi'_s, \phi'_b)$. When a supplier can borrow from banks at a relatively lower rate (i.e., $\phi'_s > \phi'_b$), an open account is the optimal payment system for this transaction, and the borrowing cost $r^j(\phi'_s)$ is as in equation (1.13) with $j = D$ and $F$ for domestic and international transactions, respectively. Since the borrowing cost is

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29 This is shown in the appendix.

30 In this figure, marginal gains curves are drawn as upward sloping. This is always true when $\mu_G = 1/2$. Otherwise, it is ambiguous whether the curves are upward or downward sloping, but this does not affect the following Proposition.

31 Throughout the paper, when we compare domestic and international transactions, the comparison is conditional on characteristics of transaction pairs (i.e., $(\phi'_s, \phi'_b)$).
decreasing in the loan repayment probability $\chi^D_G \chi^j_G$, and $\chi^F_G < \chi^D_G$ from Proposition 1, it follows that $r^F(\phi')/r^D(\phi') > 1$, which we will call the trade finance premium. Furthermore, since there is a complete pass-through of the borrowing cost to the final goods price, this leads to $p^F_{ba}(\phi')/p^D_{ba}(\phi') > \tau_F$: reinforcing the home market bias when demand is elastic, as in this model. The same is true for $(\phi < \phi_b')$ under a cash-in-advance system, and this completes the proof of the following Corollary.

**Corollary 1** There exists a trade finance premium, $r^F(\phi'_s, \phi'_b)/r^D(\phi'_s, \phi'_b) > 1$, reflecting riskier international transactions than domestic transactions. This is completely passed-through to the final goods price, and reinforces the home market bias.

### 1.3.2 Counter-cyclical Trade Finance Premium

Next, we turn to the cyclical property of a trade finance premium. The default rate of firms fluctuates over a business cycle, i.e., default rates are higher in recessions than in booms. This section performs a simple comparative static analysis by changing the default probability of firms in the economy, $\lambda$.\(^{32}\) We take the precision level of screening tests as predetermined, and examine the sole effect of a change in $\lambda$ on the trade finance premium and export-to-domestic sales ratio. The implicit assumption here is that in the very short run, banks cannot quickly update or adjust their information on firms. Therefore, they apply screening tests based on the information acquired earlier. This is best understood as short run fluctuations around the steady state.

From Assumption 1, only the good signaled transactions get financed by banks. The probability of receiving good signals on borrowers and their counterparts is $\gamma_D$ and $\gamma_j$ respectively. Among them, $\chi^D_G$ fraction of the good signaled borrowers and $\chi^j_G$ fraction of the good signaled counterparts operates successfully. Therefore, the actual volume of successful transactions for each pair $(\phi_s, \phi_b)$ is expressed as:

\(^{32}\)Alternatively, we can think of a decrease in the share of good firms ($\mu_G$) during the recession. This gives qualitatively identical results.
\[ V^{j,k}(\varphi_s, \varphi_b) = \gamma_D \gamma_j \chi_D^j \cdot q^{j,k}(\varphi_s, \varphi_b) = \gamma_D \gamma_j \chi_D^j \cdot A \left[p^{j,k}(\varphi_s, \varphi_b)\right]^{-\sigma} \]  

for \( j = D, F \), and \( k = OA \) for \( \varphi_s \geq \varphi_b \) and \( k = CA \) for \( \varphi_s < \varphi_b \).

It then follows that the relative volume of successful international transactions to domestic transactions for a pair \((\varphi'_s, \varphi'_b)\) with \( \varphi'_s \geq \varphi'_b \) is:

\[
V^{F,D,OA}(\varphi'_s, \varphi'_b) = \frac{V^{F,OA}(\varphi'_s, \varphi'_b)}{V^{D,OA}(\varphi'_s, \varphi'_b)} = \frac{\beta_F}{\beta_D} \cdot \left[\frac{p^{F,OA}(\varphi'_s, \varphi'_b)}{p^{D,OA}(\varphi'_s, \varphi'_b)}\right]^{-\sigma}
\]

where \( \beta_j = \mu_G \alpha_j + (1 - \mu_G)(1 - \alpha_j)(1 - \lambda) \), and the same is true for a pair \((\varphi'_s, \varphi'_b)\) with \( \varphi'_s < \varphi'_b \) by replacing the price effect term with \([\tau_F / r^D(\varphi'_b)]^{-\sigma}\).

There are two terms that determine the relative volume of export-to-domestic sales. The probability effect term represents the relative success probability of international transactions to domestic transactions. Since the counterparts screening is less precise for international transactions from Proposition 1, a larger share of bad firms that are subject to default is included in international transactions, leading to a smaller number of successful international transactions relative to domestic transactions: \( \beta_F / \beta_D < 1 \). A direct interpretation of this result is already discussed in Corollary 1, that international transactions are riskier than domestic transactions, and thus there exists a trade finance premium. This is captured by the price effect term.

Moreover, a change in the default rate \( \lambda \) will affect both terms in equation (1.24), and their movements will govern the cyclical property of the export-to-domestic sales ratio. As \( \lambda \) increases during a recession, the probability of successful transactions decreases for both international and domestic transactions. In particular, Lemma 2 predicts that this tendency is stronger for international transactions.
because there is a larger share of bad firms that are directly affected by an increase in the default rate $\lambda$. This implies that the relative riskiness of international transactions increases during a recession, and the opposite is also true during a boom. This in turn implies that the trade finance premium increases as $\lambda$ increases (i.e., counter-cyclical trade finance premium). Therefore, we conclude that both probability and price effect generate a pro-cyclical export-to-domestic sales ratio.

**Proposition 2** The export-to-domestic sales ratio is pro-cyclical in that it decreases as $\lambda$ increases, and increases as $\lambda$ decreases via both probability effect and price effect. This is the direct consequence of the counter-cyclical relative riskiness of international transactions.

**Proof.** In the appendix. ■

The counter-cyclical movement in the relative price is consistent with the evidence reported in Ahn et al. (2011) that export price increased relative to domestic price in Japan, the U.S., and European Union countries during the recent crisis. This also explains the finding in Haddad et al. (2010) that U.S. import prices rose in financially vulnerable sectors. This price effect would lead to a decline in the export-to-domestic sales ratio along the intensive margin, which was the predominant channel in the collapse in trade (Bricongne et al., 2010; Paravisini et al., 2010).

1.4 **Extension: A Letter of Credit (L/C)**

In this section, we extend the baseline model to consider the letter of credit system together with the open account and the cash-in-advance system, and we will show why letters of credit are used only for international transactions, and how this amplifies the pro-cyclicality of export-to-domestic sales ratio. In the real world, letters of credit are used exclusively for international transactions, and they involve a buyer’s bank and a supplier’s bank in such a way that the former guarantees the payment to
the latter on behalf of buyers. For this reason, the supplier’s bank is now free from
the buyer’s default risk. Instead, by accepting the agreement, the supplier’s bank is
obliged to pay the supplier whether the buyer’s bank actually pays or not.\textsuperscript{33} Since the
buyer’s bank is also subject to default risk (with $1/2 \leq \mu_{\text{bank}} < 1$ and $0 < \lambda_{\text{bank}} < 1$),
the supplier’s bank needs to evaluate the creditworthiness of the counterpart bank
prior to accepting the letters of credit procedure. We make the following assumptions
regarding the inter-bank screening test:\textsuperscript{34}

\textbf{Assumption 1’} A letter of credit issued by a buyer’s bank is denied by a
suppliers’ bank if a bad signal on the buyer’s bank is received.

\textbf{Assumption 3} The precision level of inter-bank screening is exogenously
given as $\bar{\alpha}_{\text{bank}} < 1$.

\subsection*{1.4.1 A Letter of Credit (L/C)}

\textbf{Buyer’s Problem} By issuing a letter of credit, a buyer’s bank obligates
itself to pay a supplier’s bank on behalf of a buyer, as long as the intermediate goods
are shipped. From the bank’s perspective, the letter of credit issuance essentially
amounts to providing a loan to the buyer because the reimbursement is made to the
buyer’s bank only if the buyer and the supplier operate successfully in the market
(with probability $\chi_{G}^{D} \chi_{G}^{D}$).\textsuperscript{35} The cost function for a buyer with $\varphi_{b}$ is expressed as
$p_{s}qr(\varphi_{b})$, and taking the interest rate as a given, the buyer maximizes the expected

\textsuperscript{33}This corresponds to the irrevocable confirmed letters of credit. Detailed descriptions on various
kinds of letters of credit can be found, for example, in Venedikian and Warfield (2000).

\textsuperscript{34}Instead of introducing Assumption 3, we could have the precision level of inter-bank screening
$\bar{\alpha}_{\text{bank}}$ as an endogenous variable as we did for firms screening. We do not pursue this path because
it complicates the model without adding much insights.

\textsuperscript{35}Note that a buyer’s screening is done by the buyer’s local bank with domestic screening precision
level ($\alpha_{D}$), while a supplier’s screening is done by the supplier’s local bank with domestic screening
precision level ($\alpha_{D}$).
profit function:

$$\max_{p_b} \chi_G D \chi_G D[p_b q - p_s q r_b]$$

that yields the optimal final goods price:

$$p_b = \frac{1}{\rho} p_s r_b$$ \hspace{1cm} (1.25)

**Issuing Bank’s Problem (Buyer’s Bank)** Once the agreement to use a letter of credit is made (with probability $\gamma_D \gamma_D \gamma_{bank}$) and the intermediate goods are shipped (with probability $\chi_G^D$), the buyer’s bank has to meet the obligation to pay the supplier’s bank. $36$ $\varphi_b$ fraction of the total payment is secured by a buyer’s collateral, which will be collected if the buyer defaults (with probability $1 - \chi_G^D$). Unless the buyer defaults, the bank receives the repayment at the gross interest rate $r_b$ (i.e., a letter of credit fee). The expected profit of the buyer’s bank is then:

$$\max_{r_b} \chi_G D p_s q r_b + (1 - \chi_G^D) p_s q \varphi_b - p_s q$$ \hspace{1cm} (1.26)

and the corresponding optimal interest rate (a letter of credit fee) is:

$$r_b = \frac{1}{\rho} \left[ \frac{\chi_G^D \varphi_b + (1 - \varphi_b)}{\chi_G^D} \right] = \frac{1}{\rho} \left[ \varphi_b + \frac{(1 - \varphi_b)}{\chi_G^D} \right]$$ \hspace{1cm} (1.27)

The buyer’s cost of using a letter of credit decreases as the buyer can pledge more collateral or the reimbursement probability increases. Considering spatial competition between banks as addressed earlier, the equilibrium interest rate will be:

$$r(\varphi_b) = \min \left\{ \frac{1}{\rho}, t(z) \right\} \cdot \left[ \varphi_b + \frac{(1 - \varphi_b)}{\chi_G^D} \right]$$

$36$ For a letter of credit to be used for a transaction, it is necessary that a buyer passes a screening test by the buyer’s local bank (with probability $\gamma_D$), and a supplier and the buyer’s bank pass screening tests by the supplier’s local bank (with probability $\gamma_D \gamma_{bank}$).
and if we assume strong banking competition, the equilibrium interest rate becomes:

$$r(\varphi_b) = t(\tilde{\varphi}) \cdot \left[ \varphi_b + \frac{1 - \varphi_b}{\lambda_G^0} \right]$$  \hspace{1cm} (1.28)

**Supplier’s Problem**  The supplier’s bank is guaranteed to receive the payment from the buyer’s bank on behalf of the buyer, but at the same time promises to pay the supplier whether the buyer’s bank actually pays or not. Since the supplier receives the payment only after the successful production and delivery of the inputs (with probability $\chi_G^D$), the supplier still faces the working capital financing problem. A supplier with collateral parameter $\varphi_s$ borrows the total working capital from the bank at the interest rate $r(\varphi_s)$, and thus the cost function for the supplier is $q\tau_jw r(\varphi_s)$. With the letter of credit discount rate $\delta$ charged by the supplier’s bank, the supplier’s expected profit function becomes:

$$\max_{p_s} \chi_G^D \left[ (1 - \delta)p_s q - q\tau_jw r_s \right]$$

and the optimal input price is set as:

$$p_s = \frac{\tau_j w r_s}{\rho \cdot (1 - \delta)}$$  \hspace{1cm} (1.29)

**Confirming Bank’s Problem (Supplier’s Bank)**  The supplier’s bank would receive the payment from the buyer’s bank only if the buyer’s bank does not default (with probability $\chi_G^{bank}$), while the guaranteed payment with discounts is made to the supplier irrespective of the buyer’s bank default, as long as the intermediate goods are shipped without any problem (with probability $\chi_G^D$). The supplier completes the process by repaying the gross working capital loan. This is summarized in the following expected profit maximization problem:

$$\max_{\delta, r_s} \chi_G^D \left[ \chi_G^{bank} p_s q - (1 - \delta)p_s q + q\tau_jw r_s \right] + (1 - \chi_G^D)q\tau_jw \varphi_s - q\tau_jw$$  \hspace{1cm} (1.30)
Note that there are two choice variables for the supplier’s bank: the discount rate \( \delta \) for the letter of credit, and interest rate \( r_s \) for working capital loan. Solving the first order condition with regard to the discount rate, we get:

\[
\frac{1}{1 - \delta} = \frac{1}{\rho} \left[ \frac{(1 - \varphi_s) + \chi^D_G \varphi_s}{\chi^D_G \lambda^\text{bank}_G r_s} \right]
\]

as a function of \( r_s \) and other model parameters. This equation provides the set of combinations \((\delta, r_s)\) that maximizes the bank’s profit. Any pair of \((\delta, r_s)\) that satisfies the equation \((1.31)\) can be chosen by the profit maximizing bank. Without loss of generality, we will focus on one particular pair in order to simplify the mathematical expressions:

\[
r_s = \frac{1}{\rho} \left[ \varphi_s + \frac{(1 - \varphi_s)}{\chi^D_G} \right] \equiv \frac{1}{1 - \delta} = \frac{1}{\chi^\text{bank}_G}
\]

\[(1.32)\]

The supplier’s bank charges the constant discount rate for letters of credit across firms that is solely up to the counterpart bank’s default risk, but firms still face different borrowing costs depending on their pledgeability. Considering spatial competition between banks, the equilibrium interest rate is:

\[
r(\varphi_s) = \min \left\{ \frac{1}{\rho}, t(\zeta) \right\} \cdot \left[ \varphi_s + \frac{(1 - \varphi_s)}{\chi^D_G} \right]
\]

and strong banking competition leads to the following equilibrium interest rate:

\[
r(\varphi_s) = t(\zeta) \cdot \left[ \varphi_s + \frac{(1 - \varphi_s)}{\chi^D_G} \right]
\]

\[(1.33)\]

Substituting the supplier bank’s optimal discount and interest rate from equation \((1.32)\) and \((1.33)\) into equation \((1.29)\), we get the input price:

\[
p_s = \frac{t(\zeta) \tau_j \omega}{\rho} \left[ \chi^D_G \varphi_s + \frac{(1 - \varphi_s)}{\chi^\text{bank}_G \chi^D_G} \right]
\]

which, in turn, enters equation \((1.25)\) together with equation \((1.28)\) to yield the final good price:
\[ p_{L/C} = \frac{t(z)^2 \tau_j w}{\rho^2} \left[ \left( \frac{\lambda_G^D \varphi_s + (1 - \varphi_s)}{\lambda_G^D \lambda_G^D} \right) \frac{\lambda_G^D \varphi_b + (1 - \varphi_b)}{\lambda_G^D \lambda_G^D} \right] \] (1.34)

1.4.2 Optimal Payment System

In actual business transactions, we observe the letter of credit system being used exclusively for international transactions. In our model, this will be true if the expected profit from the letter of credit system is always smaller than the expected profit from cash-in-advance or open account system for domestic transactions, but not necessarily for international transactions. The incentive for using a letter of credit in international transactions comes from the asymmetric nature of screening tests for domestic and foreign firms. Since domestic screening is always superior to foreign screening, as shown in Proposition 1, passing along the task of screening foreign counterparts to their own domestic banks will reduce the overall credit risk of the transaction.\textsuperscript{37} However, using a letter of credit incurs additional costs involved in the screening procedure of the counterpart bank, due to inter-bank informational friction. The gains from a letter of credit will exceed the costs of using it if there is a large quality difference in domestic and foreign screening relative to the size of inter-bank informational friction. On the contrary, there would be no incentive to use a letter of credit for domestic transactions because it would result in no gain whatsoever.

This is illustrated in <Figure 1.4>. For domestic transactions, screening tests for both a supplier and a buyer are conducted by domestic banks at the same precision level, \( \alpha_D \), under both the letter of credit and the open account systems, implying no

\textsuperscript{37} Once we introduce the letter of credit system in the economy and the condition in Proposition 3 is met, it is easy to see that Propositions 1 and 2 not only remain valid, but are even strengthened. In other words, the difference in the precision level of screening between domestic and foreign firms gets even larger. This is because some of the international transactions will switch to the letter of credit system, while no such switch is made for domestic transactions. This leads to an even smaller volume of international transactions subject to banks’ foreign screening, and therefore, smaller marginal gains from foreign screening improvement. At the same time, the volume of transactions subject to banks’ domestic screening increases, and hence there are greater marginal gains from domestic screening improvement.
gains from using a letter of credit. Bank intermediation in the letter of credit system, however, gives rise to additional inter-bank screening to evaluate the creditworthiness of the counterpart bank \( \alpha_{\text{bank}} \). Therefore, compared to using an open account, using a letter of credit always incurs additional costs without any gain, and therefore will not be preferred to using an open account in domestic transactions. On the other hand, the open account system in international transactions involves a foreign screening test on a buyer’s credit (with \( \alpha_F \)), whereas the use of a letter of credit assigns this task to a buyer’s domestic bank, which can perform more accurately (with \( \alpha_D \)). There will be additional costs of inter-bank screening, but as long as the gains from a letter of credit outweigh the costs of using a letter of credit, the letter of credit will be preferred to the open account system in international transactions.

**Proposition 3** When
\[
t(z) : \left[ \frac{x_F}{x_D} \right]^{\sigma/(\sigma-1)} < x_D^{\text{bank}} < t(z)x_D^D \text{ holds, (i) there is no transaction using a letter of credit between domestic firms, and (ii) there are some international transactions using a letter of credit.}
\]

**Proof.** In the appendix. ■

The sufficient condition given in the above Proposition makes it clear that the result is more likely to hold as the quality gap between foreign and domestic screening widens (i.e., gains from using a letter of credit increase) for a given level of inter-bank informational friction (i.e., costs of using a letter of credit).

### 1.4.3 Banking Crisis and A Letter of Credit

We repeat the comparative statics by changing the firms and banks default rates \( \lambda \) and \( \lambda_{\text{bank}} \) to study their impacts on the export-to-domestic sales ratio, but now only for a set of collateral parameter pairs that chose a letter of credit as the optimal payment system for international transactions. For the other set of transaction pairs, the result will be the same as before. Again, we will focus only on the
short run response wherein the optimal payment system as well as the optimal level of information is predetermined.

From Assumption 1’, only good signaled banks are approved for issuing a letter of credit on behalf of buyers, and this occurs with probability $\gamma_{\text{bank}}$. Buyers and suppliers receive good signals from screening tests with probability $\gamma_D$, and $\chi^D$ fraction of them operate successfully. Therefore, the actual volume of successful international transactions for each pair $(\varphi'_s, \varphi'_b) \in \Psi_{L/C}$ under the letter of credit system is:

$$V^{F,L/C}(\varphi'_s, \varphi'_b) = \gamma_D \gamma_{\text{bank}}^\prime \chi^D x^D \cdot q^{F,L/C}(\varphi'_s, \varphi'_b)$$

$$= \gamma_D \gamma_{\text{bank}}^\prime \chi^D x^D \cdot A \left[ p^{F,L/C}(\varphi'_s, \varphi'_b) \right]^{-\sigma},$$

where $\Psi_{L/C}$ denotes a set of buyer-supplier pairs that chose a letter of credit as the optimal payment system for international transactions. Domestic transactions between buyers and suppliers in this set will be undertaken by an open account or a cash-in-advance (equation (1.23)), and thus the relative volume of export-to-domestic sales is:

$$V^{F,D,L/C} = \frac{V^{F,L/C}}{V^{D,k}} = \gamma_{\text{bank}} \left( \frac{p^{F,L/C}(\varphi'_s, \varphi'_b)}{p^{D,k}(\varphi'_s, \varphi'_b)} \right)^{-\sigma},$$

for $k = OA$ or $CA$.

Since the changes in the default rate have no effect on $\gamma_{\text{bank}}$ (i.e., $\frac{\partial \gamma_{\text{bank}}}{\partial \gamma_{\text{bank}}} = 0$), the cyclical property of the relative volume of export-to-domestic sales depends only on the movements in the relative price of export to domestic goods. The main determinant of the final goods price is the overall borrowing cost of each transaction, and the borrowing cost reflects the precision levels of screening tests involved. As an economy goes under and default rates increase, the potential risk of the loans will also increase, the degree of which will depend on the relative precision level of screening tests.

<Figure 1.5> gives an intuitive explanation on the cyclical property of the relative
price in this case. For an international transaction using a letter of credit, inter-bank screening is performed with the precision level $\alpha_{bank}$ and firms' screening with $\alpha_D$; the latter applies for a domestic transaction under an open account as well. As the firms default rate increases, the potential risks of a buyer and a seller increases but at the same rate for an international transaction using a letter of credit and a domestic transaction under an open account due to the identical precision level of screening tests. Thus, an increase in the firms default rate does not affect the relative price. However, the inter-bank dimension unique in the letter of credit system provides the channel through which the changes in the banks default rate drives the relative price away from the steady state level. An increase in the banks default rate leads to an increase in the price of the goods exported using a letter of credit without any impact on the domestic goods. This results in a counter-cyclical relative price, and hence a pro-cyclical movement in the export-to-domestic sales ratio. This movement will be proportional to the changes in the banks default rate, and therefore a banking crisis with a surge in the banks default rate is expected to accompany a drop in the export-to-domestic sales ratio as we saw during the recent trade collapse.

**Proposition 4** Exports using a letter of credit decline faster than domestic sales during recessions, and the opposite is true during booms. This is due to a counter-cyclical movement in the relative price of export to domestic goods, and is expected to be much more severe when a recession is accompanied by a banking crisis.

**Proof.** In the appendix. ■

The inter-bank dimension in the letter of credit system resembles the one in the inter-bank loan market. A banking crisis raises uncertainty about the counterparty default risk. This results in soaring inter-bank loan rates (Afonso, Kovner, and Schoar, forthcoming; Heider, Hoerova, and Holthausen, 2010). Similarly, an increase in the counterparty default risk raises the price of a letter of credit (IMF-BAFT, 2009). Since a letter of credit is used only for international transactions from Proposition 3,
this effect exacerbates a collapse in trade.

1.5 Loan Supply Shocks

Thus far, we have assumed that banks have an unlimited source of funds such that they can finance all the transactions that pass the screening test. The cyclical movement in the export-to-sales ratio discussed above is entirely driven by the changes in the relative financing costs due to the changes in the relative riskiness of the international transactions. Adverse loan supply shocks, however, often accompany economic downturns, and there is evidence that they may cause a recession by adversely affecting the real economic activity (e.g., Peek, Rosengren, and Tootel, 2003). This "credit channel" will be even more highlighted when it comes to a banking crisis such as the recent global recession. In particular, researchers suspect that exports will be more sensitive to negative loan supply shocks than domestic sales to the extent that banks may want to cut international trade finance business loans first for a "flight to safety" motive (Chauffour and Farole, 2009) or that the export activity is more "trade finance intensive" than the domestic activity (Amiti and Weinstein, 2009).

In the current framework of the model, we will show that negative loan supply shocks induce banks to cut the loans for international transactions first, because they are less profitable than the loans for domestic transactions. When there is a shortage of funds to finance all the qualified transactions, banks need to set priorities for their lending activities. The loans with higher expected profits will be made first, while the ones with lower expected profits are contingent on the availability of funds. To determine the order of priority, we compare a bank’s expected profits from each type of trade finance lending activity.

Plugging equation (1.14) into equation (1.1), and using equation (1.13), a bank’s expected profits from a trade finance lending to an open account transaction
(equation (1.11)) become:

\[ A' \lambda_G^D \lambda_G^j \left[ p_b^{j,OA}(\varphi_s) \right]^{1-\sigma}, \tag{1.35} \]

where \( A' = \rho^2 t(\bar{z})^{-1}(t(\bar{z}) - 1)RP^\sigma - 1 \) and similarly equations (1.16), (1.18), and (1.20) give the expression for a bank’s expected profits from a trade finance lending to a cash-in-advance transaction:

\[ \frac{1}{\rho} A' \lambda_G^D \lambda_G^j \left[ p_b^{j,CA}(\varphi_b) \right]^{1-\sigma}, \tag{1.36} \]

for \( j = D, F \) for domestic and international transactions respectively. Then, for any pair \((\varphi'_s, \varphi'_b)\) that transacts under an open account or a cash-in-advance system, we find that the expected profits from international trade finance loans are always lower than the ones from domestic trade finance loans:

\[ \tau_F^{1-\sigma} \left[ \left( \frac{\varphi'_k + \frac{1-\varphi'_s}{\lambda_G^D}}{\varphi'_k + \frac{1-\varphi'_s}{\lambda_G^D}} \right) \frac{\lambda_F}{\lambda_G} \left( \frac{\lambda_G}{\lambda_G} \right) < 1, \]

where \( k = b, s, \) and the inequality holds because \( \tau_F > 1 \) and \( \lambda_F < \lambda_G. \) Intuitively, a higher precision screening for domestic transactions makes domestic trade finance loans more likely to be repaid than international trade finance loans. This increases the profitability of domestic relative to international trade finance loans directly through the probability effect. In addition, a higher loan repayment probability lowers the cost of financing domestic relative to international transactions, and hence the price of domestic relative to export price. This indirectly raises the profitability of domestic relative to international trade finance loans through the volume effect.

Similarly, using equations (1.30), (1.32), (1.33), and (1.34), we can derive the following expected profits of a supplier’s bank from international letters of credit financing:
and equations (1.26), (1.28), (1.29), and (1.34) lead to a bank’s expected profits from supporting international transactions using a letter of credit on the buyer’s side as:

$$
\frac{1}{t(\tilde{z})} A' \left[ \frac{\chi^\text{bank}_G \chi^D_G \varphi_b}{\chi^D_G \varphi'_b + 1 - \varphi'_b} \right] \left[ p_b^{F,LC}(\varphi_s', \varphi_b) \right]^{1-\sigma},
$$

and equations (1.37), (1.38), (1.39), and (1.40) lead to a supplier’s bank’s expected profits from international letters of credit financing in equation (1.37), relative to the ones from domestic open account financing in equation (1.35), is less than one:

$$
\frac{1}{\rho} A' \chi^D_G \left[ \frac{p_b^{F,LC}(\varphi_s', \varphi_b)}{p_b^{D,CA}(\varphi'_s)} \right]^{1-\sigma} < 1,
$$

for any transaction pair \((\varphi'_s, \varphi'_b) \in \Psi_{L/C}\) with \(\varphi'_b \leq \varphi'_s\) as long as the condition for Proposition 3 is satisfied. Likewise, we construct the relative profits from international letters of credit financing on the buyer’s side to the ones from domestic cash-in-advance financing:

$$
\chi^D_G \left[ \frac{p_b^{F,LC}(\varphi_s', \varphi_b)}{p_b^{D,CA}(\varphi'_s)} \right]^{1-\sigma},
$$

for any transaction pair \((\varphi'_s, \varphi'_b) \in \Psi_{L/C}\) with \(\varphi'_b > \varphi'_s\), and the sufficient condition for this to be less than 1 is given as \(\tau_F^{1-\sigma} < \chi^D_G\). A reasonable value of \(\chi^D_G\) is very close to 1 in the real world, and thus the sufficient condition is very likely to be satisfied.

---

38 This inequality is least likely to hold when \(\varphi'_b = 1\), leaving the left hand side maximized with \([\chi^\text{bank}_G / (t(\tilde{z}) \chi^D_G)] \left[ p_b^{F,LC}(\varphi'_s', \varphi'_b) / p_b^{D,CA}(\varphi'_s) \right]^{1-\sigma}\). As shown in the proof of Proposition 3 in the appendix, since the sufficient condition for Proposition 3 is \(p_b^{D,LC}(\varphi'_s', \varphi'_b) / p_b^{D,CA}(\varphi'_s) > 1\), and \(p_b^{D,LC}(\varphi'_s', \varphi'_b) < p_b^{F,LC}(\varphi'_s', \varphi'_b)\), the left hand side reduces to \(\chi^\text{bank}_G / t(\tilde{z}) \chi^D_G\). This is less than one as long as the condition for Proposition 3 is met.

39 As long as the condition for Proposition 3 is met, i.e., \(p_b^{D,LC}(\varphi'_s', \varphi'_b) / p_b^{D,CA}(\varphi'_s) > 1\), since \(p_b^{F,LC}(\varphi'_s', \varphi'_b) = \tau_F p_b^{D,LC}(\varphi'_s', \varphi'_b)\), the sufficient condition becomes \(\tau_F^{1-\sigma} < \chi^D_G\).

40 If we match the average loan default rates for domestic and international trade financing, 0.20%
in the presence of even small trade costs. If we restrict our interests to this case, we conclude that.\footnote{We reach the same conclusion when we consider a bank’s per unit profitability instead. That is, international trade finance loans for an open account and a cash-in-advance yield the lowest per unit profit.}

**Proposition 5** When there is an adverse loan supply shock, banks will cut their loans for international transactions first, because an international trade finance business is less profitable than a domestic trade finance business.

### 1.6 Quantification

This section provides a quantitative exercise to gauge the importance of trade finance in explaining the pro-cyclical export-to-domestic sales ratio over a business cycle, and in particular, its importance in the great trade collapse during the recent banking crisis episode. The detailed procedure for the exercise is described below.

**Parameterization** We generate $500 \times 500$ transaction pairs $(\varphi_s, \varphi_b)$ with $\varphi_k$ drawn from the bounded Pareto distribution function between $[0, 1]$, for $k = s, b$. Each transaction pair parameter $(\varphi_s, \varphi_b)$ supports a domestic transaction and an international transaction, and hence the *ex post* joint distribution $G(\varphi_s, \varphi_b)$ for matched buyers and suppliers is identical for domestic and international transactions. We choose the Pareto shape parameter of 1.2, which is close to the one for U.S. firms’ size distribution studied in Axtell (2001) and Luttmer (2007). We fix the share of good firms and banks in the economy, $\mu_G$ and $\mu_{bank}$, as $1/2$, and set trade costs, $\tau_F$, as 1.1, and banking competition to be intense with $t(z) = 1.001$, implying .1% of markup over marginal costs of funds. The elasticity of substitution, $\sigma$, is chosen to be 3.8, and 0.35% respectively, with the ones from our model, $(1 - \chi_D^G \chi_D^P)$ and $(1 - \chi_D^P \chi_D^F)$, we get $\chi_D^P = 0.999$ and $\chi_D^F = 0.9975$. This is discussed in more detail in the next section.
following Bernard, Redding, and Schott (2008).\footnote{We take the average default rate of firms in the economy \((1 - \mu_G)\lambda\) in the model from Fisher (1999), who calculates the quarterly bankruptcy rate of 0.00974 for 1984-1990 using the Dun & Bradstreet database.\footnote{The average default rate of banks \((1 - \mu_{bank})\lambda_{bank}\) in the model is chosen as 0.0035 to be consistent with actual U.S. bank failure rates available from the FDIC.\footnote{These imply \(\lambda = 0.01948\) and \(\lambda_{bank} = 0.007\). Key parameters that generate the asymmetric nature of domestic and international trade finance are the precision levels of domestic and foreign firms’ screening tests, \(\alpha_D\) and \(\alpha_F\). To calibrate them, we match the average loan default rates for domestic and international trade financing, \(0.20\%\) and \(0.35\%\) respectively,\footnote{Export sales drop by around 2\% relative to domestic sales, and the export-to-domestic price ratio increases by about 42\%. They take this value based on the findings from Bernard, Eaton, Jensen, and Kortum (2003). This is also very close to the median value of 3.7 from Broda and Weinstein (2006).\footnote{For example, 3 banks out of 7,293 failed in 2007, and 4 banks out of 7,637 failed in 2004, but no bank failed in 2005 and 2006. The total number of banks can be found at (http://www2.fdic.gov/hsob/SelectRpt.asp?EntryTyp=10), and the failed banks list is available at (http://www.fdic.gov/bank/individual/failed/banklist.html).}}\footnote{This is reported by Industrial and Commercial Bank of China (ICBC), the only available source for such numbers (October 9th article in http://www.icbc.com.cn/icbc/icbc%20news/).\footnote{This is to reflect the seriousness of the recent banking crisis during which U.S. bank failure rate increased by 500\% over the period 2007-2009 as can be seen in the aforementioned FDIC website.} with the ones from our model, \((1 - \chi_G\chi_D)\) and \((1 - \chi_G\chi_F)\). This gives \(\alpha_D = 0.9487\) and \(\alpha_F = 0.8717\). Lastly, we calibrate the precision level for the inter-bank screening test, \(\alpha_{bank} = 0.722\), by matching the share of L/C transactions in total international transactions to be 35\% as reported in the survey by IMF-BAFT (2009).}}

\textbf{Loan Supply and Default Rate Shocks} Dotted lines in <Figure 1.6> and <Figure 1.7> illustrate the effects of the changes in the firms’ default rate \((\lambda)\) by up to 50\% as well as the effects of the changes in the banks’ default rate \((\lambda_{bank})\) by up to 500\% (i.e., moving from 0 to 7 in X axis).\footnote{This is to reflect the seriousness of the recent banking crisis during which U.S. bank failure rate increased by 500\% over the period 2007-2009 as can be seen in the aforementioned FDIC website.} Export sales drop by around 2\% relative to domestic sales, and the export-to-domestic price ratio increases by about up to 50\% as well as the effects of the changes in the banks’ default rate \((\lambda_{bank})\) by up to 500\% (i.e., moving from 0 to 7 in X axis). Export sales drop by around 2\% relative to domestic sales, and the export-to-domestic price ratio increases by about
5%. This suggests that although an increase in default rate leads to a larger drop in export relative to domestic sales, this alone would not generate such a dramatic trade collapse. Nevertheless, this effect cannot be dismissed because it amplifies the loan supply shock effect outlined below.

According to the Federal Reserve statistical release, total commercial and industrial loans made by the U.S. commercial banks declined by 10% between September 2008 and September 2009. Given that this is the result of declines in both loan demand and supply, we consider adverse loan supply shocks by up to 7%. Specifically, to look at the pure loan supply effects, we cut the loans for the least profitable transactions (bottom 0% ~7% of transactions), while keeping the default rate of both firms and banks (λ and λbank) fixed at the original level. The results are illustrated as dashed lines in Figure 1.6 and Figure 1.7. By cutting 7% of loan supply, export sales drop 14% more than domestic sales, and the export price index rises about 5.5% relative to the domestic price index. This indeed shows a sizeable role of trade finance, because a standard model without trade finance would predict equal drops in export and domestic sales, and no changes in export-to-domestic price ratio. Solid lines in Figure 1.6 and Figure 1.7 show the combined effects of default rate and loan supply shocks. Export sales drop further down by 15.5% relative to domestic sales, and the export-to-domestic price ratio increases by 6%.

How do these results compare to actual consequences of 2008-2009 financial crisis? Following the Lehman collapse, Japan and Euro countries, for example, experienced about 3% increase in export prices relative to domestic prices (Ahn et al., 2011), while exports dropped 20~25% more than domestic outputs. This suggests that demand factors dampened an increase in export-to-domestic price ratio by half (3/6), and trade finance alone can explain about 60% (15.5/25) of the great trade collapse. Although this implies a significantly larger role of trade finance than the findings from other studies (e.g., Eaton et al., 2011), it is important to point out

47The data is available at http://www.federalreserve.gov/datadownload/Choose.aspx?rel=H8
that since intra-firm trade is less likely to suffer from such trade finance effects, our results better describe the drops in inter-firm trade. Hence, we can conclude that trade finance has very significant effects on inter-firm trade, and given the large share of intra-firm trade in world trade, the actual role of trade finance in the overall trade collapse would have been lower than the one suggested above.

1.7 Conclusion

This paper presents a unique framework that explains the different nature of international relative to domestic trade finance. In particular, the current paper explains why international trade finance loans are riskier than domestic trade finance loans, and why a letter of credit is used exclusively for international trade. The model considers banks’ optimal screening decision in the presence of counterparty default risks. In equilibrium, banks will maintain a higher precision screening test for domestic firms and a lower precision screening test for foreign firms, which gives rise to the different nature of domestic and international trade finance. The model can explain the role of trade finance in the recent great trade collapse based on two results: first, the relative riskiness of international transactions to domestic transactions increases during economic downturns, and second, international trade finance is more sensitive to adverse loan supply shocks than domestic finance. Both lead to larger drops in trade than domestic output during a recession. The asymmetric nature of screening tests for domestic and foreign firms gives an incentive for using a letter of credit for some international transactions but not for any domestic transactions. This exacerbates the great trade collapse especially when a recession is triggered by a banking crisis.

Extensions of the model developed in this paper could be used to explore other interesting issues. The cyclical property of the screening tests is useful for the inter-bank loan market literature. The onset of the Lehman bankruptcy brought about
soaring inter-bank loan rates (Afonso et al., forthcoming). The current mechanism, which predicts soaring lending rates during a financial crisis, would be complementary to existing theory models based on Knightian uncertainty (Pritsker, 2010) or liquidity hoarding in the presence of adverse selection (Heider et al., 2010). Also, a direct extension of the model suggests the unique role of foreign banks in developing countries. Foreign banks will have a comparative advantage in evaluating the creditworthiness of the firms in their home countries, and thus will specialize in international trade finance business. Foreign lending supply shocks are, therefore, expected to have larger adverse impacts on trade than domestic activity. This will be an interesting agenda for future study.

Appendix

1.A.1 Proof of Propositions

Proposition 1 In equilibrium, the screening test for domestic firms has a higher precision level than the one for foreign firms ($\alpha^*_F < \alpha^*_D$).

Proof. A bank earns profits from domestic and international finance business, each of which encompasses open account and cash-in-advance transactions:

\[
\pi^i_{\text{bank}} = \pi^i_{\text{OA}} + \pi^i_{\text{CA}} = \frac{N}{n} Aw^{1-\sigma} \left[ \int_{\varphi_b \leq \varphi_s} B^j(\varphi_s)dG(\varphi_s, \varphi_b) + \int_{\varphi_b > \varphi_s} \frac{1}{\rho} B^j(\varphi_b)dG(\varphi_s, \varphi_b) \right] (1.39)
\]

where $B^j(\varphi_k) = \rho^{\varphi_k}_{\sigma-1} [\chi^D G \chi^j G \varphi_k + (1 - \varphi_k)]^{1-\sigma} (\chi^D G \chi^j G)^{\sigma}$, $k = s, b$ and $j = D, F$. $N/n$ in the above equation appears because the mass of transactions $(2N)$ for each pair $(\varphi_s, \varphi_b)$ equally splits into international and domestic transactions, and there are $n$ identical banks in each country with an identical market share.

Differentiating the banks’ profits from each line of business (equation (1.39))
with respect to $D$ and $F$ gives:

\[
\frac{\partial \pi^D_{\text{bank}}}{\partial \alpha_D} = \frac{\partial \chi^D_G \partial \pi^D_{\text{bank}}}{\partial \alpha_D \partial \chi^D_G} = \frac{\partial \chi^D_G}{\partial \alpha_D} \cdot \frac{N}{n} A w^{1-\sigma} \cdot 2 \left[ \int_{\phi_b \leq \phi_s} \frac{\partial B^D(\phi_s)}{\partial \chi^D_G} dG(\phi_s, \phi_b) + \int_{\phi_b > \phi_s} \frac{1}{\rho} \frac{\partial B^D(\phi_b)}{\partial \chi^D_G} dG(\phi_s, \phi_b) \right]
\]

\[
= 2 \frac{\partial \chi^D_G}{\partial \alpha_D} K(\chi^D_G) \chi^D_G,
\]

\[
\frac{\partial \pi^F_{\text{bank}}}{\partial \alpha_D} = \frac{\partial \chi^F_G \partial \pi^F_{\text{bank}}}{\partial \alpha_D \partial \chi^F_G} = \frac{\partial \chi^F_G}{\partial \alpha_D} \cdot \frac{N}{n} A w^{1-\sigma} \tau^1_j \left[ \int_{\phi_b \leq \phi_s} \frac{\partial B^F(\phi_s)}{\partial \chi^F_G} dG(\phi_s, \phi_b) + \int_{\phi_b > \phi_s} \frac{1}{\rho} \frac{\partial B^F(\phi_b)}{\partial \chi^F_G} dG(\phi_s, \phi_b) \right]
\]

\[
= \tau^1_j \frac{\partial \chi^F_G}{\partial \alpha_D} K(\chi^F_G) \chi^D_G,
\]

and

\[
\frac{\partial \pi^F_{\text{bank}}}{\partial \alpha_F} = \frac{\partial \chi^F_G \partial \pi^F_{\text{bank}}}{\partial \alpha_F \partial \chi^F_G} = \frac{\partial \chi^F_G}{\partial \alpha_F} \cdot \frac{N}{n} A w^{1-\sigma} \tau^1_j \left[ \int_{\phi_b \leq \phi_s} \frac{\partial B^F(\phi_s)}{\partial \chi^F_G} dG(\phi_s, \phi_b) + \int_{\phi_b > \phi_s} \frac{1}{\rho} \frac{\partial B^F(\phi_b)}{\partial \chi^F_G} dG(\phi_s, \phi_b) \right]
\]

\[
= \tau^1_j \frac{\partial \chi^F_G}{\partial \alpha_F} K(\chi^F_G) \chi^F_G,
\]

where $K(\chi^j_G) = \frac{N}{n} A w^{1-\sigma} \left[ \int_{\phi_b \leq \phi_s} L^j_s dG(\phi_s, \phi_b) + \int_{\phi_b \geq \phi_s} \frac{1}{\rho} L^j_b dG(\phi_s, \phi_b) \right]$ for $j = D, F$

and $L^j_k = \frac{\phi^\sigma}{\sigma-1} B^j(\phi_k) \left[ \frac{1-(1-\phi_k)^{\lambda-1}}{\chi^j_G \chi^s_G \phi_k + (1-\phi_k)} + \frac{\sigma}{\chi^j_G \chi^s_G} \right]$ for $k = s, b$. The first two equations correspond to the marginal gains from improving the domestic screening test:

\[
\frac{\partial \pi_{\text{bank}}}{\partial \alpha_D} = \left( \frac{\partial \pi^D_{\text{bank}}}{\partial \alpha_D} + \frac{\partial \pi^F_{\text{bank}}}{\partial \alpha_D} \right) = 2 \frac{\partial \chi^D_G}{\partial \alpha_D} K(\chi^D_G) \chi^D_G + \tau^1_j \frac{\partial \chi^F_G}{\partial \alpha_D} K(\chi^F_G) \chi^F_G, \quad (1.40)
\]
while the last equation expresses the marginal gains from improving the foreign screening test:

\[
\frac{\partial \pi_{\text{bank}}}{\partial \alpha_F} = \frac{\partial \pi_{\text{bank}}^F}{\partial \alpha_F} = \gamma_j^{1-\sigma} \frac{\partial X_G^F}{\partial \alpha_F} K(\chi_G^F) \chi_D^F
\]

(1.41)

In equilibrium, the marginal gains from improving each screening test should be equal to the marginal costs of improving each test:

\[
\frac{\partial \pi_{\text{bank}}}{\partial \alpha_j^*} = C'(\alpha_j^*)
\]

for \( j = D, F \).

We want to show that \( \alpha_D^* > \alpha_F^* \), but let us suppose first that \( \alpha_D^* \leq \alpha_F^* \) holds. Recalling Assumption 2, that the marginal cost is increasing in the precision level, it must be true that the marginal gains from improving the domestic screening test are smaller than the marginal gains from improving the foreign screening test:

\[
\frac{\partial \pi_{\text{bank}}}{\partial \alpha_D^*} \leq \frac{\partial \pi_{\text{bank}}}{\partial \alpha_F^*}
\]

(1.42)

From equations (1.4) and (1.5) in Lemma 1, it should also be true that \( \frac{\partial X_G^F}{\partial \alpha_F} \leq \frac{\partial X_G^D}{\partial \alpha_D} \) and \( \chi_D^D \leq \chi_D^F \) in equations (1.40) and (1.41), and hence \( \frac{\partial \pi_{\text{bank}}}{\partial \alpha_F} < \frac{\partial \pi_{\text{bank}}}{\partial \alpha_D} \), which leads to a contradiction of equation (1.42). Therefore, \( \alpha_D^* > \alpha_F^* \) must be true. ■

**Proposition 2** The export-to-domestic sales ratio is pro-cyclical in that it decreases as \( \lambda \) increases, and increases as \( \lambda \) decreases via both probability effect and price effect. This is the direct consequence of the counter-cyclical relative riskiness of international transactions.

**Proof.** (i) probability effect: we are interested in the sign of \( \frac{\partial}{\partial \ln \lambda} \left( \ln \frac{\beta_j}{\gamma_D} \right) \). Since \( \frac{\partial \ln \gamma}{\partial \ln \lambda} = 0 \) and \( \beta_j = \gamma_j \chi_j \), \( \frac{\partial \ln \beta_j}{\partial \ln \lambda} = \frac{\partial \ln \chi_j}{\partial \ln \lambda} \) holds, and thus it is sufficient to check the sign of \( \frac{\partial}{\partial \ln \lambda} \left( \ln \frac{\beta_j}{\gamma_D} \right) \). Part (ii) of Lemma 2 combined with Proposition 1 gives \( \frac{\partial \ln \gamma}{\partial \ln \lambda} < \frac{\partial \ln \chi_D}{\partial \ln \lambda} \), and hence \( \frac{\partial}{\partial \ln \lambda} \left( \ln \frac{\gamma_D}{\gamma_D} \right) < 0 \). Therefore, the probability effect term moves in a pro-cyclical way.
(ii) price effect: an interest rate for a given pair \((\varphi_s' > \varphi_b')\) under an open account system (equation (1.13)) is rewritten as 
\[ r(\varphi_s') = \frac{1}{\rho} \left[ \frac{1-(1-\chi_G^D\chi_G^F)\varphi_s'}{\chi_G^D} \right]. \]
Log of trade finance premium is therefore expressed as
\[ \ln \frac{r^{E}(\varphi_s')}{r^{D}(\varphi_s')} = \ln \chi_G^D - \ln \chi_G^F + \ln \left[ 1 - \varphi_s' + \chi_G^D \chi_G^F \varphi_s' \right] - \ln \left[ 1 - \varphi_s' + \chi_G^D \chi_G^F \varphi_s' \right]. \]
Differentiating this with respect to \(\lambda\) gives,
\[
\frac{\partial \ln \frac{r^{E}(\varphi_s')}{r^{D}(\varphi_s')}}{\partial \ln \lambda} = -\frac{\partial \ln \chi_G^D}{\partial \ln \lambda} \cdot \frac{(1 - \varphi_s')}{\left[ 1 - \varphi_s' + \chi_G^D \chi_G^F \varphi_s' \right]} + \frac{\partial \ln \chi_G^D}{\partial \ln \lambda} \cdot \left( \frac{1 - \varphi_s' + \chi_G^D \chi_G^F \varphi_s'}{\left[ 1 - \varphi_s' + \chi_G^D \chi_G^F \varphi_s' \right]} \right) + \frac{\partial \ln \chi_G^D}{\partial \ln \lambda} \cdot \left( \frac{1 - \varphi_s' + \chi_G^D \chi_G^F \varphi_s'}{\left[ 1 - \varphi_s' + \chi_G^D \chi_G^F \varphi_s' \right]} \right) + \frac{\partial \ln \chi_G^D}{\partial \ln \lambda} \cdot \left( \frac{1 - \varphi_s' + \chi_G^D \chi_G^F \varphi_s'}{\left[ 1 - \varphi_s' + \chi_G^D \chi_G^F \varphi_s' \right]} \right).
\]

Since \( \chi_G^E < \chi_G^D \) from Proposition 1, part (i) and part (ii) of Lemma 2 delivers \( I < III < 0 \), and Lemma 1 ensures \( II > IV > 0 \). Therefore, \( \frac{\partial \ln \frac{r^{E}(\varphi_s')}{r^{D}(\varphi_s')}}{\partial \ln \lambda} \) > 0, implying a counter-cyclical trade finance premium. Since \( \frac{p^{E, OA}_{\varphi_s', \varphi_b'}}{p^{D}_{\varphi_s', \varphi_b'}} = \tau_F^{E}(\varphi_s') \), the relative price of export to domestic goods is also counter-cyclical, and thus the price effect term moves in a pro-cyclical way as well when demand is elastic \((\sigma > 1)\). The same is true for \((\varphi_s' < \varphi_b')\) under a cash-in-advance system. ■

**Proposition 3** When \( t(\xi) \cdot \left[ \chi_G^E / \chi_G^D \right]^{\sigma/(\sigma-1)} < \chi_G^{bank} < t(\xi) \chi_G^D \) holds, (i) there is no transaction using a letter of credit between domestic firms, and (ii) there are some international transactions using a letter of credit.

**Proof.** In this proof, we focus on transaction pairs \((\varphi_s, \varphi_b) \in \Psi^{OA}\), where \(\Psi^{OA}\) is the set of pairs with \(\varphi_s \geq \varphi_b\). The same proof will hold for other pairs with an OA replaced by a CA. When a buyer has control over the payment system, to determine whether a letter of credit could be a preferred payment system over an open account system, we need to compare the buyer’s expected profit from using a letter of credit:
\[
\pi^{i,L/C}_{\varphi_s, \varphi_b} = \chi_G^D \chi_G^D \left[ A(1-\rho) \left( p^{i,L/C}_{\varphi_s, \varphi_b} \right)^{1-\sigma} \right]
\]
to the buyer’s expected profit from an open account system:
\[
\pi^{i,OA}_{\varphi_s, \varphi_b} = \chi_G^D \chi_G^D \left[ A(1-\rho) \left( p^{i,OA}_{\varphi_s, \varphi_b} \right)^{1-\sigma} \right],
\]
where \( j = D \) for domestic transactions and \( j = F \) for international transactions.

(i) The necessary condition for any L/C usage in domestic transactions would be \( p_{b}\overset{D,OA}{\longrightarrow} > p_{b}\overset{L/C}{\longrightarrow} \) for some pairs \((\varphi_s, \varphi_b)\). This condition will not be satisfied if the opposite holds for all pairs \((\varphi_s, \varphi_b) \in \Psi^{OA}:\)

\[
[\chi^D_G \chi^D_G \varphi_s + (1 - \varphi_s)] < \frac{t(z)}{\chi^D_G} \left[ \chi^D_G \varphi_s + (1 - \varphi_s) \right] \left[ \chi^D_G \varphi_b + (1 - \varphi_b) \right],
\]

Noting that \( [\chi^D_G \chi^D_G \varphi_b + (1 - \varphi_b)] < [\chi^D_G \varphi_b + (1 - \varphi_b)] \) because \( \chi^D_G < 1 \), the sufficient condition for the above inequality will be

\[
[\chi^D_G \varphi_s + (1 - \varphi_s)] < \frac{t(z)}{\chi^D_G} \left[ \chi^D_G \varphi_s + (1 - \varphi_s) \right] \left[ \chi^D_G \varphi_b + (1 - \varphi_b) \right], \forall (\varphi_s, \varphi_b) \in \Psi^{OA},
\]

which reduces to:

\[
1 < \frac{t(z)}{\chi^D_G} \left[ \chi^D_G \varphi_b + (1 - \varphi_b) \right], \forall (\varphi_s, \varphi_b) \in \Psi^{OA}
\]

The right hand side is minimized when \( \varphi_b = 1 \), and thus,

\[
\chi^D_{bank} < t(z)\chi^D_G
\]

ensures that there is no domestic transaction undertaken using a letter of credit.

(ii) Similarly, for international transactions, if one can show that:

\[
\chi^F_G \left[ A(1 - \rho) \left( p_{b}\overset{F,OA}{\longrightarrow} \right)^{1-\sigma} \right] < \chi^D_G \left[ A(1 - \rho) \left( p_{b}\overset{F,L/C}{\longrightarrow} \right)^{1-\sigma} \right]
\]

holds for any single pair \((\varphi_s, \varphi_b) \in \Psi^{OA},\) it is ensured that there is at least one pair \((\varphi_s, \varphi_b)\) that optimally chooses a letter of credit over an open account system. We will show first that the pair \((0, 0)\) is most likely to choose a letter of credit over an open account system, and then provide the condition under which the pair \((0, 0)\) finds it optimal to choose a letter of credit over the alternative payment systems. The above condition is rewritten as:

\[
\chi^F_G \left[ \frac{[\chi^D_G \chi^F_G \varphi_s + (1 - \varphi_s)]}{\chi^F_G} \right]^{1-\sigma} < \chi^D_G \left[ \frac{t(z)}{\chi^D_G} \left[ \chi^D_G \varphi_s + (1 - \varphi_s) \right] \left[ \chi^D_G \varphi_b + (1 - \varphi_b) \right] \right]^{1-\sigma}
\]
which reduces to

\[
\left[ \frac{\lambda^\text{bank}_G}{\lambda_G} \right] \cdot \left[ \frac{\chi_G^{D}}{\chi_G^{F}} \right]^{1/(1-\sigma)} \gtrsim \left[ \frac{\chi_G^{D} \varphi_s + (1 - \varphi_s)}{\chi_G^{D} \varphi_b + (1 - \varphi_b)} \right] \left[ \chi_G^{D} \varphi_s + (1 - \varphi_s) \right] / \left[ \chi_G^{D} \chi_G^{F} \varphi_s + (1 - \varphi_s) \right].
\]

This inequality is most likely to hold when the right hand side is minimized, which happens at \( \varphi_s = \varphi_b \), yielding:

\[
\left[ \frac{\lambda^\text{bank}_G}{\lambda_G} \right] \cdot \left[ \frac{\chi_G^{D}}{\chi_G^{F}} \right]^{1/(1-\sigma)} \gtrsim \left[ \frac{\chi_G^{D} \varphi_s + (1 - \varphi_s)}{\chi_G^{D} \chi_G^{F} \varphi_s + (1 - \varphi_s)} \right]^2.
\]

Moreover, the right hand side can be shown to be minimized at \( \varphi_s = 0 \).\(^{48}\) This implies that the inequality is most likely to be satisfied for \((\varphi_s, \varphi_b) = (0, 0)\) that gives:

\[
\chi^\text{bank}_G \gtrsim t(\tilde{z}) \cdot \left[ \frac{\chi_G^{D}}{\chi_G^{F}} \right]^{\sigma/(\sigma-1)} (1.44)
\]

Combining two inequalities (1.43) and (1.44), the condition for (ii) can be summarized as:

\[
t(\tilde{z}) \cdot \left[ \frac{\chi_G^{D}}{\chi_G^{F}} \right]^{\sigma/(\sigma-1)} \lesssim \chi^\text{bank}_G < t(\tilde{z}) \chi_G^{D} (1.45)
\]

In sum, when the condition (1.45) holds, it will be true that there is no transaction using a letter of credit between domestic firms, but there are some international transactions that use a letter of credit. For given parameter values, this condition is more likely to hold as domestic screening is relatively more precise than foreign screening, (i.e, \( \alpha_F/\alpha_D \) is lower). ■

**Proposition 4**  Exports using a letter of credit decline faster than domestic sales during recessions, and the opposite is true during booms. This is due to a counter-cyclical movement in the relative price of export to domestic goods, and is expected to be much more severe when a recession is accompanied by a banking crisis.

**Proof.** In this proof, we will focus on the transaction pair \((\varphi'_s, \varphi'_b) \in \Psi_{L/C}\)
with \( \varphi'_s \geq \varphi'_b \), but the same will hold for the other set of pairs (i.e., \( \varphi'_s < \varphi'_b \)) with CA instead of OA in the following.

\(^{48}\)That is, \( (\partial Q/\partial \varphi_s) > 0 \) for \( \varphi_s \in [0, 1] \), where \( Q = \left[ \chi_G^{D} \varphi_s + (1 - \varphi_s) \right] / \left[ \chi_G^{D} \chi_G^{F} \varphi_s + (1 - \varphi_s) \right] \).
We are interested in the cyclical property of the relative price of export to domestic goods, which is expressed as:

\[
\frac{p_{b}^{F.L/C}(\varphi'_s, \varphi'_b)}{p_{b}^{D.OA}(\varphi'_s, \varphi'_b)} = \frac{t(\varsigma)}{\chi_{G}^{\text{bank}}} \cdot \frac{[\chi_{G}^{D}\varphi'_s + (1 - \varphi'_s)] [\chi_{G}^{D}\varphi'_b + (1 - \varphi'_b)]}{[\chi_{G}^{D}\chi_{G}^{D}\varphi'_b + (1 - \varphi'_b)]}
\]

Taking log and totally differentiating the above equation gives:

\[
d\ln \left[ \frac{p_{b}^{F.L/C}}{p_{b}^{D.OA}} \right] = \left[ -\frac{2\varphi'_b}{\chi_{G}\chi_{G}^{D}\varphi'_b + (1 - \varphi'_b)} + \frac{\varphi'_s}{\chi_{G}\chi_{G}^{D}\varphi'_s + (1 - \varphi'_s)} + \frac{\varphi'_b}{\chi_{G}\chi_{G}^{D}\varphi'_b + (1 - \varphi'_b)} \right] d\lambda
\]

\[
\text{firm default effect}
\]

\[
\text{bank default effect}
\]

Note that \(\frac{dx_{G}^{D}}{d\lambda} < 0\) and \(\frac{dx_{G}^{\text{bank}}}{d\lambda_{\text{bank}}} < 0\), when \(d\lambda > 0\) and \(d\lambda_{\text{bank}} > 0\), the bank default effect term is always positive but the sign of the firm default effect term is ambiguous. If we limit to the case with \(\chi_{G}^{D} \simeq 1\), this reduces to:

\[
d\ln \left[ \frac{p_{b}^{F.L/C}}{p_{b}^{D.OA}}(\varphi'_s, \varphi'_b) \right] = - (\varphi'_b - \varphi'_s) \frac{dx_{G}^{D}}{d\lambda} d\lambda
\]

\[
\text{firm default effect}
\]

\[
\text{bank default effect}
\]

Since we are looking at the transaction pairs with \(\varphi'_s \geq \varphi'_b\), the firm's default effect term will be non-positive. However, we showed, in the proof of Proposition 3, that a letter of credit will be most likely to be chosen by the transaction pairs with \(\varphi'_s = \varphi'_b\). Therefore, if we restrict to the case with \(\varphi'_s \simeq \varphi'_b\), the firm default effect term becomes zero, and there remains the bank default effect term only, which is positive. Hence, the relative price of the export goods using a letter of credit to domestic goods increases as the banks default rate increases, and it decreases as the banks default rate decreases. Since this movement is proportional to the changes in the banks default rate, we expect a huge increase in the relative price during a banking crisis. \(\blacksquare\)
1.A.2 Allowing Borrower Specific Information

This appendix section relaxes the assumption that the information is market specific (i.e., domestic vs foreign), and allows the information on borrowers to be different from the information on other domestic and foreign firms. That is, now there are three distinct precision levels of screening tests: $\alpha_C$, $\alpha_D$, and $\alpha_F$. The main purpose of this appendix is to show that Proposition 1 is not simply driven by the particular assumption that the screening test on borrowers is the same as the one on other domestic firms, but the presence of trade costs is sufficient for Proposition 1.

Slightly modifying equations in the proof of Proposition 1, we have a bank’s profits function:

$$
\pi_{\text{bank}}^j = \pi_{\text{bank}}^{j,OA} + \pi_{\text{bank}}^{j,CA} = \frac{N}{n} Aw^{1-\sigma} \left[ \int_{\varphi_b \leq \varphi_s} B^j(\varphi_s) dG(\varphi_s, \varphi_b) + \int_{\varphi_b > \varphi_s} \frac{1}{\varphi_b} B^j(\varphi_b) dG(\varphi_s, \varphi_b) \right] \tag{1.46}
$$

where \( B^j(\varphi_k) = \frac{\partial^\sigma}{\sigma-1} \left[ \chi^C_G \chi^D_G \varphi_k + (1 - \varphi_k) \right]^{1-\sigma} \left( \chi^C_G \chi^D_G \right)^\sigma, \) \( k = s, b \) and \( j = D, F \). Differentiating the bank’s profits from each line of business (equation (1.46)) with respect to $\alpha_D$ and $\alpha_F$ gives:

$$
\frac{\partial \pi_{\text{bank}}^j}{\partial \alpha_D} = \frac{\partial \chi^D_G}{\partial \alpha_D} \frac{\partial \pi_{\text{bank}}^j}{\partial \chi^D_G} = \frac{\partial \chi^D_G}{\partial \alpha_D} \cdot \frac{N}{n} Aw^{1-\sigma} \cdot 2 \left[ \int_{\varphi_b \leq \varphi_s} \frac{\partial B^D(\varphi_s)}{\partial \chi^D_G} dG(\varphi_s, \varphi_b) + \int_{\varphi_b > \varphi_s} \frac{\partial B^D(\varphi_b)}{\partial \chi^D_G} dG(\varphi_s, \varphi_b) \right] \\
= \frac{\partial \chi^D_G}{\partial \alpha_D} K(\chi^D_G) \chi^C_G,
$$
and

\[
\frac{\partial \pi_{bank}^F}{\partial \alpha_F} = \frac{\partial \chi_G^F}{\partial \alpha_F} \frac{\partial \pi_{bank}^F}{\partial \chi_G^F} = 
\]

\[
= \frac{\partial \chi_G^F}{\partial \alpha_F} \cdot \frac{N}{n} A w^{1-\sigma} \tau_j^{1-\sigma} \left[ \int_{\varphi_b \leq \varphi_s} \frac{1}{\varphi_b} \frac{\partial B^F(\varphi_b)}{\partial \chi_G^F} dG(\varphi_s, \varphi_b) + \int_{\varphi_s > \varphi_b} \frac{1}{\varphi_s} \frac{\partial B^F(\varphi_b)}{\partial \chi_G^F} dG(\varphi_s, \varphi_b) \right]
\]

\[
= \tau_j^{1-\sigma} \frac{\partial \chi_G^F}{\partial \alpha_F} K(\chi_G^F) \chi_G^C,
\]

where \(K(\chi_G^j) = \frac{N}{n} A w^{1-\sigma} \left[ \int_{\varphi_b \leq \varphi_s} L^j \varphi_s dG(\varphi_s, \varphi_b) + \int_{\varphi_s > \varphi_b} \frac{1}{\varphi_s} L^j \varphi_s dG(\varphi_s, \varphi_b) \right] \) for \( j = D, F \).

L^{j,k} = \frac{\varphi_s}{\sigma-1} B^k(\varphi_s) \left[ \frac{(1-\sigma) \varphi_b}{\chi_G^j \chi_G^k + (1-\varphi_b)} + \frac{\sigma}{\chi_G^j \chi_G^k} \right] \) for \( k = s, b \).

The first equation corresponds to the marginal gains from improving the domestic screening test:

\[
\frac{\partial \pi_{bank}^D}{\partial \alpha_D} = \frac{\partial \pi_{bank}^F}{\partial \alpha_F} = \frac{\partial \chi_G^D}{\partial \alpha_D} K(\chi_G^D) \chi_G^C,
\]

while the last equation expresses the marginal gains from improving the foreign screening test:

\[
\frac{\partial \pi_{bank}^D}{\partial \alpha_D} = \frac{\partial \pi_{bank}^F}{\partial \alpha_F} = \tau_j^{1-\sigma} \frac{\partial \chi_G^F}{\partial \alpha_F} K(\chi_G^F) \chi_G^C
\]

For every level of \( \alpha_D \) and \( \alpha_F \) with a given \( \alpha_C \), equation (1.47) and (1.48) are identical except for the additional term \( \tau_j^{1-\sigma} < 1 \) in equation (1.48). The interpretation is as follows. The presence of trade costs leads to a smaller volume of international transactions relative to domestic transactions. Since the marginal gains from improving each screening test are proportional to the volume of transactions that benefit from that specific improved test, the marginal gains from improving the domestic screening test should be greater than the marginal gains from improving the foreign screening test. This is depicted in <Figure 1.3>, where the marginal gains curve for domestic screening improvement always lies above the one for foreign screening improvement. This establishes \( \alpha_D > \alpha_F \) in equilibrium.
In addition, we are also curious about the relative precision level of $\alpha_C$. To investigate this, we now derive the marginal gains from improving the borrower specific screening test:

$$
\frac{\partial \pi_{\text{bank}}}{\partial \alpha_C} = \frac{\partial \pi^D_{\text{bank}}}{\partial \alpha_C} + \frac{\partial \pi^F_{\text{bank}}}{\partial \alpha_C} = \frac{\partial \chi^C_G}{\partial \alpha_C} \frac{\partial \pi^D_{\text{bank}}}{\partial \chi^C_G} + \frac{\partial \chi^C_G}{\partial \alpha_C} \frac{\partial \pi^F_{\text{bank}}}{\partial \chi^C_G}
$$

$$
= \frac{\partial \chi^C_G}{\partial \alpha_C} K(\chi^D_G)^2 + \tau^{1-\sigma} \frac{\partial \chi^C_G}{\partial \alpha_C} K(\chi^F_G)^2.
$$

(1.49)

where $K(\chi^j_G)$ is as before.

Let us first suppose that $\alpha^*_C \leq \alpha^*_D$ in equilibrium. Again, from Assumption 2, it must be true that the marginal gains from improving the borrower specific screening test is smaller than the marginal gains from improving the foreign screening test:

$$
\frac{\partial \pi_{\text{bank}}}{\partial \alpha^*_C} \leq \frac{\partial \pi_{\text{bank}}}{\partial \alpha^*_D}
$$

(1.50)

From equations (1.4) and (1.5) in Lemma 1, it should be also true that $\frac{\partial \chi^D_G}{\partial \alpha^*_C} \leq \frac{\partial \chi^D_G}{\partial \alpha^*_D}$ and $\chi^*_G \leq \chi^*_D$ in equations (1.47) and (1.49), and hence $\frac{\partial \pi_{\text{bank}}}{\partial \alpha^*_D} < \frac{\partial \pi_{\text{bank}}}{\partial \alpha^*_C}$, which leads to a contradiction to equation (1.50). Therefore, $\alpha^*_C > \alpha^*_D$ must hold. We conclude that the order of the screening precision level is $\alpha^*_C > \alpha^*_D > \alpha^*_F$. 

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Figures

Figure 1.1: Property of Screening Tests
Figure 1.2: Screening Tests in OA and CA
Figure 1.3: Optimal Investment in Screening Tests
Figure 1.4: L/C vs OA in domestic transactions

Figure 1.5: Cyclicality of the Relative Export Price (L/C) to Domestic Price (OA)
Figure 1.6: Export-to-Domestic Sales Ratio

Y axis plots % changes in export-to-domestic sales ratio. X axis is scaled such that every point in X axis stands for 2% decline in loan supply, (50/7)% increase in firms default rate, and (500/7)% increase in banks default rate.

Figure 1.7: Export-to-Domestic Price Ratio

Y axis plots % changes in export-to-domestic price ratio. X axis is scaled such that every point in X axis stands for 2% decline in loan supply, (50/7)% increase in firms default rate and (500/7)% increase in banks default rate.
Chapter 2

Heterogeneous Firms, Horizontal FDI, and Welfare Implications

2.1 Introduction

"Foreign direct investment can be a Faustian bargain. In the short-run, it may bring benefits, but, in the long-run, it may actually be bad for economic development."

- Chang (2008, p.100)

Foreign Direct Investment (FDI) liberalization is often seen as a key step toward development in developing countries. Asian Development Bank, for example, attributes the rapid growth in Asian countries to the deregulation of foreign capital brought on by the introduction of FDI (Asian Development Outlook, 2004). Another example is a report from the OECD, which concluded that one way for South Korea to boost its productivity growth is to provide a better environment for FDI (OECD Policy Brief, June 2007). Although there has been ongoing intense academic debate on the gains from free capital mobility, when it comes to FDI the debate is muted; even a leading skeptic on free capital mobility, Jagdish Bhagwati, takes a position that attracting FDI is beneficial, unlike short-term portfolio capital flows (Bhagwati,
Indeed, governments in developing countries did not shy away from sharing such a view. Several episodes of FDI law reform featured various kinds of deregulation that include expediting administrative procedures, increasing the stakes that foreigners can hold, and treating foreign and national investors the same. Even developed countries like the U.S. or UK are seen to offer tax holidays, tariff exemptions, and subsidies for infrastructure to attract FDI (Harrison and Rodríguez-Clare, 2010).

Behind such a strong consensus lie the theoretical channels through which FDI benefits host countries. Apart from the job creation and capital formation effect that directly come with inward FDI, several additional effects have been predicted. Entering foreign firms can benefit the host country by improving local upstream industries through the increased demand for inputs, which in turn improves local downstream industries (backward and forward linkages). Given the well-rooted notion that foreign firms have better performance, the advanced technology embodied in foreign firms can be transferred to local firms (the technology spillover effect). In addition, the entry of foreign firms may raise the intensity of competition, reducing the inefficiency of local markets (the pro-competitive effect).¹

It is, then, rather surprising that there is weak empirical evidence that host countries benefit from FDI. Empirical studies that have estimated the effect of FDI on local firms provide mixed results, partly dependent on the quality of data, methodologies used, and the countries that are studied.² For example, Aitken and Harrison (1999) find a negative spillover effect in Venezuela, whereas Haskel, Pereira, and Slaughter (2007) and Keller and Yeaple (2008) report positive spillover effects in the UK and U.S., respectively. Aitken and Harrison (1999) attribute the negative

¹Formal description of each channel is developed in Rodríguez-Clare (1996) for backward and forward linkages, Findlay (1978) and Glass and Saggi (1998, 2002) for the technology spillover effect, and Barba-Navaretti and Venables (2004) for the pro-competitive effect.

²Görg and Greenaway (2003), Lipsey and Sjöholm (2005), and Barba-Navaretti and Venables (2004, ch7) provide rich surveys on this topic. Based on such observations, Hanson (2001) casts doubts on the validity of economic policies that promote FDI.
spillover to the market stealing effect caused by entering foreign firms. This is not necessarily inconsistent with the abovementioned pro-competitive effect, which predicts that more productive foreign firms would force less productive local firms out of the industry, raising the average productivity in the industry and bringing welfare gain. Thus, seemingly conflicting empirical evidence might be univocal. *Is that really so?*

This paper provides a formal framework to re-evaluate the pro-competitive effect of FDI, and shows that market stealing FDI eventually deteriorates the welfare of the host country in the long-run. The framework is adapted from the work of Melitz (2003), and FDI is introduced into the model *à la* Helpman, Melitz and Yeaple (2004).³ A heterogeneous firms model is particularly well-suited in this context because it predicts which firms will ultimately become multinational corporations (MNCs) based on their productivity levels.⁴ The model is then developed to examine the welfare effect of horizontal FDI in source and host countries. Since the model assumes full employment and introduces neither a technology spillover nor backward/forward linkages, the model provides an ideal laboratory for the purpose, leaving the pro-competitive effect as the only channel through which FDI can benefit a host country.

There has been little research evaluating the welfare implications of FDI in this context. Helpman et al. (2004) do not go far enough to reach the welfare consequence of FDI. A notable exception is Chor (2009), who shows that the host country always gains from liberalizing FDI. However, the particular assumption of a

³Following Helpman et al. (2004), horizontal FDI is the only form of FDI that will be discussed in this study. Henceforth, all references to FDI should be considered as horizontal FDI only. It has been reported that substantial amount of total FDI is considered as horizontal FDI (Brainard, 1997). Even a very conservative approach identifies around half of total FDI can be classified as horizontal FDI (Alfaro and Charlton, 2009).

⁴Markusen and Venables (1998, 2000) analyze the homogeneous firms model with MNCs in oligopoly and monopolistic competition markets. Since firms are identical, MNCs are arbitrarily chosen and there is no such pro-competitive effect.
country of origin specific market in his model, that restricts the degree of substitution between Home and Foreign goods, prevents the full-blown pro-competitive effect.

In this sense, the current study is the first to investigate the pro-competitive effects of FDI in a heterogeneous firms setting. The model yields several interesting results. First, when FDI is symmetric (two-way), both countries benefit from FDI. This is quite intuitive and similar to the case of opening trade described in Melitz (2003). Consumers enjoy a reduction in the price of FDI goods, and resources are reallocated through FDI toward more productive firms.

To break down the welfare improving effect of FDI into host- and source-country effects, asymmetric (one-way) FDI equilibrium is introduced. In particular, the model is modified such that FDI flows only from the one source country to the other host country. The results of such a model are somewhat counterintuitive. I find welfare improves in the source country and deteriorates in the host country in the long-run.\(^5\)

On opening FDI, consumers in the host country enjoy lower priced FDI goods from the source country. At the same time, entry of more productive foreign firms causes the least productive local firms to exit, raising the average productivity of the industry and lowering the overall price level. This is the short-run benefits of inward FDI, which has been understood as the pro-competitive effect of FDI. After allowing the mass of firms to adjust, however, the model predicts the long-run losses of inward FDI. In the host country, the tougher competition due to the presence of lower-priced FDI products reduces the profitability of average domestic firms, discouraging new domestic firms from entering the market. As a result, in the long-run, the mass of domestic entrants decreases, leading to a lower domestic cutoff productivity level and a higher overall price level.\(^6\) The opposite reasoning holds for the source country.

\(^5\)Leahy and Montagna (2000) also discuss the possibility that inward FDI might reduce the host country’s welfare, particularly when local firms compete with foreign firms and there is a centralized wage bargaining in an industry.

\(^6\)Markusen and Stähler (2009) highlights the important distinction between endogenous and fixed
Thus, the model formalizes the cautions stated by critics of globalization, from Stiglitz (2002) to Chang (2008), that FDI would eventually deter national entrepreneurs from starting a business.

This type of production relocation effect is parallel to the results from unilateral trade liberalization that emerges in Venables (1987), Melitz and Ottaviano (2008), and Ossa (2011). Opening FDI in the host country means "liberalization" for, in particular, the more productive source country firms that can afford to pay large FDI fixed cost, and this new profit opportunity implies firms will be more likely to locate in the source country. In other words, firms prefer to locate in the source country because they can access both markets more efficiently there. Thus, the host country consumers end up having to pay the transport costs for goods shipped from the source country that originally would have been produced domestically. This more than offsets the initial benefits from price reduction in FDI goods.

Lastly, I consider the welfare effect of trade liberalization in a model that includes FDI. In earlier studies that did not introduce FDI, trade liberalization effectively amounted to lowering trade costs, raising the profitability of exporting firms. This was the only mechanism through which trade liberalization affected the market. In the presence of MNCs, this effect still remains present, but, simultaneously, the decline in trade costs reduces the surplus profits available to MNCs. The former mechanism drives welfare gains, whereas the latter works in the opposite direction by weakening the incentives for FDI. Although the net effect proves to be always positive, the results suggest that gains from bilateral trade liberalization would dwindle as countries host more FDI.

The next section of the paper introduces the basic model framework. Then, section 3 compares the equilibrium of the model when FDI is two-way symmetric, to entry/exit decisions in studying the effects of greenfield and acquisition FDI.

7 The current terminology of "production relocation effect" is somewhat misleading as it suggests that existing firms are footloose. Although it would be more precise to describe the mechanism as "entry effect", I keep the terminology so as to be compatible with the literature.
the one with one-way asymmetric FDI. Section 4 further discusses the welfare effects of trade liberalization in the presence of FDI, and Section 5 concludes.

2.2 The Basic Model Framework

2.2.1 Consumption

There are two countries, Home \((H)\) and Foreign \((F)\), and I assume identical consumer preference across countries. The representative consumer’s utility depends on consumption of both homogeneous goods and differentiated goods. Utility is characterized by a standard Cobb-Douglas utility function:

\[
U = C_A^{\alpha_A} C_D^{\alpha_D},
\]

where \(C_A\) denotes the consumption of homogeneous goods and \(C_D\) is a CES aggregate over the consumption of differentiated goods. The expenditure share on each type of goods satisfies \(\alpha_A + \alpha_D = 1\). The CES aggregate over the consumption of differentiated goods is further defined by:

\[
C_D = \left[ \int_{\omega \in \Omega} q(\omega)^\rho d\omega \right]^{\frac{1}{\rho}},
\]

where \(\Omega\) is the set of total available varieties in the differentiated goods sector. The corresponding aggregate price index for the differentiated goods sector is then expressed as:

\[
P_D = \left[ \int_{\omega \in \Omega} p(\omega)^{1-\sigma} d\omega \right]^{\frac{1}{1-\sigma}},
\]

where \(\sigma = \frac{1}{1-\rho} > 1\) is the constant elasticity of substitution across varieties.

In addition, I assume that each consumer supplies one unit of labor inelastically, and the population size, \(L\), is identical across countries.
2.2.2 Production

Homogeneous goods are produced by identical, constant returns to scale technology. Specifically, I assume that one unit of homogeneous goods is produced by one unit of labor. Thus, if I normalize wage rate to one, the price of homogeneous goods produced domestically would also be one. Further, homogeneous goods are assumed to be traded freely without any additional costs. This implies that the wage rate is equalized across countries as long as homogeneous goods are produced in both countries.\(^8\)

The differentiated goods sector follows the basic structure of Melitz (2003) in which FDI is introduced \(à la\) Helpman et. al. (2004). There is a continuum of firms in a monopolistically competitive market, and each firm produces a unique variety with constant marginal cost and fixed per period overhead cost. Firms are heterogeneous in productivity, which is defined as the inverse of marginal cost. Specifically, technology is such that the amount of labor required to produce \(q\) units for a firm with productivity level \(\varphi\) is:

\[
l = f + \frac{q}{\varphi}
\]

To enter the market, each firm has to pay fixed entry cost, \(f_e\), and draw a productivity level from a given distribution \(g(\varphi)\). Upon entry, conditional on productivity draw \(\varphi\), a firm has the option to exit the market. If a firm remains in the market, conditional again on \(\varphi\), it makes a second decision of whether it will serve the foreign market in addition to domestic market.\(^9\) Once a firm has decided to serve the foreign market, the firm can choose the mode of serving the foreign market, exporting or FDI.

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\(^8\)In this study, I do not consider the case in which either country specializes in one sector.

\(^9\)I assume that only firms serving the domestic market can serve the foreign market. This is guaranteed by restricting the fixed cost of exporting to be larger than a threshold value. In the case of a symmetric model, this value is \(f_x > \tau^{1-\sigma} \cdot f\). In the asymmetric case, \(f_x > \tau^{1-\sigma} \cdot f \cdot A\), where \(A > 1\) is relative domestic cutoff level between countries (See equation (2.9a)).
Horizontal FDI is defined such that firms can bring their own technology (i.e., productivity level, \( \varphi \)) to a foreign country and serve the foreign market directly through local production. The fixed per period cost of FDI, \( f_I \), is greater than fixed per period cost for exporting, \( f_x \), reflecting that FDI firms have to duplicate production facilities abroad.\(^{10}\) Hence, there exists a proximity-concentration tradeoff in that a firm’s incentive to choose FDI and, therefore, save on trade costs is counterbalanced by higher fixed cost associated with FDI. Finally, I impose that every incumbent faces an exogenous exit shock in each period, which is characterized by a constant probability \( \delta \).

A profit maximizing firm with a productivity level \( \varphi \) sets the optimal price as a mark up over marginal cost:

\[
\text{price for domestic goods: } p_{dJ}(\varphi) = \frac{1}{\rho \varphi} \quad (2.2a) \\
\text{price for exporting goods: } p_{xJ}(\varphi) = \frac{\tau}{\rho \varphi} \quad (2.2b) \\
\text{price for FDI goods: } p_{IJ}(\varphi) = \frac{1}{\rho \varphi} \quad (2.2c)
\]

for \( J = H, F \)

### 2.2.3 Cutoff Productivity Condition

Firms decide to serve each market only when it is profitable to do so. This fact naturally leads to the following cutoff conditions for domestic and foreign markets. A firm will be active only when it can cover the fixed cost of domestic production. Among active firms, only those who can cover the associated fixed cost of exporting will serve the foreign market. And, finally, only those that find FDI more profitable

---

\(^{10}\) Throughout the paper, I assume fixed cost of FDI sufficiently higher than that of exporting so that only the most productive firms opt FDI over exporting. More specifically, \( f_I > \tau^{\sigma-1} \cdot f_x \) as in Helpman et.al. (2004). This assumption is consistent with empirical evidence (e.g., Head and Ries, 2003).
than exporting will switch from exporting to FDI. These cutoff conditions are described by the following set of equations:

\begin{align*}
\text{cutoff for domestic market: } & \pi_d^J(\varphi_d^J) = \frac{r_d^J(\varphi_d^J)}{\sigma} - f = 0 \tag{2.3a} \\
\text{cutoff for exporting: } & \pi_x^J(\varphi_x^J) = \frac{r_x^J(\varphi_x^J)}{\sigma} - f_x = 0 \tag{2.3b} \\
\text{cutoff for FDI: } & \pi_I^J(\varphi_I^J) = \frac{r_I^J(\varphi_I^J)}{\sigma} - f_I = \pi_x^J(\varphi_x^J) = \frac{r_x^J(\varphi_x^J)}{\sigma} - f_x \tag{2.3c}
\end{align*}

for \( J = H, F \), and \( f_I^J \) is the fixed cost for FDI that a firm from \( J \) country has to pay in the other country. The domestic revenue for a firm with productivity \( \varphi \) is given by:\

\begin{align*}
\text{domestic revenue: } & r_d^J(\varphi) = R^J \cdot \left( \frac{P_d^J}{\bar{p}_d^J(\varphi)} \right)^{\sigma-1} = R^J \cdot (\rho \varphi P_D^J)^{\sigma-1} \tag{2.4a} \\
\text{export revenue: } & r_x^J(\varphi) = R^{-J} \cdot \left( \frac{P_D^{-J}}{\bar{p}_d(\varphi)} \right)^{\sigma-1} = \tau^{1-\sigma} \cdot \left( \frac{P_D^{-J}}{P_D} \right)^{\sigma-1} \cdot \left( \frac{R^{-J}}{R^J} \right) \cdot r_x^J(\varphi) \tag{2.4b} \\
\text{FDI revenue: } & r_I^J(\varphi) = R^{-J} \cdot \left( \frac{P_D^{-J}}{\bar{p}_I(\varphi)} \right)^{\sigma-1} = \tau^{\sigma-1} \cdot r_x^J(\varphi) \tag{2.4c}
\end{align*}

where \( R^J = \alpha_D L \) is total expenditure on the differentiated sector in country \( J \), and \(-J\) denotes \( J \)'s trading partner.

### 2.2.4 Free Entry Condition

When new firms face no barriers to entry outside of the fixed cost, an equilibrium with positive production of any variety requires that the present value of expected profit from entry must be equal to entry cost, \( f_e \). Given an exogenous exit rate \( \delta \), the free entry condition is then expressed as:

\[
V_J = \left[ 1 - G(\varphi_d^J) \right] \cdot \left[ \frac{r_d^J(\varphi_d^J)}{\delta} + \chi_x^J \cdot \bar{p}^J_x + \chi_I^J \cdot \bar{p}^J_I \right] = \left[ 1 - G(\varphi_d^J) \right] \cdot \frac{\bar{p}^J_I}{\delta} = f_e \tag{2.5}
\]

for \( J = H, F \), where \( \bar{p}_d \) is the average profit across firms from domestic market, \( \bar{p}_x \) is the average profit from exporting, and \( \bar{p}_I \) is the average profit abroad from FDI. \( \chi_x \) is
the probability of exporting, conditional on successful entry, and \( \chi_I \) is the probability of FDI, conditional on successful entry. It follows that \( \frac{\pi}{\alpha} \) denotes the present value of average expected profit of firms conditional on successful entry, while \( 1 - G(\varphi_d^*) \) is the probability of successful entry.

### 2.2.5 Aggregate Revenue Condition

In equilibrium, the goods market must be cleared for every sector in each country. This amounts to the requirement that total expenditure in the differentiated good sector in country \( J \) equals the sum of domestic and foreign firms’ revenue from market \( J \):

\[
[M_J \cdot r_d^J(\varphi_d^*) + M_{-J} \cdot \chi_x^J \cdot r_x^{-J}(\varphi_x^{-J}) + M_{-J} \cdot \chi_I^{-J} \cdot r_I^{-J}(\varphi_I^{-J})] = \alpha_D L \tag{2.6}
\]

for \( J = H, F \), where \( M_J \) is the mass of national incumbent firms in country \( J \). The weighted average productivity of domestic firms serving \( J \)'s domestic market is defined as

\[
\tilde{\varphi}_d^* = \left[ \frac{1}{1 - G(\varphi_d^*)} \int_{\varphi_d^J}^{\infty} \varphi^{\sigma-1} \cdot g(\varphi) d\varphi \right]^{\frac{1}{\sigma-1}}
\]

Likewise, the weighted average productivity of domestic firms that export and domestic firms that conduct FDI are defined as

\[
\tilde{\varphi}_x^* = \left[ \frac{1}{G(\varphi_x^J) - G(\varphi_x^*)} \int_{\varphi_x^J}^{\varphi_x^*} \varphi^{\sigma-1} \cdot g(\varphi) d\varphi \right]^{\frac{1}{\sigma-1}}
\]

and

\[
\tilde{\varphi}_I^* = \left[ \frac{1}{1 - G(\varphi_I^*)} \int_{\varphi_I^J}^{\infty} \varphi^{\sigma-1} \cdot g(\varphi) d\varphi \right]^{\frac{1}{\sigma-1}}
\]
respectively. As shown in Melitz (2003), the weighted average productivity for each group is the same as a representative firm’s productivity in a group such that average revenue and profit are equal, respectively, to the revenue and profit of a firm with weighted average productivity. The steady state equilibrium implies that net flow in the mass of firms to be zero, i.e., \( M_J^c \left[ 1 - G(\varphi^*_d) \right] = \delta M_J \), where \( M_J^c \) is the mass of domestic entrants in country \( J \).

### 2.2.6 Balance of Trade Condition

The total value of imports should be equal the total value of exports in each country. In a symmetric setting, since there is no trade flow within the homogeneous good sector, this implies that the total value of imports in the differentiated goods sector must equal the total value of exports in the differentiated goods sector, or:

\[
M_J \cdot \chi_x^J \cdot r_x^J(\tilde{\varphi}_x^J) = M_{-J} \cdot \chi_x^{-J} \cdot r_x^{-J}(\tilde{\varphi}_x^{-J}) \quad (2.7a)
\]

In an asymmetric world, the trade balance condition needs not be binding at the sector level. Instead, sector level net export will be determined after taking into account the FDI profit that is repatriated from foreign country, satisfying current account balance between countries. That is, net export in differentiated sector, net export in homogeneous sector and repatriated profit via FDI firms must sum to zero, or:

\[
NX_J^D + NX_J^H + \Pi_I = 0 \quad (2.7b)
\]

### 2.3 Equilibrium of the Model

I define the welfare measure as the real wage level. When the nominal wage level is equalized across countries and normalized to one, the inverse of the price
level becomes the welfare measure. Since the price of homogeneous goods is fixed at one, the relevant price level to look at is the aggregate CES price index for the differentiated goods sector in each country.

**Lemma 3** The welfare level of a country can be completely characterized by the domestic cutoff productivity level for given parameter values in the economy. Specifically,

\[ P_D^J = \frac{1}{\rho} \left( \frac{R^J}{\sigma f} \right)^{\frac{1}{1-\sigma}} \cdot \frac{1}{\varphi_d^{x^J}} \]  

(2.8)

for \( J = H, F \).

**Proof.** It follows directly from equations (2.3a) and (2.4a). □

The above lemma ensures that it is sufficient to derive a domestic cutoff productivity level for each country in order to access a country’s welfare level. The higher the domestic cutoff productivity is, the higher the aggregate price level is, and the better off the country becomes. One can derive the equilibrium domestic cutoff productivity level by combining the cutoff productivity condition and the free entry condition. The equations that characterize the cutoff productivity conditions, equation (2.3a)-(3c), can be further solved to express cutoff levels for exporting and FDI as functions of trading partner’s domestic cutoff level:

\[ \varphi_{x^J} = \tau \cdot \left( \frac{f_x}{f} \right)^{\frac{1}{\sigma-1}} \cdot \varphi_d^{x^J} \]  

(2.9a)

\[ \varphi_{I^J} = \left( \frac{f_I^J - f_x}{f} \right)^{\frac{1}{\sigma-1}} \cdot \left( \frac{1}{1 - \tau^{1-\sigma}} \right)^{\frac{1}{\sigma-1}} \cdot \varphi_d^{x^J} \]  

(2.9b)

for \( J = H, F \).

---

11This is true for both symmetric and asymmetric equilibrium because the domestic cutoff productivity level always depends on the domestic price level from the cutoff condition.

12This is derived from the property that \( \left( \frac{\varphi}{\varphi_d} \right)^{\sigma-1} = \frac{r(\varphi')}{r(\varphi)} \) from equation (2.4a).
To facilitate the welfare analysis in following sections, the free entry condition in (2.5) is tweaked as:

\[ f_e = \frac{f}{\delta} \left[ \int_{\varphi_d^J}^{\infty} \left[ \left( \frac{\varphi}{\varphi_d^J} \right)^{\sigma-1} - 1 \right] \cdot g(\varphi) d\varphi \right] + \frac{K}{\delta} \left[ \int_{\varphi_d^J}^{\infty} \left[ \left( \frac{\varphi}{\varphi_d^J} \right)^{\sigma-1} - 1 \right] \cdot g(\varphi) d\varphi \right] + \int_{\varphi_d^J}^{\infty} \left[ \left( \frac{\varphi}{\varphi_d^J} \right)^{\sigma-1} - 1 \right] \cdot g(\varphi) d\varphi \]

(2.10)

for \( J = H, F \).

It shows that the profit made abroad through FDI is composed of two parts: the profit that would have been earned through exporting, and the extra profit available via FDI over exporting. Once equation (2.9a) and (9b) are substituted into equation (2.10), it reduces to two equations with two unknown variables, \( \varphi_d^H \) and \( \varphi_d^F \). With variable \( \varphi_d^J \) pinned down, each country’s welfare level can be evaluated.

Furthermore, the equilibrium values of variables \( \{ \varphi_x^J, \varphi_l^J, \chi_x^J, \chi_l^J, \varphi_d^J, \varphi_x^J, \varphi_l^J \} \), all of which are functions of own- and foreign-domestic cutoff levels, can be identified. Then, the equilibrium mass of firms in each country can be obtained from equation (2.6).

### 2.3.1 Symmetric Trade Equilibrium

I begin by reviewing symmetric trade equilibrium as presented by Melitz (2003) as a benchmark for the welfare level achieved in the FDI equilibrium. The free entry condition in the trade equilibrium without FDI is composed of first two terms of equation (2.10):

\[ f_e = \frac{f}{\delta} \left[ \int_{\varphi_d^J}^{\infty} \left[ \left( \frac{\varphi}{\varphi_d^J} \right)^{\sigma-1} - 1 \right] \cdot g(\varphi) d\varphi \right] + \frac{f_x}{\delta} \left[ \int_{\varphi_d^J}^{\infty} \left[ \left( \frac{\varphi}{\varphi_d^J} \right)^{\sigma-1} - 1 \right] \cdot g(\varphi) d\varphi \right] \]

\[ \text{See Appendix A.1 for the derivation.} \]
for \( J = H, F \).

Defining \( f_{\varphi^*} \int_{\varphi^*}^{\infty} \left[ \left( \frac{\varphi^*}{\varphi} \right)^{\sigma-1} - 1 \right] \cdot g(\varphi) \, d\varphi \) as \( K(\varphi^*) \), decreasing in \( \varphi^* \), and using equation (2.9a), the above equation can be rewritten as:

\[
\begin{align*}
 f_e &= \frac{f}{\delta} K(\varphi_d^H) + \frac{f_x}{\delta} K \left( \left( \frac{f_x}{f} \right)^{\sigma-1} \cdot \tau \cdot \varphi_d^F \right) \\
 f_e &= \frac{f}{\delta} K(\varphi_d^F) + \frac{f_x}{\delta} K \left( \left( \frac{f_x}{f} \right)^{\sigma-1} \cdot \tau \cdot \varphi_d^H \right)
\end{align*}
\]

for Home and Foreign, respectively.

These two equations pin down the equilibrium domestic cutoff level for each country. They form a system of two equations with two unknown variables, \( \varphi_d^H \) and \( \varphi_d^F \). Demidova (2008) shows the uniqueness of the resulting solutions. Further, it is shown that the system of equations corresponds to <Figure 1>. The idea is that, at any intersection of the two curves, Home’s free entry curve is flatter than Foreign’s. Since the countries are symmetric in every dimension in this case, any intersection lies along the 45 degree line.

### 2.3.2 Two-Way (symmetric) FDI

In this subsection, I introduce FDI into the model and analyze the equilibrium in which countries are symmetric across all dimensions. Since countries face the same fixed costs of FDI, i.e., \( f_I^J = f_I^{-J} = f_I \), equation (2.10) can now be expressed as:

\[
\begin{align*}
 f_e &= \frac{f}{\delta} K(\varphi_d^H) + \frac{f_x}{\delta} K \left( \left( \frac{f_x}{f} \right)^{\sigma-1} \cdot \tau \cdot \varphi_d^F \right) + \frac{f_I - f_x}{\delta} K \left( \left( \frac{f_I - f_x}{f} \right)^{\sigma-1} \left( \frac{1}{1 - \tau^{1-\sigma}} \right)^{\frac{1}{\sigma-1}} \varphi_d^F \right) \\
 f_e &= \frac{f}{\delta} K(\varphi_d^F) + \frac{f_x}{\delta} K \left( \left( \frac{f_x}{f} \right)^{\sigma-1} \cdot \tau \cdot \varphi_d^H \right) + \frac{f_I - f_x}{\delta} K \left( \left( \frac{f_I - f_x}{f} \right)^{\sigma-1} \left( \frac{1}{1 - \tau^{1-\sigma}} \right)^{\frac{1}{\sigma-1}} \varphi_d^H \right)
\end{align*}
\]

for Home and Foreign, respectively.
Compared to the equilibrium in the case of no FDI in the previous subsection, there is now an additional term in each equation that captures extra profits available to FDI firms. Consider first Home’s free entry condition. Since there is an additional positive term for FDI firms and $K(\varphi)$ is decreasing, for every level of $\varphi_d^{*F}$, each corresponding $\varphi_d^{*H}$ must be greater than the one achieved in the equilibrium without FDI. This means that Home’s curve shifts upward. Likewise, Foreign’s free entry condition reveals that, for every level of $\varphi_d^{*H}$, each corresponding $\varphi_d^{*F}$ must be greater than the one achieved in the equilibrium without FDI, leading to a right-ward shift of Foreign’s curve. This is summarized graphically in Figure 2.\footnote{Note that the intersection remains along the 45 degree line due to the symmetry assumption which has not changed. In fact, it is possible to also have multiple equilibria off the 45 degree line. However, since the two countries are symmetric along every dimension, it is reasonable to focus on the equilibrium point along that line.} This completes the proof of the following proposition:

**Proposition 6** Consumers in both countries are better off at the symmetric FDI equilibrium than they were at the equilibrium without FDI.

Opening FDI enables higher productivity Foreign (Home) firms to serve the Home (Foreign) market via FDI instead of exporting. Consumers will enjoy a reduction in the price of FDI goods, while FDI firms increase their profits. Lower productivity firms are forced to exit the market due to tougher competition in from FDI firms. The domestic cutoff level increases and resources are reallocated within the sector. Thus, the sector experiences a higher average productivity level. As a result, the price level decreases, and consumers become better off. This is a simple extension of the results from opening trade in Melitz (2003).

Since symmetry implies that no trade takes place in the homogeneous good sector between countries, each country equates production and consumption of homogeneous goods, leaving fixed the remaining share of the labor force that can be allocated toward the differentiated goods sector in each country. Therefore, firms in
the differentiated goods sector compete against one another for the available labor supply. Increased labor demand from more productive foreign firms that switched from exporting to FDI crowds out less productive local firms by bidding up the real wage. A key difference between this result and those presented in Melitz (2003) lies in the impact on the export cutoff productivity level. Here, this level also increases, reflecting tougher competition in the foreign market due to the emergence of FDI firms with lower prices.

At this stage, however, it is not yet clear whether the increase in net welfare is attributable to being the host country, the source country, or both. The next subsection introduces asymmetric FDI in order to break down the result into host- and source-country effects.

### 2.3.3 One-Way (Asymmetric) FDI

In this subsection, I restrict the focus to an asymmetric setting wherein only Home firms can conduct FDI in Foreign, but Foreign firms cannot conduct FDI in Home.\(^{15}\) Then, it is straightforward that the free entry condition for Home becomes:

\[
f_e = \frac{f}{\delta} K(\varphi_d^{sH}) + \frac{f_x}{\delta} K \left( \left( \frac{f_x}{f} \right)^{\frac{1}{\sigma-1}} \tau \varphi_d^{sF} \right) + \left( \frac{f_H^I - f_x}{f} \right) K \left( \left( \frac{f_H^I - f_x}{f} \right)^{\frac{1}{\sigma-1}} \left( \frac{1}{1 - \tau^{1-\sigma}} \right)^{\frac{1}{\sigma-1}} \varphi_d^{sF} \right),
\]

while Foreign’s free entry condition is

\[
f_e = \frac{f}{\delta} K(\varphi_d^{sF}) + \frac{f_x}{\delta} K \left( \left( \frac{f_x}{f} \right)^{\frac{1}{\sigma-1}} \tau \varphi_d^{sH} \right).
\]

\(^{15}\)Essentially, I assume that Home firms’ fixed cost of FDI in Foreign, \(f_H^I\), is smaller than \(f_F^I\), where \(f_F^I = \infty\) hence, \(\varphi_d^{sF} = \infty\). The following results can be generalized to the case in which Home firms’ fixed cost of FDI in Foreign is smaller relative to Foreign firms’ fixed cost of FDI in Home: \(f_H^I < f_F^I < \infty\).
Compared to the equilibrium without FDI, now only Home’s free entry condition shifts upward, while Foreign’s curve remains unchanged. This leads to an increase in the domestic cutoff level in Home, and a decrease in the domestic cutoff level in Foreign. Figure 3 summarizes this result.\textsuperscript{16}

**Proposition 7** In the long-run, the host country loses, and the source country gains from one-way FDI. The magnitude of the welfare consequences is proportional to the degree of FDI liberalization captured by \( f_i^H \).

**Proof.** See Appendix A.2 for the proof.

To understand the mechanics that drive the result, let me first consider the immediate response to the opening of FDI. On opening FDI, consumers in Foreign enjoy an immediate price reduction by \( \tau \) in FDI goods, which had previously only been available as imports. In response, the market share of these FDI goods rises (i.e., the market stealing effect), and the least productive Foreign firms are forced to exit the market. The host country industry becomes more efficient and experiences lower average prices. This is what is known as the pro-competitive effect of FDI.\textsuperscript{17}

However, this benefit of FDI is only in the very short-run. The rest of the story begins by examining the free entry condition in equation (2.5). An initial increase in the domestic cutoff level leads to a lower probability of successful entry (\( [1 - G(\varphi_d^F)] \downarrow \)). At the same time, incoming FDI goods seize a portion of Foreign market share, reducing the profit of all incumbent Foreign firms (\( \pi^F \downarrow \)). Consequently, entrepreneurs considering entry in the host country face negative expected profit net of fixed entry cost. Since there is no incentive for them to replace those driven to exit with exogenous rate, \( \delta \), there occurs an outflow of firms in the industry, driving down

\textsuperscript{16}No matter whether multiple equilibria exist or not, all the intersections will lie north-west from the original equilibrium along the 45 degree line.

\textsuperscript{17}Regarding this effect in such a model, it is conjectured that:

"Entry of relatively efficient multinational firms crowds out less efficient national firms, \ldots. Consumers then gain, as multinational entry raises productivity, and reduces average costs and prices in the market." (Barba-Navaretti and Venables, 2004 (Ch3)).
the mass of host country firms. The process continues until the domestic cutoff level declines enough to recover the free entry condition, i.e., zero expected profit net of fixed entry cost.\(^ {18}\) That is, the new steady state equilibrium features fewer Foreign firms entering the market, raising the probability of successful entry \(\left[1 - G(\varphi_d^*)\right] \uparrow\), which implies even less competition than before. Once the mass of domestic firms adjusts to reach the equilibrium, losses from the reduced mass of domestic firms dominate the benefits from cheaper FDI goods available in the host country.

The exact opposite situation occurs in the source country. When FDI becomes an option, nothing changes in Home’s domestic market, and thus there are no changes in the domestic cutoff level in the short-run. However, higher productivity firms are endowed with new opportunities for FDI, and this raises average profit for Home firms \(\uparrow\). As a result, newly entering Home firms face positive average expected profit net of fixed entry cost. To satisfy the free entry condition, it must be the case that the mass of entering firms exceeds the mass of exiting firms, i.e., net inflow of firms. As the mass of domestic firms increases, the source country market experiences tougher competition, resulting in an increase in the domestic cutoff level. These two opposite processes across countries interact, intensifying their overall effects.

Indeed, what is driving this result is analogous to the production relocation effect from unilateral trade liberalization.\(^ {19}\) Opening FDI in Foreign only effectively "liberalizes trade" for more productive Home firms that can afford large FDI fixed cost. The increase (decrease) in average profitability for Home (Foreign) firms implies that firms will be more (less) likely to enter in Home (Foreign), which leads to losses in welfare in Foreign that will outweigh the welfare gains brought on by the price reductions from FDI goods. As a result of this production relocation process, the

\(^ {18}\)Such a transition process in the case of trade liberalization in Melitz economy is carefully analyzed in Chaney (2005).

\(^ {19}\)See Venables (1987) and Ossa (2011) for a discussion of this effect in the homogeneous firms model with CES demand. See Melitz and Ottaviano (2008) for the heterogeneous firms model with linear demand.
following proposition states that the mass of entering firms is greater in the source country than in the host country.

**Proposition 8** In the long-run, one-way (asymmetric) FDI results in a decline in the mass of entrants in the host country, and an increase in the mass of entrants in the source country.

**Proof.** See Appendix A.3 for the proof. ■

### 2.4 Trade Liberalization in the Presence of FDI

In this section, I turn to the impact of trade liberalization in a model with symmetric FDI. What will happen if countries liberalize trade by lowering variable trade costs in the presence of FDI? This question is relevant especially when FDI takes a form of a substitute for exporting as in the current model. Trade liberalization raises the incentive for exporting, but reduces the incentive for FDI. To answer the question, I start from the symmetric FDI equilibrium, and suppose that Foreign decides to liberalize trade unilaterally by lowering trade costs (i.e., decreasing $\tau_F$, holding $\tau_H$ fixed).\(^{20}\) In this thought experiment, equation (2.9a) and (9b) for Home now become:

\[
\varphi_{xH} = \tau_F \cdot \left( \frac{f_x}{f} \right)^{\frac{1}{\sigma - 1}} \varphi_{dF}^{*F}
\]

\[
\varphi_{IH} = \left( \frac{f_I - f_x}{f} \right)^{\frac{1}{\sigma - 1}} \left( \frac{1}{1 - \tau_F^{1-\sigma}} \right)^{\frac{1}{\sigma - 1}} \varphi_{dF}^{*F}
\]

The same equations hold for Foreign, substituting $\tau_H$ for $\tau_F$.

Accordingly, Home’s free entry condition can be expressed as:

\(^{20}\)I will use $\tau_F$ to denote variable trade costs that Home firms have to pay to export goods to Foreign and vice versa for $\tau_H$. 
\[ f_e = \frac{f}{\delta} K(\varphi_{d}^H) + \frac{f_x}{\delta} K \left( \left( \frac{f_x}{f_x} \right)^{\frac{1}{\sigma-1}} \frac{1}{\tau_F \varphi_{d}^F} \right) \]

\[ + \frac{f_I - f_x}{\delta} K \left( \left( \frac{f_I - f_x}{f_x} \right)^{\frac{1}{\sigma-1}} \left( \frac{1}{1 - \tau_F^{1-\sigma}} \right)^{\frac{1}{\sigma-1}} \varphi_{d}^F \right), \]

and similarly for Foreign’s free entry condition with \( \tau_H \) instead of \( \tau_F \).

As is clear from the above equation, a decrease in \( \tau_F \) does not affect the Foreign’s free entry condition directly, but it changes the Home’s free entry condition through terms \( A \) and \( B \). The question reduces to which of the following effects is dominant:

\[ \frac{\partial A}{\partial \tau_F} = \frac{f_x}{\delta} \left( \frac{f_x}{f} \right)^{\frac{1}{\sigma-1}} \varphi_{d}^F \left( \frac{\partial K(\varphi)}{\partial \varphi} \right)_{\varphi_{d}^H} < 0 \quad (2.11) \]

\[ \frac{\partial B}{\partial \tau_F} = - \left( \frac{f_I - f_x}{\delta} \right) \left( \frac{f_I - f_x}{f} \right)^{\frac{1}{\sigma-1}} \left( \frac{1}{1 - \tau_F^{1-\sigma}} \right)^{\frac{\sigma}{\sigma-1}} \tau_F^{-\sigma} \varphi_{d}^F \left( \frac{\partial K(\varphi)}{\partial \varphi} \right)_{\varphi_{d}^H} > 0 \quad (2.12) \]

Unilateral trade liberalization by Foreign affects Home’s free entry condition directly by increasing the profitability of Home’s exporting firms. Home’s curve shifts up through the term \( A \), leading to an increase in Home’s equilibrium cutoff productivity level and a decrease in Foreign’s. Equation (2.11) captures this effect, and this is the extent of the conclusions in previous studies regarding the unilateral trade liberalization by Foreign government.

However, there is another force that drives down the average profitability of Home firms in a model with FDI. The decrease in trade costs makes FDI less attractive to Home firms. This is because the extra profit available to FDI firms is effectively
the difference between the profit from FDI and the profit from exporting. Profit from exporting increases due to lower trade costs and, hence, reduces this "extra" profit available to FDI firms. Equation (2.12) captures this counter force of trade liberalization.

<Figure 4> depicts each of these competing effects. The former effect, equation (2.11), drives the Home's curve upward, while the latter effect, equation (2.12), shifts the curve downward. After all, one can prove that the former effect in equation (2.11) to be always greater than the latter effect in equation (2.12) in absolute value, leading to the following proposition.

**Proposition 9** In a model with symmetric FDI, unilateral trade liberalization always harms the liberalizing country.

**Proof.** See Appendix A.4 for the proof. ■

Unilateral trade liberalization by Foreign generates a production relocation effect toward Home via exporting firms, but there is a simultaneous counter flow of activity brought on by FDI firms. Though the former effect proves to be always dominating, the overall magnitude is reduced compared to the case in a model without FDI. This result suggests that effects of trade liberalization would dwindle as FDI becomes more prevalent across countries over time.

Lastly, since the same argument holds for unilateral liberalization by Home, the consequence of bilateral trade liberalization will be a combination of these two cases.

**Corollary 2** In a model with symmetric FDI, bilateral trade liberalization is always good for both countries.
2.5 Conclusion

In this study, I analyze welfare implications of FDI, particularly via the pro-competitive channel, in a heterogeneous-firms model. The framework is adapted from Melitz (2003), and FDI is introduced into the model à la Helpman et. al. (2004). I show symmetric FDI liberalization improves net welfare across both participating countries. Breaking down the effects of FDI into source- and host-country, a source country benefits from FDI, while a host country experiences welfare loss. As in previous studies on unilateral trade liberalization, in the long-run, the production relocation effect plays a crucial role in determining both the sign and the magnitude of these effects. Additionally, my analysis confirms that in the presence of FDI, bilateral trade liberalization is always good for both countries but the magnitude of the positive effect is reduced compared to the case in a world without FDI. All of these results have assumed an exogenous wage. It might be interesting to solve the model with endogenously determined wage.

One should be careful in interpreting the results in this paper. The results should not be generalized to conclude that FDI is always bad for the host country. As stated earlier, the main purpose of the study is to evaluate one specific channel through which FDI affects the host country welfare, i.e., the pro-competitive effect of FDI. Thus, the model omits other potential externality effects as well as job creation effects. If these other effects are large enough to offset the adverse pro-competitive channel, the overall effect of FDI in the host country will still be net positive. Alternatively, noting that a source country becomes better off, one could also argue that accepting FDI might be a compromise a country undertakes in order to be able to send FDI abroad.\(^{21}\)

\(^{21}\)Similar reasoning is developed in Ethier (1999), which argues that countries might consider attracting FDI integral to a successful entry into the multilateral trading system.
Appendix

2.A.1 Derivation of Equation (2.10)

In equation (2.5), the average profit from domestic market is:

\[
\pi_d^J = \pi_d^J(\varphi_d^J) = \frac{\varphi_d^J}{\sigma} \cdot \sigma f - f = f \left( \frac{\varphi_d^J}{\varphi_d^J} \right) - 1
\]

where the last equality holds from an earlier definition that \( \varphi_d^J = \left[ \frac{1}{1 - G(\varphi_d^J)} \int_{\varphi_d^J}^{\varphi_d^J} \varphi^\sigma g(\varphi) d\varphi \right]^{\frac{1}{\sigma}} \).

Similarly, using the fact that \( \varphi_x^J = \left[ \frac{1}{G(\varphi_x^J) - G(\varphi_x^J)} \int_{\varphi_x^J}^{\varphi_x^J} \varphi^\sigma g(\varphi) d\varphi \right]^{\frac{1}{\sigma - 1}} \), the average profit from exporting is:

\[
\pi_x^J = \pi_x^J(\varphi_x^J) = \frac{\varphi_x^J}{\sigma} \cdot \sigma f_x - f_x = f_x \left( \frac{\varphi_x^J}{\varphi_x^J} \right) - 1
\]

The average profit from FDI is derived as follows. Noting that the cutoff condition for FDI in equation (2.3a), (3b), and (3c) implies:

\[
r_I(\varphi_I^J) = r_I(\varphi_I^J) - \sigma f_I = \sigma f_I + \left( \frac{\varphi_I^J}{\varphi_I^J} \right) - \sigma f_I = \sigma f_I + \sigma f_x \left[ \left( \frac{\varphi_I^J}{\varphi_I^J} \right) - 1 \right],
\]

one can derive:

\[
r_I(\varphi_I^J) = \left( \frac{\varphi_I^J}{\varphi_I^J} \right) - r_I(\varphi_I^J) = \sigma f_I \left( \frac{\varphi_I^J}{\varphi_I^J} \right) + \sigma f_x \left[ \left( \frac{\varphi_I^J}{\varphi_I^J} \right) - \left( \frac{\varphi_I^J}{\varphi_I^J} \right) \right].
\]
Then, plugging this into the average profit for FDI firms, we get:

\[
\pi'_I = \frac{\bar{\varphi}^{s,J}_I}{\sigma} - f'_I = f'_I \left( \frac{\varphi^{s,J}_I}{\varphi^*_I} \right)^{\sigma-1} + f_x \left[ \left( \frac{\varphi^{s,J}_I}{\varphi^*_I} \right)^{\sigma-1} - \left( \frac{\bar{\varphi}^{s,J}_I}{\varphi^*_I} \right)^{\sigma-1} \right] - f'_I
\]

Since the weighted average productivity for FDI firms is

\[
\bar{\varphi}^{s,J}_I = \left[ \frac{1}{1-G(\varphi^{d,J}_I)} \int_{\varphi^{d,J}_I}^{\infty} \varphi^{\sigma-1} g(\varphi) d\varphi \right]^{\frac{1}{\sigma-1}},
\]

it follows that:

\[
\pi'_I = f'_I \left[ \frac{1}{1-G(\varphi^{d,J}_I)} \int_{\varphi^{d,J}_I}^{\infty} \left( \frac{\varphi}{\varphi^*_I} \right)^{\sigma-1} g(\varphi) d\varphi - 1 \right] + f_x \left[ \frac{1}{1-G(\varphi^*_I)} \int_{\varphi^*_I}^{\infty} \left( \frac{\varphi}{\varphi^*_I} \right)^{\sigma-1} \left( \frac{\varphi}{\varphi^*_I} \right)^{\sigma-1} g(\varphi) d\varphi \right]
\]

Now, all that is left is plugging the above average profit expression for each activity into equation (2.5). Since probabilities of exporting and FDI, conditional on successful entry, can be written as

\[
\chi^H_x = \frac{G(\varphi^{d,J}_I) - G(\varphi^{d,J}_d)}{1-G(\varphi^{d,J}_d)} \quad \text{and} \quad \chi^H_I = \frac{1-G(\varphi^{d,J}_I)}{1-G(\varphi^{d,J}_d)},
\]

equation (2.5) becomes:

\[
f_e = \frac{f}{\delta} \left[ \int_{\varphi^{d,J}_d}^{\infty} \left( \frac{\varphi}{\varphi^{d,J}} \right)^{\sigma-1} g(\varphi) d\varphi \right] + \frac{f_x}{\delta} \left[ \int_{\varphi^{d,J}_d}^{\infty} \left( \frac{\varphi}{\varphi^*_I} \right)^{\sigma-1} g(\varphi) d\varphi \right] + \frac{f'_I}{\delta} \left[ \int_{\varphi^{d,I}_I}^{\infty} \left( \frac{\varphi}{\varphi^*_I} \right)^{\sigma-1} g(\varphi) d\varphi \right] + \frac{f_x}{\delta} \left[ \int_{\varphi^{d,J}_I}^{\infty} \left( \frac{\varphi}{\varphi^*_I} \right)^{\sigma-1} \left( \frac{\varphi}{\varphi^*_I} \right)^{\sigma-1} g(\varphi) d\varphi \right]
\]

Rearranging terms, we get equation (2.10):
2.A.2 Proof of Proposition 7

The first part of the proposition is proved in the main text and described in Figure 3. What follows proves the latter part of the proposition.

Home’s free entry condition is expressed as

\[ f_e = \frac{f}{\delta} K(\varphi_d^* H) + \frac{f_x}{\delta} K \left( \left( \frac{f_x}{f} \right) \left( \frac{1}{\tau} \varphi_d^* F \right) \right) + \frac{f^* H - f_x}{\delta} K \left( \left( \frac{f^* H - f_x}{f} \right) \left( \frac{1}{\sigma-1} \left( \frac{1}{1 - \tau^{1-\sigma}} \right) \varphi_d^* F \right) \right)^A \]

We are interested in changes in the term denoted as \( A \) as FDI fixed cost varies (i.e., the sign of \( \frac{\partial A}{\partial f_H^*} \)). The remaining part closely follows the Appendix B in Melitz (2003). Let \( K(\varphi) \) be composed of two parts such that \( K(\varphi) = [1 - G(\varphi)]k(\varphi) \), where \( k(\varphi) \) is defined as \( \left( \frac{\varphi}{\varphi} \right)^{\sigma-1} - 1 \). Thus, \( k'(\varphi) = \frac{k(\varphi)g(\varphi)}{1 - G(\varphi)} - \frac{(\sigma-1)[k(\varphi)+1]}{\varphi} \). Then, one can find that \( \frac{\partial K(\varphi)}{\partial \varphi} = -\frac{1}{\varphi}(\sigma - 1)[1 - G(\varphi)][k(\varphi) + 1] < 0 \). Therefore, \( \frac{k' \partial K(\varphi)}{k(\varphi)} < -(\sigma - 1) \), which leads to \( \frac{\partial A}{\partial f_H^*} = \frac{1}{\delta} \left( K \left( \varphi_d^* H \right) + \frac{1}{\sigma-1} \varphi_d^* H \frac{\partial K(\varphi_d^* H)}{\partial \varphi_d^* H} \right) < 0 \).

2.A.3 Proof of Proposition 8

Aggregate revenue condition in equation (2.6) is given by:

\[ [M_H \cdot r^{H}_{d}(\varphi_d^* H) + M_F \cdot r^{F}_{x}(\varphi_x^* F)] = \alpha_D L \]

in Home and:

\[ [M_F \cdot r^{F}_{x}(\varphi_x^* F) + M_H \cdot r^{H}_{x}(\varphi_x^* H) + M_H \cdot \chi^H \cdot r^{H}_{I}(\varphi_I^* H)] = \alpha_D L \]

in Foreign, respectively. One can rewrite these as

\[ [M_H^r \cdot A + M_F^r \cdot B] = \delta \alpha_D L \]

and
\[ [M_F^e \cdot C + M_H^e \cdot D + M_H^e \cdot E] = \delta \alpha_D L, \]

where \( M^e \) is the mass of entering firms, and all of the followings are positive:

\[
\begin{align*}
A &= \sigma f \int_{\phi^*_d}^{\infty} \left( \frac{\phi}{\phi^*_d} \right)^{\sigma-1} g(\phi) d\phi \\
B &= \sigma f_x \int_{\phi^*_F}^{\infty} \left( \frac{\phi}{\phi^*_F} \right)^{\sigma-1} g(\phi) d\phi \\
C &= \sigma f \int_{\phi^*_d}^{\infty} \left( \frac{\phi}{\phi^*_d} \right)^{\sigma-1} g(\phi) d\phi \\
D &= \sigma f_x \int_{\phi^*_F}^{\infty} \left( \frac{\phi}{\phi^*_F} \right)^{\sigma-1} g(\phi) d\phi \\
E &= \sigma (f_I - f_x) \int_{\phi^*_I}^{\infty} \left( \frac{\phi}{\phi^*_I} \right)^{\sigma-1} g(\phi) d\phi 
\end{align*}
\]

Then, one can solve for the mass of entering firms in each country as:

\[
M_H^e = \delta \alpha_D L \cdot \frac{C - B}{AC - B(D + E)}
\]

\[
M_F^e = \delta \alpha_D L \cdot \frac{A - (D + E)}{AC - B(D + E)}
\]

Since I focus on incomplete specialization across countries, the mass of entering firms in each country is always positive. There are two possible cases for the mass of entering firms in both countries to be positive; (i) \( AC > B(D + E), A > (D + E) \), \( C > B \) such that \( M_H^e > M_F^e \); (ii) \( AC < B(D + E), A < (D + E) \), \( C < B \) such that \( M_H^e < M_F^e \).

Proposition 2 states that \( \phi^{*_d}_d > \phi^{*_F}_d \) and \( \phi^{*_F}_d > \phi^{*_H}_d \). Therefore, \( C > A \), and \( D > B \). Furthermore, one can show that:

\[
\frac{A}{B} = \frac{\sigma f \int_{\phi^*_d}^{\infty} \left( \frac{\phi}{\phi^*_d} \right)^{\sigma-1} g(\phi) d\phi}{\sigma f_x \int_{\phi^*_F}^{\infty} \left( \frac{\phi}{\phi^*_F} \right)^{\sigma-1} g(\phi) d\phi} = \frac{1}{\sigma f_x \int_{\phi^*_F}^{\infty} \phi^{\sigma-1} g(\phi) d\phi} > 1
\]

Therefore, \( A > B \Rightarrow C > A > B \), which implies that only the first case holds (i.e., \( M_H^e > M_F^e \)).
2.A.4 Proof of Proposition 9

The question reduces to:

\[ \left| \frac{\partial A}{\partial \tau_F} \right| \leq \left| \frac{\partial B}{\partial \tau_F} \right| \]

This is equivalent to

\[ \left| \left( \frac{\partial K(\varphi)}{\partial \varphi} \right)_{\varphi_x^H} \right| \leq \left( \frac{f_1 - f_x}{f_x} \right)^{\frac{\varphi}{\tau_F}} \left( \frac{\tau_F^{1-\sigma}}{1 - \tau_F^{1-\sigma}} \right)^{\frac{\varphi}{\tau_F}} \left| \left( \frac{\partial K(\varphi)}{\partial \varphi} \right)_{\varphi_I^H} \right|, \]

which can be reduced again, by equation (2.9a) and (2.9b), to:

\[ \left| \left( \frac{\partial K(\varphi)}{\partial \varphi} \right)_{\varphi_x^H} \right| \leq \left( \frac{f_1 - f_x}{f_x} \right)^{\frac{\varphi}{\tau_F}} \left( \frac{\tau_F^{1-\sigma}}{1 - \tau_F^{1-\sigma}} \right)^{\frac{\varphi}{\tau_F}} \left| \left( \frac{\partial K(\varphi)}{\partial \varphi} \right)_{\varphi_I^H} \right| \]

Since \( \varphi_x^H < \varphi_I^H \) and \( \frac{\partial K(\varphi)}{\partial \varphi} < 0 \), it is sufficient to check if \( \frac{\partial}{\partial \varphi} \left( \frac{\partial K(\varphi)}{\partial \varphi} \cdot \varphi^\sigma \right) \leq 0 \). From the earlier proof of Proposition 2, one can confirm that:

\[ \frac{\partial}{\partial \varphi} \left( \frac{\partial K(\varphi)}{\partial \varphi} \cdot \varphi^\sigma \right) = (\sigma - 1)g(\varphi)\varphi^{\sigma-1} > 0 \]

Therefore, \( \left| \frac{\partial A}{\partial \tau_F} \right| > \left| \frac{\partial B}{\partial \tau_F} \right| \).
Bibliography


Figures

<Figure 1> Symmetric Trade(No FDI) Equilibrium

<Figure 2> Two-Way Symmetric FDI Equilibrium

<Figure 3> One-Way Asymmetric FDI
<Figure 4> Unilateral Trade Liberalization by Foreign
Chapter 3

The Role of Intermediaries in Facilitating Trade

3.1 Introduction

Research using firm-level data has uncovered that only a fraction of firms directly export products to foreign markets (Bernard and Jensen (1995) and Bernard, Jensen, and Schott (2009)). This fact is now well-grounded in theoretical models featuring firm heterogeneity and fixed export costs (e.g., Melitz 2003). These empirical and theoretical findings, however, ignore the role of intermediary firms in trade. The prominence of intermediaries appears in aggregate trade statistics; in the U.S., wholesale and retail firms account for approximately 11 and 24 percent of exports and imports (Bernard, Jensen, Redding and Schott 2010), respectively. The use of intermediary firms has been especially pervasive in developing economies, particularly in Asia. In the early 1980s, three hundred trading (non-manufacturing) Japanese firms accounted for 80 percent of Japanese trade (Rossman, 1984). Li and Fung, ¹

¹This chapter is joint work with Professor Amit Khandelwal and Professor Shang-Jin Wei from Columbia Business School. This chapter is published in Journal of International Economics 84(1), May 2011.
the 100-year-old trading company, is a prominent example of an intermediary that connects clients with thousands of apparel suppliers in low-wage countries. In China today, the setting of our study, 22 percent of Chinese exports are handled by Chinese intermediaries.

In this paper, we develop a simple theoretical framework to explain why firms export their products using intermediaries and document the pattern of intermediated trade using data from China. In the model, manufacturing firms can choose between direct and indirect export modes to each market. As in Melitz (2003), a firm can directly reach foreign customers by incurring a fixed cost and variable trade cost. The new feature of our model is an intermediation technology. Firms that use the intermediary sector incur a one-time global fixed cost that provides indirect access to all markets which allows firms to save on market-specific bilateral fixed costs. The disadvantage is that intermediation results in higher marginal costs of foreign distribution which raises the price to foreign consumers. Analogous to Helpman, Melitz and Yeaple (2006), this new entry margin creates a third type of firm: an indirect exporter. However, unlike in Helpman et al. (2006), the intermediation technology here benefits less productive firms. The presence of intermediaries provides a mechanism by which firms can access the export market even if they are not quite productive enough to establish their own distribution network.

This simple extension has important aggregate implications. The model predicts that the share of exports handled by intermediary firms increases with variable and fixed costs of exporting and decreases with market size. The reason is that firms need to possess higher levels of productivity to overcome smaller profits from direct exports. When barriers to trade are large, a larger fraction of less-productive (e.g., small) firms use intermediaries to export. The share of aggregate exports handled by intermediaries therefore increases with the difficulty of accessing destination markets. This prediction is consistent with observations from the business literature (e.g., Peng and Ilinitch 1998), and with objectives of policies, such as the 1982 U.S. Export Trad-
ing Company Act, that encouraged the entry of intermediary firms to export on behalf of the "tens of thousands" of small- and medium-sized U.S. businesses (Export Trading Company Act of 1982). The model here highlights a particular mechanism—trade costs—that explains why firms may need intermediaries to reach foreign markets.

We exploit information from two databases to verify the predictions of the model. The Enterprise Survey Data for Chinese firms collected by the World Bank records direct and indirect exports at the firm level. These data indicate that the most productive firms directly export their products while firms of intermediate levels are relatively more likely to use intermediation. This evidence is consistent with the sorting pattern predicted by the model. A shortcoming of the data is that they do not provide export information by destination market. To verify the main predictions of the model, we turn to a recently constructed database of firm-level international trade transactions from China’s customs. An added advantage of the customs data is that they provide the full census of China’s trade and so we can obtain a complete portrait of direct exports and indirect exports handled by intermediary firms.

The customs data reveal several stylized facts about China’s overall trade patterns. In 2005, Chinese intermediaries accounted for 22 percent of total exports. Intermediary firms have a relative "country" focus while firms that engage in direct exporting appear to have a relative "product" focus. That is, intermediary firms send relatively more products per country while direct exporters behave in an opposite manner. This finding is intuitive; manufacturing firms likely possess a core competent product line (Bernard, Redding and Schott, 2009), while according to our framework, intermediaries emerge precisely to overcome the market-specific costs of international trade.

We find strong evidence that indirect export shares correlate with market characteristics. Countries that are more distant, smaller in size, and require more documents for importing (a measure of fixed costs of trade) receive a larger fraction of exports through Chinese intermediaries. Intermediary firms also play a relatively
smaller role in exporting to countries that have large Chinese-speaking population. This is intuitive if common language and cultural heritage reduce exporting costs. Consistent with our model, indirect export shares also increase with countries’ MFN tariffs on imports. Our point estimates imply that increasing a country’s distance to China by one log point would increase the share of exports handled by intermediaries to that country by about 10 percent. Likewise, an increase in tariffs by 10 percentage points (roughly one standard deviation in our sample) is associated with a 15 percent increase in intermediary export shares. This evidence, which is robust to several sensitivity checks, strongly supports the hypothesis that intermediaries facilitate trade to more difficult-to-access markets.

In the final section, we provide suggestive evidence that intermediaries may help expand the extensive margin of trade. While this phenomenon is not explicitly formalized in our (static) model, it seems plausible that once small firms export indirectly by using intermediary services, they could switch to interacting directly with their foreign clients. Firms that use intermediaries could become direct exporters more easily in subsequent periods. We provide two pieces of evidence in support of this hypothesis. First, we compare export values of new and incumbent varieties across markets and find that new varieties have relatively larger transaction values in smaller and high trade costs markets, precisely the markets where intermediaries play a relatively more important role. This suggests that although the customs data identify these varieties as new, it is likely that some firms used intermediaries to previously access these markets. Hence, the varieties in these markets have relatively larger values when they first appear in the customs data. We also provide more direct evidence for this hypothesis using a unique panel-level data on Ghanaian firms which tracks their export status and export mode over time. We observe that firms using intermediaries in previous periods are more likely to export directly in subsequent periods than firms that did not use intermediaries. While these results are only suggestive, they provide the first evidence that intermediaries facilitate direct export
participation.

The literature has offered two broad reasons for why intermediaries arise in an economy: facilitating matching of buyers and sellers (e.g., Rubinstein and Wolinsky 1987) and mitigating adverse selection by acting as guaranteers of quality (e.g., Biglaiser 1993 and Spulber 1996). Feenstra and Hanson (2004) have shown support for the latter channel in the context of Hong Kong’s exports. They find that between 1988-1993, 53 percent of China’s exports were shipped through Hong Kong, and the average markup of Hong Kong re-exports of Chinese goods was 24 percent, which suggests a quality-sorting role for Hong Kong intermediaries. In contrast, our results support previous work by Rauch and Trindade (2002), who document the importance of ethnic Chinese networks in influencing trade patterns, by emphasizing the trade facilitation mechanism. So while we find that intermediaries export higher unit values than direct exporters, which could support the adverse selection story, we observe no systematic differences in unit values according the product characteristics. Such a finding would be expected if the adverse selection mechanism was more dominant in certain products rather than others. We also observe that smaller firms, which are typically less productive and manufacture relatively lower quality products, are more likely to use intermediaries. Instead, our framework predicts differences in unit values because intermediaries aggregate orders from less-efficient firms and they charge a commission for their services.

The three papers most closely related to ours are recent work by Blum, Claro, and Horstmann (2009), Felbermayr and Jung (2009) and Akerman (2010). Blum et al. (2009) find that in the majority of importer-exporter matches between Colombian and Chilean firms, at least one firm is extremely large due to search costs, yet do not identify if the large firm is in fact a non-manufacturing intermediary firm. Their analysis is also restricted to Chilean-Colombian trading partners. Here, we provide the first systematic evidence of the characteristics of intermediary firms and their overall importance in trade for the second largest exporting economy, China, because we can
directly observe the universe of transactions by intermediary and direct exporters. Felbermayr and Jung (2009) and Akerman (2010) use a similar theoretical framework and find that less-productive firms will use intermediary technology. However, their models predict no correlation between intermediary export shares and market distance and size, which is not consistent with our model and empirical results.²

The remaining paper is structured as follows. Section 2 lays out the basic model and the predictions that we will verify in the data. Section 3 is broken into three subsections. Section 3.1 describes the data and provides summary statistics, section 3.2 verifies predictions from the model, and section 3.3 provides evidence that intermediaries facilitate direct export participation. Finally, Section 4 concludes.

### 3.2 A Theory of International Trade with Intermediaries

This section provides a theoretical framework for understanding the role of intermediation technology in international trade. We provide the basic intuition of the model and discuss the predictions that we take to the data, and refer the reader to the online appendix for the formal derivation of the model.

The model builds upon now standard open-economy heterogeneous firm models. The basic assumptions on market structure, firm heterogeneity and consumer preferences are the same as in Melitz (2003), and there are $N$ asymmetric destination markets.

The novel feature of our approach is an intermediary sector that provides manufacturing firms with an option to export indirectly. Firms face a tradeoff of whether to export their varieties directly or indirectly in each market. Direct exporting requires firms to pay bilateral fixed ($f^j_x$) and variable costs ($\tau^j$) to each market. Alternatively, $^2$Akerman (2010) finds similar empirical results for Sweden as we find in our data.
firms can choose to export their varieties indirectly by relying the intermediary sector. Our framework yields three empirically testable implications: 1) firms of intermediate levels of productivity use intermediation while the most productive firms directly reach foreign consumers, 2) exports by intermediaries will be more expensive and 3) countries that are more difficult to access because of higher trade costs or smaller market sizes will have relatively more intermediated trade.

We model the intermediary sector as perfectly competitive sector with (homogeneous) intermediary firms that export on behalf of the manufacturers. Intermediaries purchase varieties from manufacturers at the same price as domestic consumers (there is no price discrimination) and incur an additional marginal cost of selling these varieties abroad.\textsuperscript{3} This additional marginal cost captures re-labeling, packaging and other per-unit costs associated with taking the title of varieties from the manufacturers. The price of indirectly exported varieties is therefore higher than the price of directly exported varieties by this factor.\textsuperscript{4}

From the perspective of the manufacturers, the intermediary sector serves as a warehouse where manufacturing firms can deposit their varieties that they wish to export indirectly. In order to access this sector, manufacturers incur a fixed cost $f_i < f_j$, $\forall j$. The fixed cost is global and not market specific. This assumption is natural given that the intermediaries reside in the domestic market and so the intermediation fixed cost captures local search costs. One can think of $f_i$ as a membership fee to deposit varieties at the warehouse where the intermediaries are located.\textsuperscript{5} A firm that

\textsuperscript{3}We assume that intermediaries do not pay a fixed cost to export.

\textsuperscript{4}Alternatively, the intermediary sector could be modeled as imperfectly competitive. There is an one-time exclusive matching process in which the ex post distribution of the matched manufacturers' productivities is identical across intermediaries. This assumption ensures that all intermediaries operating in a market have equal market shares. These intermediaries would pay a fixed cost to export and they will charge a markup over marginal cost of distribution. This leads to double marginalization and qualitatively similar predictions as the current setup.

\textsuperscript{5}While not directly related to intermediation, Hanson and Xiang (forthcoming) provide convincing evidence that the worldwide distribution of movies supports a model with global fixed costs as opposed to bilateral fixed costs.
pays $f_i$ can indirectly access all markets and we assume that if a firm directly exports to $n$ markets, it will continue to service the remaining $N - n$ markets indirectly.

Manufacturers face a tradeoff between incurring a high fixed cost and directly exporting to a market, and incurring a lower fixed cost to access a market through intermediaries. The advantage of using intermediation is that manufacturers avoid establishing their own distribution networks. However, intermediaries provide a service by preparing varieties for the foreign market and pass these costs to the foreign consumer. For a given variety, the indirect export price therefore exceeds the direct export price. Since demand is elastic manufacturer’s revenue from direct exports exceeds its revenue from indirect exports.

The profit curves from each export mode according to manufacturing firm productivity are shown in Figure 3.1. The dashed curve shows the profits from indirectly exporting to the market. This curve starts at the origin because once a firm has incurred the global fixed cost, it does not incur another fixed cost to indirectly export to that market. This curve is flatter than the direct export profit curve (the solid line) because of higher marginal cost of foreign distribution on indirect exports. The direct export profit curve intersects the y-axis at $-f^d_x$, the fixed cost for direct exports. Exports to smaller markets or markets with higher variable trade costs will rotate both curves clockwise. Higher direct export fixed costs will shift the solid line down. The intersection of these two curves determines the cutoff firm $(\varphi^d_x)$ that is just indifferent between direct and indirect exports.

The dotted curve depicts aggregate profits from indirect exports to all markets. This curve determines the cutoff firm $(\varphi_i)$ that is just indifferent to paying $f_i$ to reach all markets indirectly and not. We impose an assumption that for firms of all productivities, aggregate profits from indirect exports to all markets exceeds direct export profits to any one particular market. This guarantees that the dotted curve

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6The online appendix provides the expression for each of these curves.

7A weaker assumption is that aggregate profits from indirect exports exceeds direct export profits.
in Figure 3.1 always lies above the direct export curve. This is a sufficient condition to ensure the case: \( \varphi^j_x > \varphi^j_i \). Although this assumption may seem strong, it follows if no single country is large enough relative to the sum of all the others. Below, we also demonstrate empirical support for two of its implications. First, if aggregate indirect exports were lower than direct exports to any market, there would be countries that receive no indirect exports (and these countries should be the easiest to access). Empirically, hardly any countries report zero indirect exports. Second, this assumption implies that more productive firms will directly export while less productive firms indirectly export; we examine and find evidence for this prediction in the data.\(^8\)

The figure shows that firms sort into export modes for each market based on productivity. The familiar cutoff \( \varphi_d \) (not shown in the figure) determines the marginal firm that is just active. Firms that lie in \([\varphi_d, \varphi_i]\) are not productive enough to cover the fixed cost of intermediation; these firms serve only the domestic market. All firms that fall in the interval \([\varphi_i, \varphi^j_x]\) indirectly export to market \( j \), and firms with productivity greater than \( \varphi^j_x \) directly serve market \( j \). The sorting pattern is similar to the exports versus FDI tradeoff in Helpman, Melitz, and Yeaple (2004), although here, intermediation technology benefits less productive firms. Our model of intermediation yields similar sorting patterns as Akerman (2010) and Felbermayr and Jung (2009).

The intuition behind this sorting pattern is very straightforward. Trade is costly and only firms that are productive enough can establish distribution channels to access foreign consumers directly. If firms are unable to do so, they can rely on intermediaries as a conduit for trade. The intermediaries act as aggregators across domestic firms and incur the marginal costs of selling goods on behalf of the manufacturers. However, the cost of using an intermediary is that the manufacturer

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\(^8\)See the footnote 13.
receives lower revenues. This intuition rationalizes the sorting pattern and leads to the following prediction that we verify in the data.

**Claim 1** *All else equal, the share of exports through intermediaries is larger in countries with (i) smaller market size, (ii) higher variable trade costs, or (iii) higher fixed costs of exporting.*

We show this claim graphically and formally in the online appendix. Figure 3.2 shows how indirect exports vary with bilateral variable trade cost or market size. Markets with higher bilateral variable trade cost or smaller market size have higher indirect export shares. This result uses all three key assumptions discussed above. The first assumption of an intermediary sector that sells varieties at higher marginal costs implies that a larger change in the slope of the direct export profit curve than the market-specific indirect export curve. The second assumption of a global fixed cost of intermediation implies \( \varphi_i \) is common across destination markets. As a result, indirect exports shares depend only on the movements in direct export cutoff, \( \varphi_x^i \). Finally, the third assumption that the aggregate profits from indirect exports is steeper than profits from any market’s direct exports ensures that \( \varphi_x^i \) lies to the right of \( \varphi_i \). As markets become smaller or more expensive to reach, the two curves rotate clockwise, the direct export cutoff shifts rightward, and this increases indirect export shares. Figure 3.3 shows that higher fixed direct export cost also increases indirect export shares by shifting down the direct export profit curve and resulting in a higher direct export cutoff. These results formalize the idea that intermediaries can facilitate exports, particularly for small- and medium firms, and that indirect export shares correlate systematically with market characteristics.\(^9\)

\(^9\) Our model contrasts to the predictions in recent models of intermediation by Blum et al. (2009), Felbermayr and Jung (2009) and Akerman (2010). Blum et al. (2009) predict that an increase in market size has a non-linear impact of intermediary trade and that higher trade costs will decrease the relative share of intermediaries in a three-country setting. Their model also predicts that intermediary and direct exporters will export varieties at the same unit values, while here, exports by intermediaries result in higher marginal costs of foreign distribution. In Felbermayr and Jung (2009)
The next section verifies the predictions of the model. In particular, we will demonstrate that smaller firms are more likely to use intermediaries to access foreign markets, exports by intermediaries are more expensive than direct exports, and market characteristics strongly correlate with intermediary shares in the manner predicted by the model.

3.3 Empirical Results

3.3.1 Customs Data and Summary Statistics

Our main analysis uses Chinese data that record the census of firm-level export transactions across products and countries.\(^\text{10}\) Products are classified at the eight-digit HS level. We observe values and quantities for each firm-product-market transaction. The data do not contain information about domestic production or characteristics of the firms; we therefore cannot assign a primary industry to identify if the firm is a manufacturer or a wholesaler, distributor and/or intermediary. We identify the set of intermediary firms based on Chinese characters that have the English-equivalent meaning of "importer", "exporter", and/or "trading" in the firm’s name.\(^\text{11}\) A useful feature about firm names in China is that they are often very descriptive (a convention that might be traced to a time when the country was under central planning and the planners favored descriptive company names). Many firms founded during

\(^{10}\) The same data have been used by Manova and Zhang (2009) and Manova, Wei, and Zhang (2010). We have checked that aggregate export values match the figures from Comtrade data.

\(^{11}\) Specifically, we search for Chinese characters that mean “trading” and “importer” and “exporter”. In pinyin (Romanized Chinese), these phrases are: “jìn4chu1kòu3”, “jìng1mao4”, “mào4yì4”, “kè1mào4” and “wài4jìng1”.
the post-1980 reform era continue to adopt this naming convention. Our classification scheme takes full advantage of this convention. Although imperfect, as shown below, firms classified as intermediary firms export many more products than direct exporters, and these products span very unrelated sectors. Our classification therefore yields the intuitive finding that manufacturing firms possess a core competency while intermediary firms act as "forwarders" of products across various sectors.

Nevertheless, our classification might underestimate the importance of intermediaries for two reasons. First, intermediaries could have names that do not contain these phrases. However, misclassifying intermediary exports based on the firm name introduces measurement error that is unlikely to be systematically correlated with market characteristics, the key independent variables. Second, the direct exporters may rely on foreign intermediary partners in their transactions who we cannot observe. In these cases, what we classify as direct exports should be classified as indirect exports. This is unlikely to be an issue for our main analysis that examines export share patterns according to market characteristics if intermediated imports behave similarly to intermediated exports. We discuss this issue in more detail in Section 3.2.3.

Another issue that could potentially complicate our analysis is that the Chinese government issued trading licenses for certain products prior to China’s entry into the WTO. The WTO mandated that China liberalize the scope and availability of licenses so that within three years after accession, all enterprises would have the right to trade products without licenses. China’s WTO accession document indicates that in the first year of accession, only wholly Chinese-invested firms with registered capital exceeding RMB 5 million could obtain direct trading rights. In the second year after accession, the minimum capital requirement for direct trading was RMB

\[RMB \text{5 million}\]

12The products which required (mostly) import and export licenses can be found in the China’s WTO Accession document (“Report of the Working Party on the Accession of China” WT/ACC/CHN/49). There were 245 HS8 codes listed for trading license liberalization out of roughly 7,000 HS8 codes.
3 million, and this fell to RMB 1 million by 2004. However, data from the World Bank’s Enterprise Survey for China that covers 2002 and 2003 indicate that firms below this cutoff reported direct exports. This could be because export licenses were only required for a limited set of products and/or because these cutoffs were not stringently applied, at least for exports. By 2005, any firm that wished to directly trade with foreign partners was free to do so. So while we are confident that the licenses will not affect the interpretation of our results, the main analysis uses data for 2005 when the licenses had been removed.

Table 3.1 reports the overall export values by firm type from 2000 to 2005. The figures illustrate China’s phenomenal export growth during this period. Total exports originating from China grew 211 percent. In 2005, intermediaries accounted for 22 percent of total Chinese exports. This number is likely to be an underestimate for the reasons given above. The aggregate figures alone highlight the importance of intermediary firms.\(^\text{13}\) Moreover, it is not the case that the aggregate numbers are driven by a handful of products or countries with large indirect trade. The average share of intermediary exports across HS6 products is 34.2\%, and only 4.5\% of products report shares of less than 1\%. Across countries, the average intermediary share is 35.3\% and only 3 countries (out of 231) report zero intermediary shares.\(^\text{14}\)

Direct and intermediary firms differ along several notable and important dimensions. Intermediaries are more likely to engage in both importing and exporting relative to their counterparts that directly trade (table not shown). Table 3.2 reports overall firm-level summary statistics in 2005 in the left panel, and statistics by firm type in the second and third panels. As is well known in customs data, a small number of exceptionally large firms dominate trade statistics, and so we also report median statistics. The second panel shows that the median direct firm exports 3 products to

\(^{13}\)Table reports that the share of intermediaries in exports fell between 2000 to 2005. This fall could reflect in part the liberalization of the export licensing regime, but more likely, declines in trade costs over time that enabled firms to switch towards direct exporting.

\(^{14}\)These countries are Montserrat, Vatican City, and Wallis and Futuna.
3 destination markets. In contrast, the median intermediary exports 11 products to 6 countries. In row 4, we classify HS codes into one of 15 unrelated sectors. The idea is to identify a firm’s core activity (e.g., animal products, wood products, textiles, etc.). Not surprisingly, the median direct firm only exports products in one of these sectors. This is consistent with theoretical work in multiple-product firm models (e.g., Eckel and Neary (2010), Nocke and Yeaple (2006), or Bernard, Redding and Schott (2009)) who introduce core competencies in a model of multiple-product firms. Intermediary firms, however, handle products that span entirely unrelated sectors; the median intermediary exports products in 4 sectors.

The statistics in Table 3.2 are suggestive that intermediaries have a relative "country" focus; compared to direct firms, they export more products per country. However, the final row of Table 3.2 reports that the average intermediary is larger than its direct exporting counterpart. It is perhaps not too surprising, then, that the summary statistics indicate that traders export more products and to more destination markets. In order to verify if trading firms have a relative country focus, we control for firm size. Column 1 of Table 3.3 report the average export varieties per country (column 1) by direct and intermediary firms, conditional on a quadratic polynomial in firm size. The table shows that intermediary firms average 10.5 varieties per country compared to direct firms that export 8.3 varieties per country. In column 2, we include additional controls for ownership types and the results continue to hold—intermediary firms export more varieties per country than direct firms. Again, these results are intuitive if manufacturing firms possess a core competency in a single line of business. In contrast, the model suggests that intermediaries arise to facilitate products to destination markets.

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16 The regression excludes the constant.
An alternative way of understanding how the distribution of export sales over countries and products differs across firm type is to consider the concentration of firms’ export sales by products. For each firm, we compute its share of exports in each product, \( s_{hf} \). We then compute its (normalized) herfindahl index by aggregating over the country dimension as:

\[
HI_f = \frac{\sum_{h=1}^{N_f} s_{hf}^2}{\frac{1}{N_f}} - \frac{1}{N_f},
\]

(3.1)

where \( N_f \) is the number of products that the firm exports. A higher \( HI \) implies that a firm’s exports are more concentrated among its product mix. In column 3 of Table 3.3, we regress the \( HI \) measure on firm type controlling for a quadratic polynomial in firm size. The table indicates that intermediaries have lower herfindahls implying that their export sales are more evenly distributed across products compared to their direct exporting counterparts. The 4th column includes ownership type dummies (state-owned enterprises, private firms, and foreign invested firms) and the patterns hold. These results provide evidence that direct exporters, relative to intermediaries, have a relative "product" focus as their firm sales are more heavily skewed towards a concentrated number of products. Thus, intermediaries appear to have a lower product concentration, and export more varieties per country on average than direct exporters.

### 3.3.2 Empirical Support for the Model

**Productivity and Export Mode**

The theoretical model offers a number of predictions that we verify in the data. We first test if the sorting pattern holds in the data. The model predicts that in each market, the most productive firms directly export and firms with intermediate levels of productivity indirectly export. The customs data are unable to verify this prediction directly because we do not observe the firms that use intermediaries as a
conduit to export. We therefore provide evidence using the World Bank’s Enterprise Survey Data that covers Chinese firms in 2002 and 2003. In addition to firms’ export status, these data record the share of firm sales that are exported directly or indirectly through a distributor, and therefore can be used to examine the relationship between export mode and productivity.\footnote{While each survey round collects three years of information on firms’ output and inputs, it only asks export information for one year, and the firms across survey rounds cannot be linked. So while we are unable to examine the dynamics of export behavior with these data, we can analyze sorting patterns. While there were some restrictions of trading during this period, they were limited to only a subset of products.}

If we identify exporters based on their direct export status, 24 percent of the firms in our sample would be identified as exporters. However, 10 percent of the firms export products only through an intermediary. The actual fraction of manufacturing firms that participate in export markets is therefore 34 percent. This fraction is 41 percent higher ($0.10/0.24$) than if we had counted firms only with direct export market participation. This evidence provides a sense of the potential undercounting of export market participation if survey instruments do not record information on manufacturing firms’ indirect export activity.

For a given market, Figure 3.1 suggests that we would expect a hockey stick relationship between productivity and direct exports—only high productivity firms directly export while low and intermediate productivity firms do not—and an inverted U-shape relationship with indirect exports. Unfortunately, the Enterprise Survey Data do not separate exports by market, and so we examine firms’ indirect and direct exports across all markets. This somewhat complicates the analysis because when firms export to multiple countries, it is possible that firms of intermediate productivity directly export to some markets and indirectly exports to others. Nevertheless, we still expect the most productive firms to export directly, while less productive firms use intermediaries more intensively.

We examine this sorting pattern by regressing firms’ direct and indirect export...
shares with measures of firm productivity and squared productivity, and including industry fixed effects. If the indirect exports exhibit an inverted-U pattern, the coefficient on firm productivity and firm productivity squared should be positive and negative, respectively. We use sales, employment and sales per worker as three different proxies for productivity.\footnote{We also note that estimating productivity from revenue data is notoriously difficult (see Erdem and Tybout (2003) and De Loecker (2007)). Moreover, there is a one-to-one relationship between size and productivity in the model.}

The results for direct exports are reported in the left panel of Table 3.4. For the three measures, we observe a linear relationship (for sales, the squared term is significant at the 15 percent level)—firms of higher productivity are more likely to export directly. The right panel reports the results for indirect exports. Here, we observe a very robust inverted-U shape prediction as the coefficient on the productivity and the squared term is positive and negative, respectively, for all three proxies. Using the point estimates from column 5, the peak of the inverted U occurs at a firm size, according to sales, of log 10.84; this is 1.14 log points larger than the median firm in the sample. The point estimates in column 6 for employment suggest that the peak occurs at .6 log points larger than the median firm by employment. We take this evidence as supportive of the sorting pattern predicted by the model.\footnote{Fergal (2010) and Lu, Lu, and Tao (2010) also find this sorting pattern of indirect and direct exporters using the similar data from the World Bank across many countries.}

**Intermediation and Unit Values**

The second prediction we examine is the difference between intermediaries’ and direct exporters’ unit values. Exports by intermediaries should be more expensive than direct exporters. In the model described above, this is because intermediation results in higher marginal costs of foreign distribution and firms with relatively higher unit costs endogenously select to use the intermediation technology. We use the unit value information in the data to test these predictions. Table 3.5 compares unit values
between firm types. In this table, we regress (log) unit values on an intermediary dummy and HS8 product-ownership pair fixed effects. We include ownership type in the fixed effect because of evidence that foreign firms charge higher prices relative to domestic firms (Wang and Wei, 2008). Consistent with the model, column 1 indicates that unit values of intermediaries are about 6.7 percent higher than direct exporters. In column 2, we control for firm size (proxied by total export revenue) using a flexible quadratic polynomial. This lowers the relative difference in unit values to 5.1 percent. In column 3, we include country-HS8-ownership fixed effects and the systematic difference remains. These results are consistent with the model’s prediction. We note that this finding also contrasts with the predictions of the model in Blum et al. (2009), who do not predict differences in prices between intermediaries and manufacturers because the costs of using intermediation technology are fixed costs.

If unit values are a proxy for quality, our findings in Table 3.5 could also be consistent with the quality-sorting role of intermediary firms. For instance, Feenstra and Hanson (2004) have shown that re-exports of Chinese products by Hong Kong intermediaries have higher markups. In order to check this alternative hypothesis, we interact the intermediary dummy with 3 product characteristics that capture differentiation: the coefficient of price variation, the product’s quality ladder as measured by Khandelwal (2010), and the elasticities of substitution from Broda and Weinstein (2006). If intermediaries mitigate adverse selection problems by acting as guranteers of quality, we might expect their relative prices to vary with a product’s scope for quality differentiation. However, as shown in columns 3-5, the interaction coefficient is not statistically different from zero. That is, the relative price difference between intermediary and direct exporters is statistically equivalent across products that span a broad range of product heterogeneity. In the last column, the interaction term between the share of intermediaries and the elasticity of substitution is positive, but statistically insignificant. Overall, this table suggests that quality sorting may not be
the dominant role among Chinese intermediaries.

**Facilitating Trade**

We next examine the central prediction of the model: intermediary shares will be systematically correlated with destination market characteristics. We begin by graphically plotting the relationship between intermediary shares and key variables of the analysis in Figures 3.4-??. Figure 3.4 shows a negative relationship between intermediary export shares and the destination’s market 2005 GDP; exports to smaller markets are more likely to be handled by intermediaries. In Figure ??, we average the share of intermediary exports by the number of documents required for imports by the country’s customs authorities (obtained from the World Bank’s Doing Business Report). While admittedly crude, this variable, also used by Helpman, Melitz and Rubinstein (2008), potentially captures the fixed costs of exporting to a market. We see a strong positive relationship between intermediary export shares and the fixed cost of exports.

In Table 3.6, we formally examine the main predictions of the model in Claim 1. We construct the share of intermediary exports in country-HS6 observations and correlate the shares with proxies for trade costs and market size. We use the following regression model

\[ s_{ch} = \alpha_h + X'_c \beta + \varepsilon_{ch} \]  

(3.2)

where \( s_{ch} \) is the share of intermediary exports from China to country \( c \) in HS6 code \( h \) and the \( X_c \)’s contain proxies for trade costs and market size. The regressions include HS6 fixed effects, \( \alpha_h \), which captures inherent differences in the amount of intermediation required for products. In column 1, we regress country-HS6 intermediary share of exports on the distance to the country and the country’s GDP. The coefficient on distance, a variable cost, is positive and the coefficient on GDP, a measure of market size, is negative. This is intuitive and accords with the model’s predictions.
Countries that are smaller and more distant rely relatively more on intermediaries for their imports from China. The results imply that increasing distance to China by one log point increases intermediary shares by 3.2 percentage points. Increasing market size by one log point results in a 2.2 percentage point decline in intermediary export shares. To get a sense of the magnitudes, the average HS6-level intermediary share is about 30 percent; thus, increasing distance to China raises intermediary shares to that country by about 10 percent. In column 2, we include the ethnic Chinese population and find that intermediaries export relatively more to countries with fewer ethnic Chinese, although the coefficient is only significant at the 10% level.\footnote{Chinese population figures are obtained from Ohio University’s Shao Center Distribution of the Ethnic Chinese Population Around the World.} This finding is also intuitive: Chinese firms will find it easier to export directly to countries with larger Chinese populations. This finding is related to Rauch and Trindade (2004) who show that bilateral trade flows are larger among countries with larger ethnic Chinese populations. Here, the results indicate that the share of exports through intermediaries is smaller in these countries. Presumably trade costs, which also encompass information barriers, are smaller between China and countries with a large Chinese diaspora.

In column 3, we include the number of required documents for imports in the destination market as a proxy for the fixed costs. The coefficient on this variable is positive and statistically significant suggesting that more-difficult-to-export markets are handled by relatively larger shares of intermediaries. The coefficients on market size and distance are also robust.

In column 4, we add the importing country’s MFN tariff rates at the HS6 level as an additional variable cost proxy. According to the model, higher trade costs reduce the likelihood that less productive firms can cover the costs of direct exporting and therefore will indirectly export products. The correlation between intermediary shares and tariffs is positive indicating that intermediaries are more
important in country-product pairs with higher tariffs. The magnitudes indicate that an 10 percentage point increase in tariffs (roughly one standard deviation in our sample), holding other variables constant, would increase intermediary shares by .59 percentage points.

We note that while our model provides an explanation for the endogenous entry of intermediary firms, there may be other explanations for why intermediary firms arise in equilibrium. For instance, if trade credit is scarce, intermediaries may export on behalf of financially constrained firms. However, the results in Table 3.6 include HS6 fixed effects and therefore control for product-level heterogeneity, such as differences in financing requirements. Thus, our results suggest that market characteristics are important determinants of intermediary export shares beyond financial constraints.

We assess the sensitivity of the results through a series of robustness checks in Table 3.7. In column 1, we use manufacturing output, rather than GDP, as the proxy for country size.\textsuperscript{21} The results continue to show that intermediary shares are negatively correlated with market size.

In column 2, we include country fixed effects in the baseline regression. This flexible specification controls for all country characteristics that were previously excluded in the baseline regressions, such as rule of law, the price index, market size, level of financial development, etc. The regression identifies the coefficient on tariffs using only cross-product variation within a country. The point estimate is positive, which is consistent with the predictions from the model; however, the coefficient is marginally insignificant (with a p-value of 11%).

Research on the nature of China’s trade with Hong Kong has revealed that a large fraction of Hong Kong’s exports originate from China, and these Hong Kong exporters are often intermediaries (Feenstra and Hanson, 2004). Our classification of

\textsuperscript{21}Manufacturing output is taken from National Accounts Database collected by the UN Statistics Division.
intermediary trade to Hong Kong, in particular, may be imprecise. Moreover, Fisman, Moustakerski and Wei (2008) present evidence that Hong Kong intermediaries that re-export Chinese products are often used to evade tariffs, and that tariff evasion increases with tariff rates. Thus, we may observe a correlation between tariff rates and intermediary exports due to the incentive to evade tariffs. For these reasons, we introduce a sensitivity check that drops all exports to Hong Kong in column 3 of Table 3.7, and the results continue to hold.

State-owned enterprises (SOEs) may have an objective function other than profit maximization, and is not consistent with the model’s assumptions. In column 4, we perform a robustness check by removing export transactions by SOEs. This check also addresses a potential concern that our identification of intermediaries based on names does not include state-owned trading companies that do not contain our key phrases. The results indicate that the magnitude on distance attenuates somewhat, but the qualitative estimate remains similar to the previous columns. The correlations with the other country characteristics remain statistically significant and have the same signs as the baseline regressions.\footnote{Some of the intermediaries in our sample are likely to have emerged during China’s restrictive trade regime. To ensure that our results are not driven by these firms, we drop intermediaries that existed in 2000, and re-compute intermediary shares using exports only from intermediaries that entered between 2000 and 2005. Our results are robust to this sensitivity check and are available upon request.}

Processing and/or assembly trade account for about half of China’s exports. Because they receive preferential tariff and tax treatment, the fixed and variable costs faced by these firms may be different from those engaging in normal trade. In column 5, we remove shipments that are classified as processing and/or assembly trade. The coefficients and patterns of signs remain as before. The overall message of these tables is consistent with the prediction that intermediaries facilitate exports to relatively "difficult-to-access" markets.

We next attempt to control for the price indices that appear in the formal
expression for indirect export shares provided in equation (A.12) in the online appendix. Since these variables are not directly observed, we estimate the indices via a gravity specification based on Anderson and Van Wincoop (2003). We then include the estimates of the price indices as controls in equation 3.2. We begin by estimating the gravity equation using bilateral aggregate trade flows for all countries. The data are taken from Comtrade for 2005. Defining aggregate trade flows $V_{od}$ from origin country $o$ to destination country $d$, the gravity specification is

$$
\ln V_{od} = \alpha_o + \alpha_d + \beta_1 \ln \text{dist}_{od} + Z_{od}' \gamma + \epsilon_{od},
$$

(3.3)

where $\alpha_o$ and $\alpha_d$ are origin and destination fixed effects, and $Z_{od}$ includes indicators if the pairs are ever in a colonial relationship, share a border, and share a common official language based on Frankel, Stein, and Wei (1995).\(^{23}\) The destination fixed effects, $\alpha_d$, capture the destination country price index, but also include other country-specific variables, such as GDP. In order to separate the price index from other country characteristics, we take the estimated fixed effects and regress them on GDP, ethnic Chinese population and the number of documents required for importing. We interpret the residual of this regression as the price index of the destination country, and include this variable as an additional covariation in equation (3.2). Column 6 shows that the coefficient on the price index variable is negative and statistically significant. This is intuitive since, all else equal, a higher price index implies lower trade barrier (see Anderson and Van Wincoop 2003). We would therefore expect a negative relationship with intermediary shares. Moreover, the pattern of coefficient signs remains for the other variables.

A drawback of the above procedure is that the estimated fixed effect potentially captures more than just the price index, even after partialling out observable market characteristics. In column 7, we use the GDP deflator as an alternative proxy for

\(^{23}\)Indicators for colonial relationships, common language and border are obtained from CEPII.
the price index. While this variable is not theoretically the price index based on the gravity specification, it has the advantage of being directly observed. Importantly, our main results do not change after controlling for this proxy for the price index.

One potential concern regarding our analysis is that we do not observe foreign intermediaries. It is possible that some exports classified as direct are in fact exported via foreign intermediaries; such exports should be classified as indirect exports. Our measured share of indirect exports is therefore likely to be lower than the actual share. While this introduces measurement error, the bias is likely to work against our findings. The importance of market characteristics is understated if intermediaries are more likely to be used when importing from smaller and/or high trade cost markets. If this is the case, our measured intermediary export share to this particular set of markets is biased downwards, and the results are biased against finding an effect of market characteristics. While we do not observe the intermediaries operating in foreign markets, we do observe Chinese-based intermediaries that import products into China. We find that China’s share of intermediate imports are indeed larger in higher trade cost and small markets.\(^{24}\) Assuming that foreign intermediaries behave similarly to these Chinese-based importing intermediaries, our estimates in (3.2) will underestimate the role of market characteristics on intermediate exports.

Finally, in Table 3.8, we compare the sensitivity of exports to country characteristics between intermediaries and direct exporters. We regress the (log) HS6-country export value on a HS6 fixed effect and interact country characteristics with a dummy for exports by intermediaries. The results indicate that exports by intermediaries are less sensitive to country characteristics, such as distance and market size, than exports by direct exporters. For instance, a one percent increase in distance

\(^{24}\)The significance level of the coefficient on market size varies across different specifications, but the sign remains negative. This is perhaps not surprising since it is not clear that an exporting country’s size will affect the decision to import through a Chinese-based intermediary. The measure of fixed cost for this regression is the number of documents required for export for a country (obtained from the World Bank’s Doing Business Report). These results are available upon request.
implies a 0.7 percent decline in exports by direct exporters compared to 0.47 percent decline of intermediary exports. Likewise, increasing market size by one percent increases direct exports by 0.68 percent compared to 0.59 percent for intermediaries. We observe a similar difference with ethnic Chinese population, but not the measure of fixed costs. These results are similar to Bernard et al. (2010) who also find that exports by U.S. wholesale firms are less sensitive to market size and distance relative to manufacturing firms. And consistent with earlier results, as well as the predictions of the model, the evidence here further suggests that intermediaries play an important role in facilitating trade by overcoming trade costs.

**Intermediaries and the Extensive Margin of Trade**

In this section, we examine the hypothesis that firms may become direct exporters after relying on intermediaries to export. As we discuss in the model, intermediaries provide a range of services ranging from facilitating matches with foreign clients, dictating quality specifications required in foreign markets and/or helping firms tailor their products for foreign consumers. More generally, they can help firms establish channels to export their products in instances where firms are unable to cover the fixed costs to do so. However, once these services have been provided, it is possible that firms could switch to interacting directly with their foreign clients. In the context of our model, the use of an intermediary may subsequently lower the fixed costs of establishing one’s own direct export distribution channels in the future. Intermediaries could therefore help expand the extensive margin of (direct) trade.

We take two approaches to examine this hypothesis. The first approach uses the customs data, but since we do not observe the set of indirect exporting firms, we infer the switching phenomenon by comparing export values between new and incumbent varieties. The idea is as follows. Using data from 2004, we classify firm-product-country pairs as new or incumbent in 2005. A new variety is defined as a new (HS6) product that a firm begins
to export in 2005, or a new market that an existing product by an existing firm begins
to export in 2005. An incumbent variety is a product-firm-market triplet that existed
in both 2004 and 2005. It is well known that new varieties have smaller exports
(by value) than incumbent varieties. However, if firms have used intermediaries in
previous periods, we should expect a smaller difference in value between new and
incumbent varieties. In other words, a firm that switches from indirect to direct
exports should have relatively larger export transactions than a firm that simply
begins to export directly without previous use of an intermediary. Based on our earlier
results, intermediaries are relatively more important in markets that are smaller and
have higher trade costs. We therefore expect that the difference between new and
incumbent varieties to be smaller in these markets.

This reasoning suggests a difference-in-differences specification that compares
export values \(x_{fch}\) between new and incumbent varieties (for direct exporters only)
across markets:

\[
\ln x_{fch} = \beta_1 \text{new}_{fch} + \sum_m \gamma_m X^m_c + \sum_m \delta_m (\text{new}_{fch} * X^m_c) + \varepsilon_{fch},
\]  

(3.4)

where \(\text{new}_{fch}\) is an indicator if firm \(f\) exported variety \(ch\) in 2005 but not 2004. The
\(X^m_c\) include the market characteristics used in equation (3.2) and the \(\gamma\) coefficients
control for the direct effect that market characteristic \(m\) has on export values. The
coefficients of interest are the \(\delta\)'s. We expect a positive sign on the distance interaction
term: in more distant markets, the difference between new and incumbent export
values is smaller compared to nearer markets. Likewise, we expect a positive sign
on the interaction with tariffs and the number of documents required for import. In
contrast, we expect a negative sign on the GDP and ethnic Chinese interactions. For
markets that are easier to access directly, the differences between new and incumbent
varieties should be larger.

The results are shown in Table 3.9. Column 1 presents results without controls
to simply show the difference between new and incumbent varieties. On average, ex-
port values of new varieties are 1.87 log points smaller than incumbent varieties. In column 2, we introduce the market characteristics and their interaction with the new variety indicator. Consistent with our prediction, we observe a positive coefficient on the distance interaction term and a negative coefficient on the interaction with market size. New varieties are relatively larger in more distant and smaller markets. This suggests that although the customs data identify these varieties as new, it is likely that (some but not necessarily all) firms used intermediaries in the previous year. In column 3, we include the additional measures of trade costs and the signs remain consistent with our hypothesis, with the exception of interactions with import documents variable which is not statistically significant. In column 4, we include country-HS6 fixed effects which imply that the $\gamma$ coefficients are not identified, but here too, the qualitative results do not change with these additional controls. In column 5, we include the country-HS6 share of intermediaries interaction. This specification shows that even after controlling for the effect of observable market characteristics, new varieties have relatively larger transactions in markets with larger indirect export shares.

We stress that these patterns, while suggestive, are not a definitive proof. One concern in interpreting the results is that the firms we identify as new are firms with no indirect exporting experience, but simply firms that are just at the direct export cutoff. Since cutoffs will be higher for farther and larger trade cost markets, these new firms will have higher exports. While this may be the case, it is useful to note that our specification compares new firms’ exports relative to the average exports, and so it controls for the effect of market characteristics on average exports.\footnote{If we assume a Pareto distribution, the model indicates that the (simple) average export value relative to the marginal direct exporter will not depend on country characteristics. But this result need not hold for other distributions.}

Given this concern, we supplement the analysis with a firm-level database from Ghana (the RPED/GMES database).\footnote{The Ghana RPED/GMES (Regional Project on Enterprise Development and Ghana Manufac-}
four survey rounds from 1992-1997 and record export status and the share of sales that are exported directly and indirectly through trading companies. The advantage of these data is that we can examine if firms begin to export directly after using trading companies in previous periods. To our knowledge, these are the only data that enable us to address this question. The drawback, however, is that these data are not available for China and the sample size is small. Similar to our findings in Section 3.2.1 for Chinese firms, Kruger (2009) has shown in these data that Ghanaian firms of intermediate productivity levels are more likely to indirectly export while the most productive firms directly export.

We exploit the panel dimension of these data to offer some suggestive evidence that firms that use intermediaries are more likely to export directly in subsequent periods than firms that do not. Of the 278 firms in the data, 67 firms report positive exports, either directly or indirectly, over the sample period. Table 3.10 presents a cross-tabulation of firms’ transition behavior over the sample. We classify firms into three mutually exclusive groups: indirect exporter only, direct exporter, and domestic only.\(^{27}\) The rows display firms’ status in the \(t-1\) and the columns report firms’ status in period \(t\). The table indicates that conditional on firms that indirectly exported in a previous period, 35.7% begin to directly export. Compare this to only 2.8% of firms that begin exporting directly conditional on serving only the domestic market in the previous period. The raw data therefore suggests that firms using intermediaries have a substantially higher probability of subsequently exporting themselves compared to firms that do not export indirectly.

We complement the analysis of the raw data with regressions that control for other factors that may also contribute to firms selection into exporting directly. In particular, we are interested in learning the determinants of changes in direct export

\(^{27}\)We classify (the very few) firms that report both direct and indirect exports as direct exporters.
status. The following specification can examine this behavior by regressing the change in direct export status on an indicator of indirect export status in the previous period:

\[
\Delta D_{ft} = \alpha_t + \beta I_{f,t-1} + \varepsilon_{ft},
\]  

(3.5)

where \( D_{ft} \) is an indicator variable that takes a value of one if firm \( f \) has positive direct exports at time \( t \). \( I_{f,t-1} \) takes a value of one if the firm indirectly exported products in \( t-1 \), and \( \alpha_t \) are year fixed effects. A positive correlation suggests that indirect exports is a positive predictor of direct exports in the next period. The results, presented in Table 3.11, report a positive and statistically significant coefficient on indirect export status, which is consistent with the cross-tabulations in Table 3.10. The finding, however, could be spurious if firms that start to export directly also make additional firm-level changes. Moreover, we know from the theory that indirect export shares is correlated with firm size. In column 2, we therefore control for lag firm sales and lag firm sales squared. The coefficient \( \beta \) remains positive and statistically significant. In column 3, we attempt to control for such additional changes in the firm that may accompany entry into the direct export market by including changes in firm sales as an additional control. The idea is that any firm-level adjustments would be captured by changes in firm sales. We present this specification in column 3, and the results continue to hold. Finally, in column 4 we include firm fixed effects to control for firm-specific trends, and the results remain robust. These results are therefore suggestive that a firm’s indirect export status in a previous period makes it more likely to export directly in the subsequent periods.

The ability to offer more stringent tests of this hypothesis, as well as to uncover the mechanisms through which intermediaries help firms learn about their foreign market potential, is limited by data constraints. Nevertheless, the evidence from both databases points to intermediaries facilitating direct export participation.
3.4 Conclusion

This paper presents the first evidence of the role of intermediary firms in facilitating trade across the entire universe of exporting firms in China. We find that non-manufacturing trading firms mediate a substantial fraction of firm trade. In 2005, they accounted for $168 billion of China’s exports, or 22% of aggregate exports. The activity of intermediaries behaves in systematically different ways than their direct exporting counterparts. Intermediaries appear to adopt a relative country focus by exporting more products per market than direct exporters. Consistent with our framework, we observe that firms of intermediate levels of productivity are more likely to use intermediaries, while the most productive firms choose to export directly. This finding is consistent with intermediaries being used by relatively smaller firms who find it difficult to enter the export market on their own. Moreover, we observe a very robust relationship between intermediary export shares and markets that are smaller and have higher trade costs.

This paper demonstrates that further research on intermediary exporting and importing firms is warranted.\(^{28}\) While the recent literature on firm heterogeneity within international trade has largely ignored the role of intermediaries, our framework predicts that small firms endogenously choose to export via intermediaries. This implies that small firms can, and do, access foreign markets even though they are unable to cover the fixed costs of direct exporting. One might extrapolate what we learn here to the import side: firms may benefit from importing products indirectly even if they do not directly import. The presence of intermediaries implies that analyzing firm-level imports may understate the true benefits from importing (see Goldberg, Khandelwal, Pavcnik and Topalova (2010)) if indirect imports via intermediaries are ignored.

Intermediaries could also serve as vehicles for small firms to learn their po-

\(^{28}\) A separate but related line of recent research has focused on the distribution of the gains from trade in the presence of intermediaries (Bardhan et al. (2009) and Antras and Costinot (2010)).
tential in foreign markets and enable firms to select directly into export markets in subsequent periods. These results raise a number of interesting questions about the mechanisms through which this dynamic process occurs. For instance, to what extent do intermediaries help firms learn about their own productivity and/or learn about tailoring their products for foreign markets? Do intermediaries provide a match with foreign clients so that firms subsequently bypass intermediaries to interact direct with their foreign clients? We leave these important open questions for future research.

Appendix

We assume that the home country has $N$ asymmetric trading partners, and focus on an open economy equilibrium because in autarky there is no role for intermediaries to export. Consumers in each country have identical CES preferences for differentiated varieties:

$$U = \left[ \int_{\omega \in \Omega^i} q(\omega)^\rho d\omega \right]^{\frac{1}{\rho}},$$

where $\Omega^i$ is the set of total available varieties in the differentiated goods sector. The corresponding price index in each country is given by $P^j = \left[ \int_{\omega \in \Omega^j} p(\omega)^{1-\sigma} d\omega \right]^{\frac{1}{1-\sigma}},$ where $\sigma = \frac{1}{1-\rho} > 1$ is the constant elasticity of substitution across varieties. Let $R^j$ denote the aggregate expenditure in market $j$. We denote the home market as $d$.

Each consumer inelastically supplies one unit of labor and is paid a normalized wage of $1$. The production technology requires a constant marginal cost and a fixed per period overhead cost, $f_d$. The amount of labor required to produce $q$ units for a firm with productivity level $\varphi$ is $l = f_d + \frac{q}{\varphi}$. Firms are heterogeneous and draw their productivity $\varphi$ from a distribution $G(\varphi)$ after paying an entry cost. The optimal price for the domestic market is $p_d(\varphi) = \frac{1}{\rho \varphi^\rho}$, and the domestic revenue is $r_d(\varphi) = R^d \left( \frac{p_d(\varphi)}{p_d^*} \right)^{1-\sigma}$.

A firm that remains in the market decides whether or not to export and its mode of export. Direct exports to $j$ requires a per period bilateral fixed cost, $f^j_x.$
and a bilateral iceberg transportation cost $\tau^j > 1$. Alternatively, firms can choose to export their varieties indirectly by relying on an intermediary sector. This indirect export mode allows firms to avoid the direct trade costs to entering market $j$. If the manufacturer sells its variety through the intermediary sector, it must pay a fixed cost $f_i < f^j_x$, $\forall j$. A firm that pays $f_i$ can indirectly access all markets and we assume that if a firm directly exports to $n$ markets, it will continue to service the remaining $N - n$ markets indirectly.

The intermediary sector is perfectly competitive with identical intermediary firms operating in each market. The manufacturer charges the intermediary a price $p_i(\varphi)$, which we derive below. As we discussed in the text, the intermediary aggregates orders across its clients, incurs a per-unit cost to prepare the variety for the foreign market ($\gamma$) as well as incurs variable trade costs to export. The foreign price of a variety exported by an intermediary is therefore

$$p^j_i(\varphi) = \gamma \tau^j p_i(\varphi) \tag{A.1}$$

Taking into account the foreign price of indirect exports, the manufacturers set their optimal price for indirect exports, $p_i(\varphi)$, by maximizing:

$$\max_{p_i(\varphi)} \pi^j_i(\varphi) = r^j_i(\varphi) - \frac{1}{\varphi} q^j_i(\varphi) \tau^j$$

$$= p_i(\varphi) q^j_i(\varphi) \tau^j - \frac{1}{\varphi} q^j_i(\varphi) \tau^j$$

$$= p_i(\varphi) R^j \left( \frac{p^j_i(\varphi)}{P^j} \right)^{-\sigma} \frac{1}{P^j} \tau^j - \frac{1}{\varphi} R^j \left( \frac{p^j_i(\varphi)}{P^j} \right)^{-\sigma} \frac{1}{P^j} \tau^j. \tag{A.2}$$

Substituting equation (A.1) into equation (A.2), the optimal price charged by manufacturers to the intermediaries is:

$$p_i(\varphi) = p_d(\varphi) = \frac{1}{\rho \varphi}. \tag{A.3}$$

We note that the price in (A.3) is identical to the domestic price. Thus, there is no price discrimination within the domestic market between domestic consumers and
intermediary firms.

We can now obtain the manufacturer’s profit on indirect exports by substituting the prices in equations (A.1) and (A.3) into profit expressions in equations (A.2). This yields:

\[
\pi_i^j(\varphi) = \frac{1}{\sigma} \gamma^{-\sigma} R^j \left( \frac{\tau^j}{\rho \varphi P^j} \right)^{1-\sigma}
\]  
(A.4)

Similarly, we can derive the intermediary’s per variety profit:

\[
\pi_{int}^j(\varphi) = \frac{1}{\sigma} \gamma^{-\sigma} (\gamma - 1) R^j \left( \frac{\tau^j}{\rho \varphi P^j} \right)^{1-\sigma}
\]  
(A.5)

Finally, we consider the prices, revenues and profits for a firm that directly exports. As in Melitz (2003), the price charged for direct exports is \( p_x^j(\varphi) = \frac{\tau^j}{\rho \varphi} \). The revenue from direct exports to market \( j \) is \( r_x^j(\varphi) = R^j \left( \frac{p_x^j(\varphi)}{P^j} \right)^{1-\sigma} \). The profit from direct exports is

\[
\pi_x^j(\varphi) = \frac{r_x^j(\varphi)}{\sigma} - f_x^j.
\]  
(A.6)

We can verify that a manufacturer’s revenues from direct exports are larger than revenues from indirect exports in each market. Substituting the optimal prices \( p_i(\varphi) \) and \( p_i^j(\varphi) \) into (A.2), we see that \( r_i^j(\varphi) = \gamma^{-\sigma} r_x^j(\varphi) < r_x^j(\varphi) \) since \( \gamma^{-\sigma} < 1 \). For a given variety, the revenue from direct exports exceeds indirect exports. This occurs because indirect export prices are higher because of the commission is passed on to foreign customers and demand is elastic. Thus, the market-specific indirect profit curve is flatter than the direct export profit curve in Figure 1 of Ahn, Khandelwal and Wei (2011). This shows the tradeoff that manufacturing firms face between high fixed and low variable costs on direct exports and vice versa on indirect exports.

We can now express the cutoff conditions. The cutoff condition for firms to remain active in the market is:

\[
\pi_d(\varphi_d) = \frac{r_d(\varphi_d)}{\sigma} - f_d = 0.
\]  
(A.7)

\[29\] We focus only on the case in which it is the least productive firms that serve domestic market only. We assume that \( \pi_d(\varphi_i) > 0 \) which implies that \( \varphi_d < \varphi_i \).
The indirect export cutoff ($\varphi_i$) determines the marginal firm that is just indifferent between paying $f_i$ to gain indirect access to all markets and not. This cutoff is determined implicitly by:

$$
\pi_i(\varphi_i) = \sum_{j=1}^{N} \pi_i^j(\varphi_i) - f_i = 0
$$

$$
= \frac{1}{\sigma} \sum_{j=1}^{N} \left[ \gamma^{-\sigma} R^j \left( \frac{\tau^j}{\rho P^j} \right)^{1-\sigma} \right] - f_i = 0
$$

(A.8)

Additionally, there are $N$ cutoff conditions that determine the firms that are indifferent between direct and indirect exports to each market:

$$
\pi_i^j(\varphi_i^j) = \frac{r_i^j(\varphi_i^j)}{\sigma} - f_i = \pi_i^j(\varphi_i^j).
$$

(A.9)

Combining equations (A.4) with (A.9) determines the direct export cutoff to market $j$:

$$
\varphi_i^j = \left( \frac{\sigma f_i^j}{R^j} \right)^{\frac{1}{1-\sigma}} \frac{\tau_i^j}{\rho P_i^j} \left[ 1 - \gamma^{-\sigma} \right]^{\frac{1}{1-\sigma}}
$$

(A.10)

In order to determine the sorting pattern, we need to impose an additional assumption. Without this assumption, it is possible that the direct export cutoff for a market may be smaller than the (global) indirect export cutoff. This would imply that the largest and/or least costly markets receive no indirect exports. However, virtually all markets receive indirect exports in the data. We therefore focus on the scenario where the slope of the profit from aggregate indirect export to all countries is steeper than the slope of the profit from direct export to country $j$ in the Figure 1 of Ahn, Khandelwal and Wei (2011), or:

$$
\frac{1}{\sigma} \sum_{j=1}^{N} \left[ \gamma^{-\sigma} R^j \left( \frac{\tau^j}{\rho P^j} \right)^{1-\sigma} \right] > \frac{1}{\sigma} R_i \left( \frac{\tau_i^j}{\rho P_i^j} \right)^{1-\sigma}, \quad \forall j
$$

(A.11)

This assumption is equivalent saying that the aggregate indirect profits from the remaining $N - 1$ countries are enough to cover the fixed costs of exporting for that marginal firm with productivity $\varphi_i^j$. This assumption (A.11) is sufficient, but not necessary, to ensure $\varphi_i^j > \varphi_i$. 
The assumptions in the model imply the following sorting pattern: firms that lie in \([\varphi_d, \varphi_i]\) serve only the domestic market, firms between \([\varphi_i, \varphi^j_x]\) indirectly export to market \(j\), and firms with productivity greater than \(\varphi^j_x\) directly serve market \(j\).

For each market, we can now derive the aggregate direct and indirect exports. The ratio of this expression is given by

\[
\frac{v^j}{R^j} = \frac{\text{total indirect exports to market } j}{\text{total direct exports to market } j} = \frac{\int_{\varphi^j_d}^{\varphi^j_x} r^j_{\text{int}}(\varphi) dG(\varphi)}{\int_{\varphi^j_d}^{\varphi^j_x} r^j_d(\varphi) dG(\varphi)} \quad (A.12)
\]

\[
= \frac{\gamma^{1-\sigma} \int_{\varphi^j_d}^{\varphi^j_x} \varphi^{-1} dG(\varphi)}{\int_{\varphi^j_d}^{\varphi^j_x} \varphi^{-1} dG(\varphi)} = \gamma^{1-\sigma} \left( \frac{\int_{\varphi^j_d}^{\varphi^j_x} \varphi^{-1} dG(\varphi)}{\int_{\varphi^j_d}^{\varphi^j_x} \varphi^{-1} dG(\varphi)} \right) \quad (A.13)
\]

where \(r^j_{\text{int}}(\varphi) = p^j_i(\varphi)q^j_i(\varphi)\) and \(Z(a) = \int_{a}^{\infty} \varphi^{-1} dG(\varphi)\) with \(Z'(a) < 0\).

This expression makes it easy to evaluate how the share of indirect exports varies with market characteristics. Note that the global fixed cost of intermediation implies \(\varphi_i\) is common across destination markets, and thus indirect exports share depends only on market specific direct export cutoff, \(\varphi^j_x\). We summarize the relationship in the following result.

**Claim 1** All else equal, the share of exports through intermediaries is larger in countries with (i) smaller market size, (ii) higher variable trade costs, or (iii) higher fixed costs of exporting.

To show that this claim holds, consider two markets \(j\) and \(k\). It follows immediately from equation (A.10) that: (i) all else equal, if \(R^j > R^k\) then \(\varphi^j_x < \varphi^k_x\), which implies that \(v^j < v^k\); (ii) all else equal, if \(\tau^j > \tau^k\) then \(\varphi^j_x > \varphi^k_x\), which implies that \(v^j > v^k\); (iii) all else equal, if \(f^j_x > f^k_x\) then \(\varphi^j_x > \varphi^k_x\), which implies that \(v^j > v^k\).
Bibliography


**Tables**
Table 3.1: Export Values by Firm Type, 2000-2005

<table>
<thead>
<tr>
<th>Year</th>
<th>Total Value ($ million)</th>
<th>Direct Export Value</th>
<th>Intermediary Export Value</th>
<th>Intermediary Value Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>249,234</td>
<td>163,047</td>
<td>86,187</td>
<td>35%</td>
</tr>
<tr>
<td>2001</td>
<td>290,606</td>
<td>198,003</td>
<td>92,603</td>
<td>32%</td>
</tr>
<tr>
<td>2002</td>
<td>325,632</td>
<td>230,740</td>
<td>94,892</td>
<td>29%</td>
</tr>
<tr>
<td>2003</td>
<td>438,473</td>
<td>323,541</td>
<td>114,931</td>
<td>26%</td>
</tr>
<tr>
<td>2004</td>
<td>593,647</td>
<td>450,813</td>
<td>142,835</td>
<td>24%</td>
</tr>
<tr>
<td>2005</td>
<td>776,739</td>
<td>608,926</td>
<td>167,813</td>
<td>22%</td>
</tr>
</tbody>
</table>

Notes: Table reports summary statistics from China's export transactions data. The values are in millions of U.S. dollars. See text for definition of intermediary firms. Source: Authors' calculations from the China's transactions data.

Table 3.2: Firm-Level Summary Statistics for Exporting Firms, 2005

<table>
<thead>
<tr>
<th></th>
<th>All Firms (1)</th>
<th>Direct Firms (2)</th>
<th>Intermediary Firms (3)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Median</td>
<td>Mean</td>
</tr>
<tr>
<td>Firms</td>
<td>144,027</td>
<td>121,928</td>
<td>22,099</td>
</tr>
<tr>
<td>Products</td>
<td>15.9</td>
<td>4</td>
<td>10.6</td>
</tr>
<tr>
<td>Countries</td>
<td>8.0</td>
<td>3</td>
<td>6.9</td>
</tr>
<tr>
<td>Sectors</td>
<td>2.55</td>
<td>1</td>
<td>2.11</td>
</tr>
<tr>
<td>Total Export Value ($)</td>
<td>5,393,010</td>
<td>4,994,145</td>
<td>519,890</td>
</tr>
</tbody>
</table>

### Table 3.3: Margins, by Firm Type

<table>
<thead>
<tr>
<th>Firm Type</th>
<th>Varieties per Country</th>
<th>Varieties per Country</th>
<th>Product Herfindahl</th>
<th>Product Herfindahl</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct Firms</td>
<td>8.34</td>
<td>10.03</td>
<td>0.48</td>
<td>0.44</td>
</tr>
<tr>
<td>Intermediary Firms</td>
<td>10.56</td>
<td>11.98</td>
<td>0.28</td>
<td>0.27</td>
</tr>
<tr>
<td>Quartic Firm-size controls</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Ownership FEs</td>
<td>no</td>
<td>yes</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.24</td>
<td>0.24</td>
<td>0.73</td>
<td>0.73</td>
</tr>
<tr>
<td>Observations</td>
<td>144,027</td>
<td>144,027</td>
<td>144,027</td>
<td>144,027</td>
</tr>
</tbody>
</table>

Notes: Column 1 regresses the firm-level products per country on firm type and a quartic polynomial of firm-size controls. Column 2 includes ownership dummies. The dependent variable in Column 3 and 4 regress firm’s herfindahl index computed over products (see text). All coefficients are statistically significant at the 1 percent level and so standard errors have been suppressed. The coefficients in each column are statistically different from each other. The regressions do not include a constant.
### Firm Size and Export Mode

<table>
<thead>
<tr>
<th></th>
<th>Direct Export Share</th>
<th>Indirect Export Share</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>{Log Sales}</td>
<td>0.015</td>
<td>0.034 ***</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>{Log Employment}</td>
<td>0.041 *</td>
<td>0.039 **</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>{Log Labor Productivity}</td>
<td>0.024 **</td>
<td>0.016 **</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Industry FEs    | yes | yes | yes | yes | yes | yes |
| R-squared       | 0.12 | 0.08 | 0.11 | 0.05 | 0.05 | 0.05 |
| Observations    | 2,469 | 2,340 | 2,364 | 2,570 | 2,437 | 2,461 |

Notes: Table uses Chinese firm-level information from the World Bank's Enterprise Survey Data. The data cover Chinese firms in 2002 and 2003. The dependent variables in the left and right panels are direct and indirect exports, respectively, as a fraction of sales. All regressions include industry fixed effects. The constant in each regression is not reported. Significance: * 10 percent; ** 5 percent; *** 1 percent.

Table 3.4: Firm Size and Export Mode
<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Intermediary)$_t$</td>
<td>0.067 ***</td>
<td>0.051 ***</td>
<td>0.023 ***</td>
<td>0.030 ***</td>
<td>0.021 **</td>
<td>0.014</td>
</tr>
<tr>
<td></td>
<td>0.005</td>
<td>0.004</td>
<td>0.004</td>
<td>0.007</td>
<td>0.010</td>
<td>0.033</td>
</tr>
<tr>
<td>(Intermediary)$_t$ X (CV)$_h$</td>
<td></td>
<td>-0.002</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.002</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Intermediary)$_t$ X (Ladder)$_h$</td>
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<td></td>
<td></td>
<td></td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Intermediary)$_t$ X (Elasticity)$_h$</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quartic Firm-size controls</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Fixed effects</td>
<td>po</td>
<td>po</td>
<td>cpo</td>
<td>cpo</td>
<td>cpo</td>
<td>cpo</td>
</tr>
<tr>
<td>R-squared</td>
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<td>0.79</td>
<td>0.85</td>
<td>0.85</td>
<td>0.86</td>
<td>0.85</td>
</tr>
<tr>
<td>Observations</td>
<td>4,594,598</td>
<td>4,594,598</td>
<td>4,594,598</td>
<td>4,594,598</td>
<td>3,697,495</td>
<td>4,583,207</td>
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</tbody>
</table>

Notes: Table regresses firms’ (f) log unit values (at the country-product level) on intermediary dummy and controls in 2005. Row 2 interacts an intermediary dummy with the coefficient of variation of unit values. Row 3 includes the interactions with the quality ladder taken from Khandelwal (2010). Row 4 uses the elasticity of substitution from Broda and Weinstein (2006). The symbols for the pair fixed effects are product (p), ownership (o) and country (c). The constant in each regression is not reported. Standard errors are clustered by product. Significance: * 10 percent; ** 5 percent; *** 1 percent.

Table 3.5: Unit Value Differentials
### Table 3.6: Intermediary Shares and Country Characteristics

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>{Log Distance}_c</td>
<td>0.032</td>
<td>0.026</td>
<td>0.028</td>
<td>0.025</td>
</tr>
<tr>
<td></td>
<td>***</td>
<td>***</td>
<td>***</td>
<td>***</td>
</tr>
<tr>
<td></td>
<td>0.008</td>
<td>0.007</td>
<td>0.007</td>
<td>0.008</td>
</tr>
<tr>
<td>{Log GDP}_c</td>
<td>-0.022</td>
<td>-0.021</td>
<td>-0.021</td>
<td>-0.019</td>
</tr>
<tr>
<td></td>
<td>***</td>
<td>***</td>
<td>***</td>
<td>***</td>
</tr>
<tr>
<td></td>
<td>0.002</td>
<td>0.002</td>
<td>0.003</td>
<td>0.003</td>
</tr>
<tr>
<td>{Log Chinese Population}_c</td>
<td>-0.002</td>
<td>*</td>
<td>-0.003</td>
<td>*</td>
</tr>
<tr>
<td></td>
<td>*</td>
<td>-0.004</td>
<td>***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.002</td>
<td>0.001</td>
<td>0.001</td>
<td></td>
</tr>
<tr>
<td>{# of Importing Procs}_c</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.003</td>
<td>**</td>
<td>0.003</td>
<td>***</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.001</td>
<td></td>
</tr>
<tr>
<td>{MFN Tariff}_hc</td>
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</tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>**</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.022</td>
</tr>
</tbody>
</table>

| HS6 FEs                  | yes     | yes     | yes     | yes     |
| R-squared                | 0.15    | 0.16    | 0.17    | 0.18    |
| Observations             | 267,201 | 221,373 | 207,594 | 185,975 |

Notes: The dependent variable in each regression is the share of intermediary exports of total country-HS6 exports. Column 1 includes distance and market size as covariates. Column 2 adds the share of ethnic Chinese population, taken from Ohio University Shao Center's Distribution of the Ethnic Chinese Population Around the World. Column 3 includes the World Bank's Doing Business Report measure of the number of procedures required for importing a container. Column 4 includes the country's HS6 MFN tariff on Chinese products, obtained from WITS. The constant in each regression is not reported. All standard errors clustered at the country level. Significance: * 10 percent; ** 5 percent; *** 1 percent.
### Table 3.7: Robustness Checks

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
<th>(7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \text{Log Distance}_c )</td>
<td>0.025 ***</td>
<td>0.020 ***</td>
<td>0.012</td>
<td>0.022 ***</td>
<td>0.025 ***</td>
<td>0.025 ***</td>
<td>0.025 ***</td>
</tr>
<tr>
<td></td>
<td>0.009</td>
<td>0.008</td>
<td>0.009</td>
<td>0.007</td>
<td>0.008</td>
<td>0.008</td>
<td>0.008</td>
</tr>
<tr>
<td>( \text{Log GDP}_c )</td>
<td>-0.020 ***</td>
<td>-0.024 ***</td>
<td>-0.016 ***</td>
<td>-0.019 ***</td>
<td>-0.019 ***</td>
<td>-0.019 ***</td>
<td>-0.019 ***</td>
</tr>
<tr>
<td></td>
<td>0.003</td>
<td>0.003</td>
<td>0.002</td>
<td>0.002</td>
<td>0.002</td>
<td>0.002</td>
<td>0.002</td>
</tr>
<tr>
<td>( \text{Log Manufacturing Output}_c )</td>
<td>-0.016 ***</td>
<td>0.003</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \text{Log Chinese Population}_c )</td>
<td>-0.004 **</td>
<td>-0.003 **</td>
<td>-0.003 **</td>
<td>-0.003 **</td>
<td>-0.004 ***</td>
<td>-0.003 **</td>
<td>-0.003 **</td>
</tr>
<tr>
<td></td>
<td>0.002</td>
<td>0.001</td>
<td>0.001</td>
<td>0.001</td>
<td>0.001</td>
<td>0.001</td>
<td>0.001</td>
</tr>
<tr>
<td>( \text{# of Importing Procs}_c )</td>
<td>0.004 ***</td>
<td>0.003 ***</td>
<td>0.004 **</td>
<td>0.003 **</td>
<td>0.004 ***</td>
<td>0.004 ***</td>
<td>0.004 ***</td>
</tr>
<tr>
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<td>0.001</td>
<td>0.001</td>
<td>0.002</td>
<td>0.001</td>
<td>0.001</td>
<td>0.001</td>
<td>0.001</td>
</tr>
<tr>
<td>( \text{MFN Tariff}_{hc} )</td>
<td>0.064 **</td>
<td>0.024</td>
<td>0.046 **</td>
<td>0.078 ***</td>
<td>0.038 *</td>
<td>0.049 **</td>
<td>0.060 ***</td>
</tr>
<tr>
<td></td>
<td>0.027</td>
<td>0.015</td>
<td>0.019</td>
<td>0.023</td>
<td>0.021</td>
<td>0.022</td>
<td>0.022</td>
</tr>
<tr>
<td>( \text{Price Index from Gravity}_c )</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-0.015 **</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.007</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \text{GDP Deflator}_c )</td>
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<td></td>
<td></td>
<td></td>
<td></td>
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<td>0.007</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.008</td>
</tr>
</tbody>
</table>

**HS6 FEs** | yes | yes | yes | yes | yes | yes | yes | yes

**Country FEs** | no | yes | no | no | no | no | no | no

**R-squared** | 0.17 | 0.17 | 0.17 | 0.18 | 0.15 | 0.18 | 0.18 |

**Observations** | 185,975 | 223,282 | 181,612 | 163,044 | 181,793 | 185,975 | 185,975 |

*Notes: The dependent variable in each regression is the share of intermediary exports of total country-HS6 exports. Column 3 excludes exports to Hong Kong. Column 4 excludes exports by state-owned enterprises and re-computes intermediary shares of country-HS6 exports. Column 5 removes all exports classified under processing and assembly trade and re-computes intermediary shares of country-HS6 exports. Column 6 includes the price index estimated from two-step procedure discussed in the text. Column 7 uses the GDP deflator as an alternative measure for the price index. The GDP deflator is obtained from UN Statistical Office. The constant in each regression is not reported. All standard errors clustered at the country level. Significance: * 10 percent; ** 5 percent; *** 1 percent.*
Table 3.8: Sensitivity to Gravity, Intermediaries vs Direct Exporters

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>(Log Distance)</em></td>
<td>-0.692 ***</td>
<td>-0.662 ***</td>
<td>-0.685 ***</td>
</tr>
<tr>
<td>X Intermediary</td>
<td>0.122</td>
<td>0.099</td>
<td>0.098</td>
</tr>
<tr>
<td><em>(Log GDP)</em></td>
<td>0.684 ***</td>
<td>0.607 ***</td>
<td>0.613 ***</td>
</tr>
<tr>
<td>X Intermediary</td>
<td>0.024</td>
<td>0.031</td>
<td>0.034</td>
</tr>
<tr>
<td><em>(Log Chinese Population)</em></td>
<td>0.085 ***</td>
<td>0.087 ***</td>
<td>0.021</td>
</tr>
<tr>
<td>X Intermediary</td>
<td>0.021</td>
<td>0.022</td>
<td></td>
</tr>
<tr>
<td><em>(# of Importing Procs)</em></td>
<td>0.009</td>
<td>0.014</td>
<td>0.015</td>
</tr>
<tr>
<td>X Intermediary</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| HS6 FEs                  | yes          | yes          | yes          |
| R-squared                | 0.412        | 0.431        | 0.433        |
| Observations             | 425,396      | 357,902      | 338,956      |

Notes: The dependent variable in each regression is (log) total country-HS6 export value for intermediaries and direct exporters. Column 1 includes distance and market size as covariates. Column 2 adds the share of ethnic Chinese population. Column 3 includes the measure of the number of procedures required for importing a container. Column 4 includes the country’s HS6 MFN tariff on Chinese products. Each covariate is interacted with a dummy for trade by intermediaries (the coefficient on intermediaries is suppressed). The constant in each regression is not reported. All standard errors clustered at the country level. Significance: * 10 percent; ** 5 percent; *** 1 percent.
Table 3.9: Export values of New and Existing Varities
<table>
<thead>
<tr>
<th>Status in Period t-1</th>
<th>Status</th>
<th>Indirect Only</th>
<th>Direct Exporter</th>
<th>Domestic Only</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indirect Only</td>
<td>35.7</td>
<td>35.7</td>
<td>28.6</td>
<td></td>
</tr>
<tr>
<td>Direct Only</td>
<td>15.0</td>
<td>55.0</td>
<td>30.0</td>
<td></td>
</tr>
<tr>
<td>Domestic</td>
<td>3.2</td>
<td>2.8</td>
<td>94.0</td>
<td></td>
</tr>
<tr>
<td>Share of Firms t</td>
<td>5.8</td>
<td>8.5</td>
<td>85.7</td>
<td></td>
</tr>
</tbody>
</table>

Notes: Table displays transition probabilities firm status in the previous period (t-1) against firm status in period t. The three groups are mutually exclusive categories. The final row reports the shares of firms in each bin (over the sample period). Each row sums to 100 percent. The data are from the Ghana RPED/GMES database.

Table 3.10: Cross-tabulation of Lag Export Mode and Change in Direct Export Status

<table>
<thead>
<tr>
<th></th>
<th>Change in Direct Exports</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
</tr>
<tr>
<td>{Lag Indicator of Indirect Exports} f, t-1</td>
<td>0.285 ***</td>
</tr>
<tr>
<td></td>
<td>0.052</td>
</tr>
<tr>
<td>{Lag Log Firm Sales} f, t-1</td>
<td>-0.045</td>
</tr>
<tr>
<td></td>
<td>0.094</td>
</tr>
<tr>
<td>{Lag Log Firm Sales}^2 f, t-1</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td>0.003</td>
</tr>
<tr>
<td>{Change in Log Firm Sales} f</td>
<td>0.013</td>
</tr>
<tr>
<td></td>
<td>0.018</td>
</tr>
<tr>
<td>Year Fixed Effects</td>
<td>yes</td>
</tr>
<tr>
<td>Firm Fixed Effects</td>
<td>no</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.06</td>
</tr>
<tr>
<td>Observations</td>
<td>528</td>
</tr>
</tbody>
</table>

Notes: Table uses firm-level data from the Ghana RPED/GMES database for 1992, 1993, 1996 and 1997. The dependent variable is the change in a firm's indicator status if it directly exports. The independent variables are a lag indicator if the firm exports any products indirectly (through a government trading company, a private agent or other means), lag firm sales, lag firm sales squared and the change in firm sales between two periods. The final column includes firm fixed effects. Significance: * 10 percent; ** 5 percent; *** 1 percent.

Table 3.11: Change in Direct Exports
aggregate indirect export to all countries

slope = \frac{1}{\sigma} \sum_{j=1}^{N} \left[ \gamma^{\sigma} R' \left( \frac{v_j}{\nu_{j\pi}} \right)^{1-\sigma} \right]

direct export to j

slope = \frac{1}{\sigma} R \left( \frac{v_j}{\nu_{j\pi}} \right)^{1-\sigma}

indirect export to j

slope = \frac{1}{\sigma} \gamma^{\sigma} R' \left( \frac{v_j}{\nu_{j\pi}} \right)^{1-\sigma}

Figure 3.1: Profit Curves and Firm Productivity
Figure 3.2: Trade Costs and Market Size and Indirect Exports
Figure 3.3: Fixed Costs and Indirect Exports
Figure 3.4: Intermediary export share and market size