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Evidence from Exchange Rate Shocks in China

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Abstract

This study investigates exchange rate pass-through (ERPT) to international prices in the context of trade credit usage. Utilizing a comprehensive dataset including customs transactions and balance sheet data of Chinese exporters during 2000-2011, we document several stylized facts. First, there exists a significant dampening effect on the sensitivity of international pricing to exchange rate fluctuations among exporters that extend substantial trade credit, indicating a more complete ERPT. Second, the interest payments made by exporters to domestic banks exhibit negative responsiveness to home currency depreciation. Third, we observe substantial complementarity between trade credit and bank loans. To explain these patterns, we introduce a theoretical model featuring trade credits, bank lending and exchange rate shocks. Our findings underscore the importance of considering the financial health of firms in policy formulation, particularly in strategies aimed at managing inflation through supply chains.

JEL alassifications: *F31, F34, G32*

Keywords: *Exchange rate pass-through, Trade credit, Financial constraints*

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1. Introduction

One fundamental question in international economics is why large movements in exchange rates have small effects on the prices of internationally traded goods. This "incomplete exchange rate pass-through" phenomenon raises critical questions on the underlying mechanisms through which exchange rates influence export prices, amidst varying economic theories and empirical evidence. Notably, Amiti, Itskhoki and Konings (2014) emphasizes the role of import intensity, while Atkeson and Burstein (2008) highlights the significance of productivity variations. At the same time, a well-known strand of literature claims that financial constraints and trade credit not only shape firms' domestic pricing strategies—as illustrated by (Gilchrist et al., 2017; Hardy, Saffie and Simonovska, 2022; Almut, Balleer; Nikolay, Hristov; Dominik, 2017; Kohn, Leibovici and Szkup, 2020) —but could also extend their influence to international pricing decisions.

This study investigates the impacts of trade credit and bank loans on international market pricing strategies of firms and examines how prices adjust in response to exchange rate fluctuations (i.e., exchange rate pass-through). Leveraging an extensive dataset from China, which includes detailed accounts of firms' balance sheets and transaction-level export pricing, alongside a theoretical framework that considers variations in firm behavior within a monopolistic competition framework, this paper introduces the roles of domestic financial markets between banks and exporting firms and cross-border trade credit relationships between exporters and importers. The critical insight from our analysis is the significant influence of trade credit and financial market dynamics on the determination of international prices and their adjustment mechanisms in the face of exchange rate volatility.

We begin with the development of a theoretical model to explore the potential impact of trade credit on exchange rate pass-through. In this model, exporters located in the home country extend trade credit to their foreign importers. That is to say, the importers are allowed to pay a fraction of the payments before the arrival of the goods, instead of a complete up-front payment. For trade credit to be economically advantageous for exporters, importers are required to compensate through an implicit interest rate included within the product's pricing structure. This interaction between the trade credit interest rate and fluctuations in the exchange rate introduces a novel mechanism by which exchange rate pass-through is influenced.

Drawing on our theoretical framework, our empirical analysis utilizes a comprehensive dataset from China spanning 2000 to 2011, where accession to WTO gave rise to Chinese exports. This dataset amalgamates three distinct sources into a unified panel for analysis: i) balance sheets of Chinese firms, including detailing long-term debt, trade credit, and interest costs; ii) transaction-level customs records capturing export prices across; and iii) bilateral exchange rate figures sourced from the International Monetary Fund. Employing this unique dataset, we uncover several key observations about the Chinese export sector. First, we observe that export prices, when measured in the producer's currency, exhibit a reduced sensitivity to exchange rate fluctuations among exporters with a higher proportion of trade credit (receivables) relative to sales compared to those with a lower proportion. Essentially, firms that extend more trade credit achieve a higher degree of exchange rate pass-through to producer currency prices. Notably, this phenomenon is more pronounced during currency devaluations. Secondly, our analysis reveals a negative relationship between the interest expenses incurred by exporters on loans from domestic banks and fluctuations in exchange rates. Given that these interest costs serve as a proxy for the interest rate, our findings imply that domestic banks adjust the interest rates levied on exporters in response to exchange rate changes. This adjustment mechanism is likely influenced by the fact that exchange rate variations can enhance the competitiveness of export prices in global markets. Thirdly, our investigation identifies that trade credit and bank loans function as complementary financial mechanisms for exporters. To extend trade credit to their purchasers, exporters depend on the ability to secure financing from domestic banks. This complementary relationship varies with the size of the firm; notably, firms with a larger market share exhibit a more pronounced complementarity between trade credit issuance and bank loan acquisition.

Building upon the insights drawn from the aforementioned stylized facts, we construct an open economy model incorporating three principal actors: exporters and domestic banks, both located in the home country, and importers located in foreign countries. This model bifurcates into two primary segments: the export market and the financial markets. Within the export market, the supply side is modeled through a monopolistic competition framework, introducing a novel integration of nominal exchange rates and trade credit mechanisms. On the demand side, importers have the capability to secure financing both from their respective local banks and directly from exporters, offering a nuanced view of the financial dynamics at play in international trade. The financial market segment of the model delineates the borrowing activities of exporters from domestic banks, where the interest rates applied by these banks are endogenously determined by a non-arbitrage condition. A key feature of this model is its responsiveness to exchange rate movements: specifically, the default rate of cross-border trade is modeled to decrease with a depreciation of the exporting country's currency. This comprehensive model aims to encapsulate the complex interrelations between trade credit, bank financing, and exchange rate dynamics in shaping international trade flows and financing structures.

Our model yields three theoretical outcomes. The first theoretical outcome of our model delineates that the equilibrium pricing of exports is influenced by three components: the variable markup over cost, the marginal production cost, and a financial term. This financial term is determined by two factors: the interest rate provided by domestic banks to exporters and the extent of trade credit, quantified as the ratio of a firm's trade credit to its sales. An increase in trade credit leads to a higher pricing of goods, as does an elevation in the interest rates charged by domestic banks. The second theoretical outcome from our model reveals that the sensitivity of prices to exchange rate fluctuations is modulated by the level of trade credit a firm extends relative to its sales. Firms that allocate a larger proportion of their sales to trade credit tend to set prices that are less responsive to changes in exchange rates. This finding aligns with the empirical evidence we have observed, validating the model's predictive capability.

The underlying mechanism for these phenomena is as follows: exporters benefit from reduced financial costs from domestic banks when the home currency depreciates, allowing these savings to be transferred to the implicit interest rate on trade credit. Consequently, with the depreciation of the home currency, the projected sales or returns for exporters in international markets improve. In a perfectly competitive banking sector, domestic banks optimize profits by setting firm-specific interest rates based on a non-arbitrage condition, which equalizes the expected return from lending and the risk-free return. There exists a positive correlation between the interest rates on bank loans and those applied to trade credit. Thus, the interest rate on trade credit decreases when the home currency depreciates, impacting the pricing strategies of exporting firms and their response to exchange rate shocks.

Related literature. Our paper contributes to three different strands of the literature. First, it contributes to the literature on the international pricing response to exchange rate changes. There is a large body of literature that focuses on different reasons why the exchange rate pass-through is incomplete, such as markup adjustment, local costs, or barriers to prices adjustment (Amiti, Itskhoki and Konings, 2014; Atkeson and Burstein, 2008; Campa and Goldberg, 2005; Gopinath, Itskhoki and Rigobon, 2010; Burstein and Gopinath, 2014; Auer and Schoenle, 2016; Berman, Martin and Mayer, 2012). This paper sheds light on an understudied source for incomplete exchange rate pass-through, which is trade credit and bank loans. Together with this paper, Strasser (2013) explores the effects of credit constraints on exports responses to shocks in terms of prices and quantities in international markets. Our contribution to this literature corresponds to a theoretical model disentangling the mechanism through which the interaction between trade credit and bank loans is connected and how this, in turn, affects the degree of exchange rate pass-through.

Second, our paper contributes to the literature relating firms' liquidity constraints and pricing decisions. Liquidity constraints can be divided into financial constraints related to domestic banks and trade credit. As regards bank loans, Gilchrist et al. (2017) shows that liquidity-constrained firms increased prices during the Great Recession in 2008, while unconstrained firms decreased prices. In contrast, Kim (2021) finds that a negative credit supply shock decreases output prices during the Lehman Brothers failure. In terms of trade credit, Amberg, Jacobson and von Schedvin (2021) finds firms issuing more trade credit increased product prices significantly more during the Great Recession. All of this literature focuses on the domestic prices of firms, while our paper expands into the international markets and, at the same time, combines in a model both mechanisms of the trade credit offered by firms and the financial constraints related to bank loans.

Third, this study relates to the body of work on trade credit and liquidity propagation. On the one hand, Desai, Foley and Hines Jr (2016) shows US multinationals use trade credits to shift capital from low-tax places to high-tax places. On the other hand, Lin and Ye (2018) finds multinationals' trade credit provision for Chinese firms is significantly affected by global liquidity shocks. This paper connects trade credit and bank loans. We first exploit the variation of our data and find the relationship between the bank loan interests and trade credit. Then, our model identifies the theoretical connection behind this result.

This paper is organized as follows. Section 2 proposes a conceptual model of prices in the context of trade credit usage. Section 3 corresponds to the data and some empirical findings. Section 4 presents a model that accounts for the empirical patterns and details a mechanism behind these patterns. In Section 5, we calibrate the model. Section 6 proposes a counterfactual and Section 7 concludes.

2. A Conceptual Model

How do trade credits affect exchange rate pass-through? In this section, we use a simple conceptual model to answer this question. The conceptual model will guide our empirical regression and will be formalized in the theoretical model.

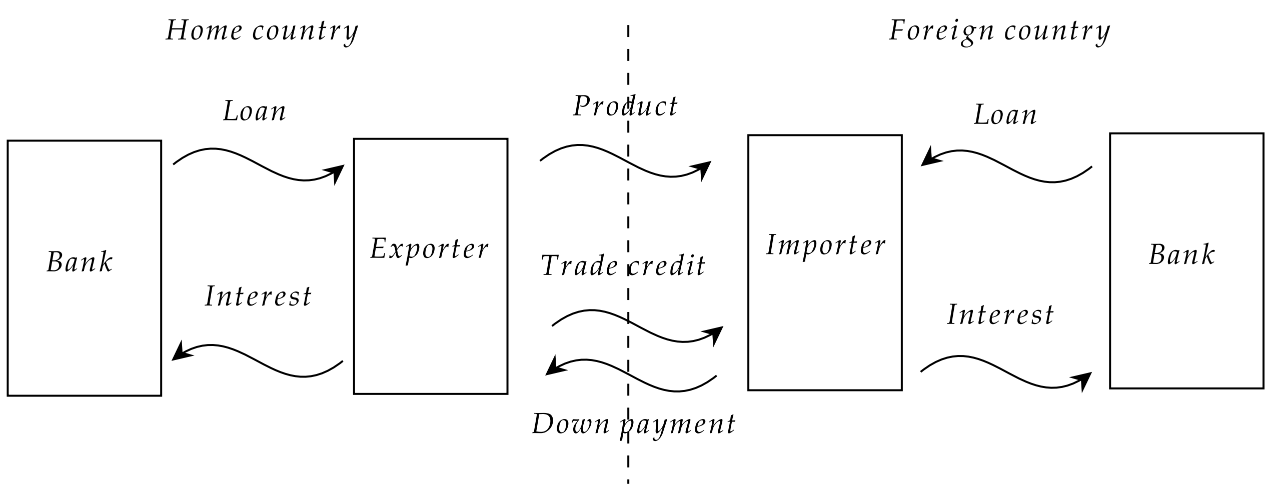


Figure 1: Trade and Financial Relationships

Notes: This figure provides an illustration of the trade and financial relationships of the economy. In the trade relationship, the exporter sells products to the importer and receives payments. The financial relationship between the exporter and the importer emerges when the exporter only requires a partial down payment and grants a trade credit to the importer. Both the exporter and the importer can borrow from banks in their own countries.

Consider an exporter in the home country selling a product to a foreign buyer, or importer (Figure 1). The exporter sets the product price in the importer's currency, $P^* = P \times E$, where E is the exchange rate defined as exporter's currency/importer's currency and P is the price in the exporter currency.

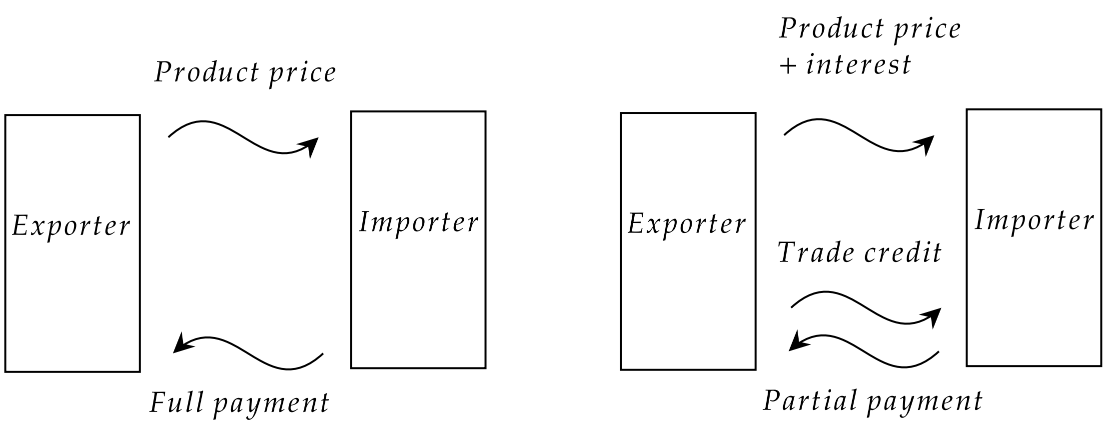
Suppose the price of the product is set with no trade credit being granted:

$$P^* = \frac{\varepsilon}{\varepsilon - 1} MC \times E^{-1} \tag{2.1}$$

where ε is the importer's demand elasticity; MC is the exporter's marginal cost in exporting country's currency unit [1]. From equation 2.1, we derive the following equation for the exchange rate pass-through with no trade credits:

$$\frac{dp}{de} = \frac{d\mu}{de} + \frac{d(mc)}{de} \tag{2.2}$$

where $p = logP$, $\mu = \log \frac{\varepsilon}{\varepsilon - 1}$, $mc = \log MC$, and $e = logE$. Equation 2.2 summarizes two channels of the channels of incomplete exchange rate pass-through that have been studied in the literature: the markup response [2] ($\frac{d\mu}{de} > 0$) or the marginal cost response ($\frac{d(mc)}{de} > 0$) [3].



(a) Full payment, no trade credit *(b) Partial payment, positive trade credit*

Figure 2: Trade Credit Utilization and the Exporting Price

Notes: Panel (a) illustrates the case where the exporter asks for full payment and grants no trade credit. The observed exporting price is the product price. Panel (b) illustrates the case where the exporter asks for partial payment and grants positive trade credits. The observed exporting price is the product price and an implicit interest rate (trade credit premium).

In this scenario, we introduce trade credit (Figure 2). Suppose the exporter allows the importer to pay for the products after a certain maturity period τ. That is, the exporter grants trade credit to the importer. Trade credit is desirable for the importer due to financial constraints. For example, an importer without cash could import inputs and sell final goods to consumers. After collecting cash from the consumers, the importer can pay the exporter back. However, as issuing trade credit is costly for the exporter, the importer needs to pay an implicit interest rate that is embedded in the product

[1]For this example, we use the standard setting with monopolistic competition and variable markups as in Atkeson and Burstein (2008)

[2]This channel assumes firms' have variable markups that vary via the response of the demand elasticity to exchange rate changes (Burstein and Gopinath, 2014)

[3]This channel is explored in studies such as Amiti, Itskhoki and Konings (2014); Berman, Martin and Mayer (2012)

price. Following Amberg, Jacobson and von Schedvin (2021), we assume there is a trade-credit premium in the product price:

$$P^T = P \times exp(r\tau) \tag{2.3}$$

where r is the implicit annual interest rate of trade credit and τ is the maturity of the trade credit, in number of net days divided by 365. With trade credit being granted, the exchange rate pass-through is:

$$\frac{dp^T}{de} = \frac{d\mu}{de} + \frac{d(mc)}{de} + \tau\frac{dr}{de} + r\frac{d\tau}{de} \tag{2.4}$$

In our empirical exercise, we focus on the role of $\tau\frac{dr}{de}$ in equation 2.4. The variation of exchange rate pass-through across exporters could be explained by the different degrees of trade credit utilization (τ) and the adjustment of the implicit interest rate to exchange rate changes ($\frac{dr}{de}$).

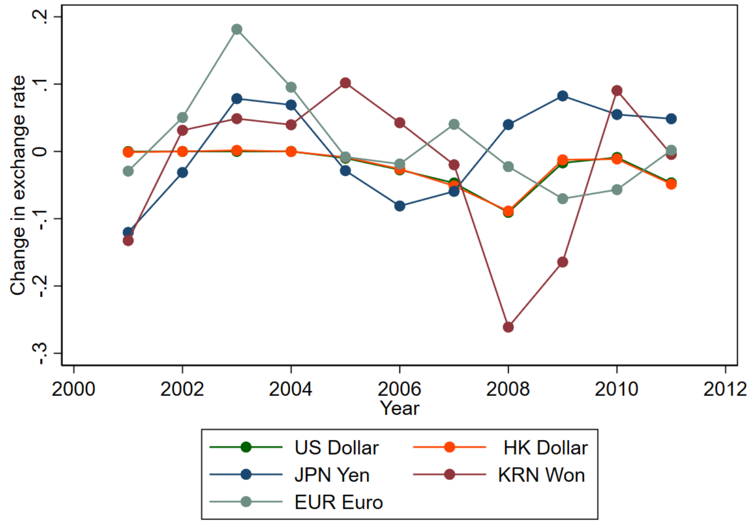
3. Data and Relevant Patterns

3.1 Data

Our sample of firms is drawn from two sources of data in China. First, we obtain the firm-level balance sheet data from the survey of Chinese manufacturing firms conducted by the National Bureau of Statistics of China. The survey covers more than 190,000 manufacturing firms' performance from 2000 to 2011. In these survey data, we are able to find the variables describing the firm's credit condition including trade credit (recorded on the balance sheet as account receivables), long-term debt, and interest costs. Together with this, we include variables that indicate the firm's size such as annual employment and sales. Second, we include a panel from customs that corresponds to the universe of Chinese trade transactions to 76 destination countries. It comprises data on trade values and trade prices for each transaction of a firm to a certain destination country in a given year. We merge the two datasets for the period 2000 to 2011 and construct the sample to conduct empirical analysis.

In addition to the firm panel, we also use the annually averaged nominal bilateral exchange rates from IMF to construct the exchange rate shocks at the importing-country level. Figure 3 shows the bilateral exchange rate shocks fluctuation from the year 2000 to 2011. Before 2005, the Chinese government implemented a fixed exchange rate policy targeted at US dollars. As a result, there were no bilateral exchange rate shocks between China and the United States before 2005. Table 1 is the summary of the key variables we use in the empirical part.

Figure 3: Times Series of Change in Exchange Rates



Notes: This figure shows the exchange rates fluctuations from 2000 to 2011. In the vertical axis, the annual exchange rate is calculated as Chinese RMB per 1 unit of exporting destination's currency averaged from monthly data.

Table 1: Summary Statistics

	Smallest firms (25% less employees)	25-50%	50-75%	25% biggest firms	Total
Receivables	5242.1	9240.2	14328.7	63284.3	31359.9
	(37629.3)	(91212.6)	(47987.9)	(418715.0)	(271797.4)
Payables	8559.5	14566.6	19686.3	112521.4	54659.2
	(60033.9)	(133549.4)	(79550.5)	(638415.6)	(417740.1)
Debt	19979.2	31811.0	51187.9	268480.5	126001.1
	(311620.7)	(292186.8)	(316846.9)	(2305890.4)	(1467169.1)
Receivables/debt	1.548	0.924	0.871	0.797	0.980
	(135.2)	(22.90)	(20.87)	(25.59)	(62.61)
Receivables/sales	0.167	0.166	0.161	0.171	0.167
	(0.206)	(0.197)	(0.192)	(0.190)	(0.195)
Payables/debt	0.193	0.192	0.182	0.178	0.185
	(0.257)	(0.249)	(0.233)	(0.211)	(0.232)
Payables/sales	0.471	0.442	0.428	0.414	0.433
	(0.339)	(0.313)	(0.325)	(0.327)	(0.327)
Interest rate	0.0306	0.0295	0.0286	0.0279	0.0286
	(0.0555)	(0.0499)	(0.0468)	(0.0435)	(0.0466)
Interest cost	919.7	1085.9	1874.8	9071.6	5640.1
	(18630.9)	(3668.8)	(10290.2)	(58569.9)	(44461.2)

Notes: Summary statistics about trade credit and debt by firm size: Mean, standard error in parenthesis. **Receivables:** Value in RMB of the loan given by the exporter firm. **Payables**: Value in RMB of the debt held by the importer. **Debt**: Value of the debt held by the firm with the bank. **Receivables/debt**: Trade credit given by the exporter over their debt with the bank. **"Receivables/sales"**: Trade credit given by the exporter over their sales. **"Payables/debt"**: Trade credit taken by the importer over their debt with the bank. **"Payables/sales"**: Trade credit taken by the importer firm over their sales.

3.2 Stylized Facts

In this section, we establish basic facts about the intricate linkages between exchange rate movements, trade financing practices, and international pricing strategies. We shed light on three relationships: the relationship between trade credit and bank loans, trade credit and export prices, and the exchange rate and bank loans.

Fact I: Larger trade credit share indicates more complete exchange rate pass-through.

We begin by exploring how exporters change their prices in response to exchange rate shocks in the context of trade credit usage. Equation 3.1 shows our main specification:

$$\Delta p_{i,j,k,t} = \underbrace{[\alpha + \beta rec_{i,0}]}_{1-ERPT} \Delta e_{k,t} + n_{i,t} + \varphi_{j,k} + \varphi_t + \varepsilon_{i,j,k,t} \tag{3.1}$$

where $\Delta p_{i,j,k,t}$ is the log change in price of good j denominated in producer-currency (Chinese RMB) from exporting firm i to destination country k at time t. $\Delta e_{k,t}$ is the log change of bilateral exchange rate (Chinese RMB per 1 unit of destination k's currency). An increase in $e_{k,t}$ corresponds to the depreciation of Chinese RMB relative to the destination-k currency. $rec_{i,0}$ is firm i's trade credit (receivables) over total sales in the first year of dataset. $n_{i,t}$ is log of employment of firm i at time t that captures remaining firm-level effects on ERPT. We also control for time fixed effects and product-destination fixed effects.

Since we are using the exporting prices, a complete exchange rate pass-through means $\alpha + \beta rec_{i,t} = 0$. The coefficient β indicates to what extent firm-level trade credit changes the pass-through to exporting prices when there exist bilateral exchange rate shocks. Table 2 reports the regression results. Column (1) shows the plain regression without controlling for trade credit shares. However, column (2) result shows that a 10% increase in trade credit share leads to a 1.24% higher exchange rate pass-through. The robustness check in columns (3)-(5) in which control for last-year trade credit share and employment demonstrate similar estimates of β. While a firm with no trade credit has a pass-through of 95.08% (= 1 - 0.0492), a firm with a 7% trade credit share (median) has a pass-through of 95.95% (= 1 - 0.0492 + 0.124· 0.07). The estimate of β indicates that firms with a larger share of trade credit relative to sales exhibit higher pass-through into destination-currency export prices.

Table 2: Regression Results

	(1)	(2)	(3)	(4)	(5)
	$\Delta p_{i,j,k,t}$	$\Delta p_{i,j,k,t}$	$\Delta p_{i,j,k,t}$	$\Delta p_{i,j,k,t}$	$\Delta p_{i,j,k,t}$
$\Delta e_{k,t}$	0.0314**	0.0492***	0.0281*	0.0497***	0.121***
	(0.0146)	(0.0176)	(0.0159)	(0.0176)	(0.0424)
$rec_{i,0}$		-0.00991**		-0.00778*	-0.00801*
		(0.00426)		(0.00412)	(0.00410)
$\Delta e_{k,t} \times rec_{i,0}$		-0.124***		-0.125***	-0.134***
		(0.0473)		(0.0476)	(0.0468)
$rec_{i,t-1}$			-0.000123*		
			(0.0000681)		
$\Delta e_{k,t} \times rec_{i,t-1}$			-0.00819***		
			(0.00264)		
$n_{i,t}$				0.00219***	0.00183***
				(0.000542)	(0.000574)
$\Delta e_{k,t} \times n_{i,t}$					-0.0111*
					(0.00588)
Product-destination FE	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes
Obs	1443809	1443809	1110858	1443809	1443809

Notes: This table reports the results of regression results from equation 3.1 Standard errors are reported in parenthesis.* Significant at 10%.** Significant at 5%.*** Significant at 1%. All columns have year-level and product-destination-level fixed effect controls.

Fact II: Interest costs decrease in response to home currency depreciation

We ran equation 3.2 to examine how firm's loan-related costs react to exchange rate shocks.

$$c_{i,t} = \alpha + \beta \Delta e_{i,t} + \varphi_i + \varphi_t + \varepsilon_{i,t} \tag{3.2}$$

where $c_{i,t}$ is the log finance costs or log interest costs of exporter i at time t. φ_i and φ_t are firm and time fixed effects. $\Delta e_{i,t}$ is the firm-level exchange rate shocks constructed as

$$\Delta e_{i,t} = \sum_{k \in \Omega_{i,t}} \Delta e_{k,t} \times \Gamma_{i,k,t}$$

where $\Gamma_{i,k,t}$ is the exporting share of firm i to destination k in period t. $\Omega_{i,t}$ is the a set of exporting countries of firm i in period t. The regression results are shown in Table 3.

Table 3: Regression Results

	(1)	(2)	(3)	(4)
	$c^F_{i,t}$	$c^I_{i,t}$	$c^F_{i,t}$	$c^I_{i,t}$
$\Delta e_{i,t}$	-0.339***	-0.566***	-0.158***	-0.149**
	(0.0919)	(0.0989)	(0.0575)	(0.0640)
Period	Yes	Yes	Yes	Yes
Firm	No	No	Yes	Yes
N	183118	183118	148458	148458

Notes: This table reports the results of regression results from Equation 3.2. Standard errors are reported in parenthesis.* Significant at 10%.** Significant at 5%.*** Significant at 1%.

Finance costs and interest cost can approximate firm's credit level and interest rate. Table 3 shows that when Chinese RMB depreciates, the loan-related costs decrease, which is consistent with the conceptual model's prediction. Home currency depreciation is to the advantage of exporting firms, who are expected to increase exports. The higher profitability in the future enables them to borrow more from local bank at a lower cost because of the improved performance and lower default risks. As a result, the interest costs are lowered. This effect is passed on to the implicit trade credit interest rate, indicating that exporters are willing to lend to downstream foreign firms at a lower cost.

We also run equation 3.2 using trade credit share to examine if firms adjust their trade credit share upon exchange rate fluctuations. Table 4 shows that firm-level trade credit share generally does not respond to exchange rate shocks, aligning with the assumption that trade credit value is exogenous in the determination of exchange rate pass-through mechanism.

Table 4: Regression Results

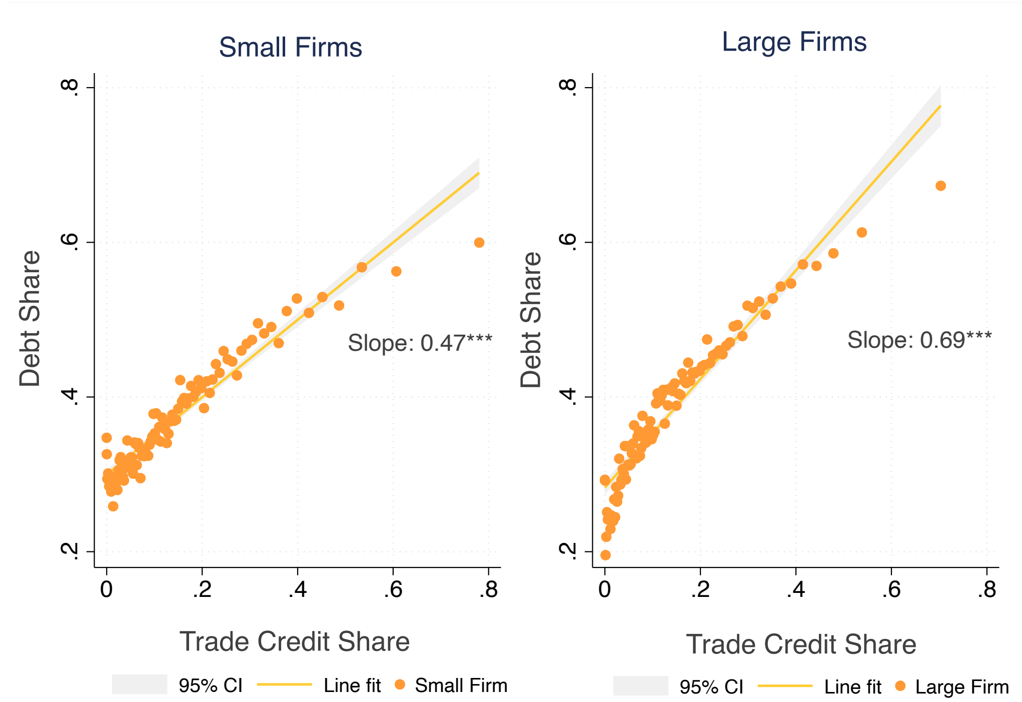
	(1)	(2)
	$rec_{i,t}$	$rec_{i,t}$
$\Delta e_{i,t}$	-0.0121	-0.00526
	(0.00636)	(0.00753)
Period	No	Yes
Firm	Yes	Yes
N	277919	277919

Notes: This table reports the results of regression results from Equation 3.2. Standard errors are reported in parenthesis.* Significant at 10%.** Significant at 5%.*** Significant at 1%.

3.2.1 Fact III: Higher trade credit is associated with higher bank loans

Not all Chinese exporters grant trade credit to their foreign buyers. One of the reasons for this is that trade credit is costly for the exporters given it poses a liquidity constraint. However, Chinese firms have access to a broad range of financial instruments that can mitigate or help cover the cost of trade credit. We explore the relationship between trade credit and bank loans for Chinese exporters [4].

Figure 4: Correlation between Trade Credit Share and Bank Loans



Notes: This figure shows the relationship between trade credit and bank loans for small and large firms. In the vertical axis, the debt share corresponds to bank loans/sales and, in the horizontal axis, trade credit/sales.

Figure 4 illustrates the interplay between trade credit and bank loans. In both panels, the debt share is denoted as the ratio between bank loans and sales at the firm level. The trade credit share corresponds to the ratio between the trade credit and sales. The plot is a binscatter showing the relationship between these two variables for two types of firms: small firms and large firms.

The main takeaway is that the higher the trade credit granted by the exporter, the higher the debt that firm holds with domestic banks. The intuition behind this finding is that exporters might face a financial constraint while offering trade credit and will solve it by taking loans from domestic banks.

Figure 4 also reveals the strength of the relationship between trade credit and bank loans varies with firm size. Small firms find it harder to substitute away granting trade credit with bank loans. A potential reason for this is small firms have less access to bank loans, while large firms might be automatically connected with banks willing to grant them credits. The lack of access could be translated into higher interests costs of bank loans

This fact corresponds to a key intuition for our theoretical model. It motivates the existence of a connection between domestic banks behavior with exporters' trade credit. In the Appendix,

[4]Studies such as Hardy, Saffie and Simonovska (2022) analyze the relationship between these instruments but from the perspective of the firms receiving trade credit from their suppliers. In this paper, we shift the focus to the suppliers granting trade credit and how the extent of trade credit is related to their access and costs of bank loans.

we include more detailed statistics on the relationship between trade credit and other financial instruments.

4. Model

In this section, we formalize the idea using a theoretical model consistent with the data. We build trade credit lending from exporters to importers, and bank loans lending from banks to exporters into a monopolistic competitive framework. The model captures the mechanism that the degrees of trade credit usage govern how much export produces price responses to exchange rate fluctuations.

The model is a static partial equilibrium model. To begin with, we allow exporters to issue trade credit. In this model, the importer pays for the product in two steps: (i) pays a portion of the price upfront (i.e., down payment), and (ii) pay the remaining portion when they receive the product (i.e., trade credit).[5] Since trade credit is a form of firm-to-firm debt, the price that the exporter sets bears the risk of default.

Second, we introduce the nominal exchange rate. The exchange rate serves two roles in our model. As in the classic small open economy model,it connects prices charged by the exporters and prices received by the importers. The nominal exchange rate will be nontrivial for the choice of the equilibrium price, and will, in turn, affect how prices react to changes in the exchange rate. This will be the case even under the common assumption of constant markups and marginal cost for the exporter.Moreover, we assume that the default probability of importer on trade credit is exogenous and is only influenced by the bilateral exchange rate shocks. The rationale is that the ability of importer repaying trade credit changes with the value of revenue denominated in the exporting country's currency, which is impacted by the exchange rate only when facing fixed demand.

Third, we include financial markets into our model. Specifically, the importer and the exporter borrow from banks in their own countries. We assume the interest rate granted to the specific exporter-importer pair is endogenously determined by the non-arbitrage condition of banks, resulting in response to the exchange rate shocks in the exporting country financial market. We assume the interest rate in the exporter's country is endogenously set by the banks, which operate in a perfectly competitive market. This setting enables us to capture the interest rate response to exchange rate changes: when home currency depreciates, the exporter specific interest rate decreases.

4.1 Model Setup

In the model, there are two countries: the exporting country and the importing country. There are three industries: a final goods industry in the importing country, an intermediate goods industry, and a banking industry in the exporting country. In the exporting country j, there are N exporters in the intermediate goods industry indexed by $k = 1, ..., N$. Each exporter produces a unique intermediate

[5] For the trade credit block, we follow Cun et al. (2022)

variety. In the importing country, there is a continuum of competitive firms. They import inputs from the exporters and combine the inputs to produce a final good.

4.2 Importers

The importers are final goods producers who combine intermediate inputs using a CES aggregator production function:

$$y_i = \left[\int_{k \in J_i} Q_i(k)^{\frac{\varepsilon-1}{\varepsilon}} dk \right]^{\frac{\varepsilon}{\varepsilon-1}} \tag{4.1}$$

where y_i is the exogenous demand for final goods in the importing country. ε is the elasticity of substitution ($\varepsilon > 1$). For simplicity, we assume the importers only purchase inputs from the exporting country.

In the importing country i, the representative importing firm is not endowed with any cash. In order to purchase inputs, the importer seeks external financing. The external financing is assumed to be two-fold; on the one hand, the importer can borrow from a bank in her home country at an exogenous interest rate, R_i. On the other hand, she can borrow trade credit from the exporter. As we discussed in the previous section, the exporter divides the full payment into a down payment and a trade credit. The down payment share is defined as $\phi(k)$, where $0 \leq \phi(k) \leq 1$, and the trade credit share in turn is defined as $1 - \phi(k)$. There's a probability β_i that the importer will pay back the pre-determined trade credit and the exporter can receive full payment. We assume the probability of fulfilling payments, β_i, increases with the exporting country's currency depreciation. The assumption can be rationalized by multiple micro-foundations. For example, currency depreciation reduces the importer's marginal cost of production. Since the importer has zero cash in hand, she has to borrow from the bank to fund for the down payment. We assume the down payment share $\phi(k)$ is exogenously given. The importer solves a cost-minimization problem as follows taking equation 4.1 as the budget constraint:

$$\min_{\{Q_i(k)\}_{k \in J_i}} \int_{k \in J_i} \left[\phi(k) + (1 - \phi(k))\beta_i \right] p_i^*(k) Q_i(k) dk + R_i \int_{k \in J_i} \phi(k) p_i^*(k) Q_i(k) dk \tag{4.2}$$

where J_i is the set of input varieties in country i available to the importer. $\phi(k)$ is the down payment share and R_i is the bank interest rate in the importer's country. $p_i^*(k)$ is the price of input k denominated in currency of importer's country faced by importer i. We can solve for the importer's demand equation of input variety k as:

$$Q_i(k) = y_i (p_i^*(k)/P_i^*)^{-\varepsilon} \tag{4.3}$$

where $P_i^* \equiv (\int_{k \in J_i} p_i^*(k)^{1-\varepsilon} dk)^{\frac{1}{1-\varepsilon}}$ is the price index.

4.3 Exporters

The exporters are intermediate input producers. The market is monopolistically competitive. There are an exogenous number of input producers in the exporting country. Input producer k is endowed with a productivity $a(k)$. In the exporting country j, exporter k is not endowed with any cash. An exporter needs to pay the fixed costs f and variable costs upfront. While part of the costs can be covered by the prepayment from importer i, the remaining costs are financed by the bank at an interest rate $r_i(k)$. The interest rate is endogenously determined by the bank. Selling goods to importer i is the only way to earn revenue. If the importer defaults, then the exporter would also default on the local bank. As a result, there is only a probability β_i that the exporter pays the finance costs. The input producer maximizes her profits under two budget constraints: the importer's demand equation, and the total financial credit should be sufficient to pay for labors. Specifically, an input producer k's problem is as follows:

$$\max_{p_i^*(k),b(k)} \quad p_i^*(k)e_iQ_i(k)[\phi(k)+(1-\phi(k))\beta_i] - a(k)w_jQ_i(k) - fw_j - \beta_i b(k)r_i(k). \tag{4.4}$$

The total profits of exporting to the country i equal to the expected revenues minus variable production costs, the fixed market entry costs, and the financial costs. The expected revenues are governed by the trade credit share ($\phi(k)$) and the exogenous default rate (β_i). With 100% probability, the producer collects the prepayment ($p_i^*(k)e_iQ_i(k)\phi(k)$), while the rest of the payments are fulfilled with a probability of β_i. The producer only pays the banks the financial costs when the importer fully pays. Thus, the financial costs also depend on the probability β_i. This maximization problem is solved under two budget constraints:

$$Q_i(k) = y_i(p_i^*(k)/P_i^*)^{-\varepsilon} \tag{4.5}$$

$$\phi(k)p_i^*(k)eQ_i(k) + b(k) = a(k)w_jQ_i(k) + fw_j \tag{4.6}$$

where e_i is the exchange rate (exporter currency over importer currency), f is the fixed costs, $r_i(k)$ is the firm-level interest rate in the exporter's country and $b(k)$ is the borrowing from banks.

Solving for the problem, we have the equilibrium price in importing country's currency :

$$p_i^*(k) = e_i^{-1}\frac{1+\beta_i r_i(k)}{[\phi(k)+(1-\phi(k))\beta_i]+\beta_i r_i(k)\phi(k)}\frac{\varepsilon}{\varepsilon-1}a(k)w_j \tag{4.7}$$

Thus, the equilibrium price in the exporting country's currency is:

$$p_i(k) = \frac{1+\beta_i r_i(k)}{[\phi(k)+(1-\phi(k))\beta_i]+\beta_i r_i(k)\phi(k)}\frac{\varepsilon}{\varepsilon-1}a(k)w_j \tag{4.8}$$

Note that the equilibrium price depends on multiple factors. First, it depends on the exporters' markup ($\varepsilon/(\varepsilon-1)$). Second, it depends on the marginal cost of production , $a(k)w_j$, corresponding to the hired labor multiplied by the wage. Third, the price depends on a novel trade credit term. This term is governed by $r_i(k)$, $\phi(k)$ and β_i. An increase in $\phi(k)$ (higher down payment, lower trade credit) leads to less "trade credit premium" in the price and in turn a lower product price. An increase in $r_i(k)$ leads to a higher product price, meaning a partial pass-through of financial cost into the product price. An increase in β_i leads to a decrease in price. In the expression for the price, both $r_i(k)$ and β_i depend on the exchange rate. In section 4.4 we characterize this relationship and explain the mechanism behind it.

4.4 Bank's Problem

We build on Agarwal et al. (2023) and Heiland and Yalcin (2021) to model the bank sector. Assume that the banking sector is perfectly competitive. The bank is risk-neutral and can hedge the risk at zero costs. The bank endogenously sets the interest rate to an exporter by equalizing the expected return from the lending and the risk-free return. Therefore, the interest rate that an exporter selling variety k receives is given by the following no-arbitrage condition:

$$\beta_i r_i(k) b(k) + (1-\beta_i) m r_i(k) b(k) = r_f b(k) \tag{4.9}$$

where m $(0 < m < 1)$ is the recovery rate of the loan interest if the exporter defaults. $r_f (r_f > 0)$ is the risk-free rate. Then the interest rate is

$$r_i(k) = \frac{r_f}{\beta_i + (1-\beta_i)m} \tag{4.10}$$

Equation 4.10 shows that the interest rates received by exporter k only varies by the exporting destinations. When β_i is increasing, $r_i(k)$ is decreasing, which is consistent with the underlying mechanism that when the Chinese RMB is relatively depreciating, the ability to pay back the trade credit of importer i is increasing. This furthermore reduces the default risk of exporters on the bank, leading to a decrease in finance costs.

Proposition 1. *The bank interest rate to exporters decreases in the bilateral exchange rate shock, if* $\frac{\partial \beta_i}{\partial \log e_i} > 0$*:*

$$\frac{\partial r_i(k)}{\partial \log e_i} < 0$$

Proof. See Appendix for proof. □

4.5 Exchange Rate Pass-through

Plug Equation 5.13 into Equation 5.11 and compute the the exchange rate pass-through:

$$\frac{\partial \log p_i^*(k)}{\partial \log e_i} = -1 + \frac{1-\phi(k)}{\phi(k)+\beta_i B_i(k)} \cdot \frac{\beta_i^2 A_i - 1}{1+\beta_i r_i} \frac{\partial \beta_i}{\partial \log e_i} \tag{4.11}$$

where

$$A_i = \frac{r_f(1-m)}{[\beta_i + (1-\beta_i)m]^2} \tag{4.12}$$

$$B_i(k) = \phi(k)(r_i - 1) + 1 \tag{4.13}$$

From the equation above, it can be seen the exchange rate pass-through depends on the trade credit share $1-\phi(k)$. When the trade credit share is higher, the first term $\frac{1-\phi(k)}{\phi(k)+\beta_i B_i(k)}$ increases. Given the assumption that $\frac{\partial \beta_i}{\partial \log e_i}$ is positive (i.e., the default probability decreases with the home currency depreciating), the pass-through of exchange shocks to the price is more complete. We formalize this in Proposition 2.

Proposition 2. *The pass-through of a bilateral exchange rate shock to the price increases in the trade credit share, if* $\frac{\partial \beta_i}{\partial \log e_i} > 0$*:*

$$\frac{\partial^2 \log p_i(k)}{\partial \log e \partial \log \phi(k)} < 0$$

Proof. See Appendix for proof. □

5. Conclusion

It is well-known that financial factors play a key role in firms' price-setting behavior. In this paper, we explore this role in international markets. Mainly, we focus on the effect of trade credit on how export prices adjust exchange rate changes—exchange rate pass-through.

Our main finding is that financial frictions play a key role in exporting price setting. Exporters charge their foreign buyers a price that includes a trade credit premium corresponding to the trade credit they issue. Moreover, the prices of an exporter issuing a high ratio of trade credit to sales are less responsive to exchange rate shocks than the prices of an exporter with a low ratio. The mechanism behind this is that the implicit interest rate embedded in the exporting price endogenously responds to exchange rate changes. The higher degree of trade credit utilization the firm has, the more the exchange pass-through is affected by the implicit interest rate.

There are relevant policy implications that can be drawn from these findings. First, trade credit has a direct effect on price. That is, firms that can issue trade credit to their foreign buyers and in turn borrow from domestic banks to sustain their liquidity and obtain some insurance against exchange rate shocks. Second, in a time of supply chain congestion, inflation, and dramatic exchange rate fluctuations, policymakers should pay attention to the financial conditions of exporters and importers.

Given our findings, some questions arise in related topics. For example, if exchange rate shocks have an effect on the interest costs domestic banks offer, do exporters' countries of destination have an effect on the financial system in a country? Another potential contribution could be to test the theory in other countries and in other time periods. Our model informs us that the interest rate could respond to the exchange rate in both directions depending on the productivity distribution of firms. It would be interesting to see the results in different economic contexts.

References

Agarwal, Natasha, Jackie ML Chan, Magnus Lodefalk, Aili Tang, Sofia Tano, and Zheng Wang. 2023. "Mitigating information frictions in trade: Evidence from export credit guarantees." Journal of International Economics, 145: 103831.

Almut, Balleer; Nikolay, Hristov; Dominik, Menno. 2017. "Financial Constraints and Nominal Price Rigidities." CESifo Working Paper no. 6309;.

Amberg, Niklas, Tor Jacobson, and Erik von Schedvin. 2021. "Trade Credit and Product Pricing: The Role of Implicit Interest Rates." Journal of the European Economic Association, 19(2): 709–740.

Amiti, Mary, Oleg Itskhoki, and Jozef Konings. 2014. "Importers, exporters, and exchange rate disconnect." American Economic Review, 104(7): 1942–1978.

Atkeson, Andrew, and Ariel Burstein. 2008. "Trade Costs, Pricing to Market." American Economic Review, 98(5): 1998–2031.

Auer, Raphael A, and Raphael S Schoenle. 2016. "Market structure and exchange rate pass-through." Journal of International Economics, 98: 60–77.

Berman, Nicolas, Philippe Martin, and Thierry Mayer. 2012. "How do different exporters react to exchange rate changes?" The Quarterly Journal of Economics, 127(1): 437–492.

Burstein, Ariel, and Gita Gopinath. 2014. "International prices and exchange rates." In Handbook of international economics. Vol. 4, 391–451. Elsevier.

Campa, Jose Manuel, and Linda S Goldberg. 2005. "Exchange rate pass-through into import prices." Review of Economics and Statistics, 87(4): 679–690.

Cun, Wukuang, Vincenzo Quadrini, Qi Sun, and Junjie Xia. 2022. "Dynamics of Trade Credit in China." The Economic Journal.

Desai, Mihir A, C Fritz Foley, and James R Hines Jr. 2016. "Trade credit and taxes." Review of Economics and Statistics, 98(1): 132–139.

Gilchrist, Simon, Raphael Schoenle, Jae Sim, and Egon Zakrajšek. 2017. "Inflation dynamics during the financial crisis." American Economic Review, 107(3): 785–823.

Gopinath, Gita, Oleg Itskhoki, and Roberto Rigobon. 2010. "Currency choice and exchange rate pass-through." American Economic Review, 100(1): 304–36.

Hardy, Bryan, Felipe E Saffie, and Ina Simonovska. 2022. "Economic Stabilizers in Emerging Markets: The Case for Trade Credit."

Heiland, Inga, and Erdal Yalcin. 2021. "Export market risk and the role of state credit guarantees." International Economics and Economic Policy, 18: 25–72.

Kim, Ryan. 2021. "The effect of the credit crunch on output price dynamics: The corporate inventory and liquidity management channel." The Quarterly Journal of Economics, 136(1): 563–619.

Kohn, David, Fernando Leibovici, and Michal Szkup. 2020. "Financial frictions and export dynamics in large devaluations." Journal of International Economics, 122: 103257.

Lin, Shu, and Haichun Ye. 2018. "Foreign direct investment, trade credit, and transmission of global liquidity shocks: Evidence from Chinese manufacturing firms." The Review of Financial Studies, 31(1): 206–238.

Strasser, Georg. 2013. "Exchange rate pass-through and credit constraints." Journal of Monetary Economics, 60(1): 25–38.

Appendix

5.1 Solving the Importers' Problem

The Lagrangian:

$$L = -\int_{k\in J_i}[\phi(k)+(1-\phi(k))\beta_i]p_i^{T*}(k)Q_i(k)dk - R_i\int_{k\in J_i}\phi(k)p_i^{T*}(k)Q_i(k)dk + \mu\left[-y_i + \int_{k\in J_i}Q_i(k)^{\frac{\varepsilon-1}{\varepsilon}}dk\right]^{\frac{\varepsilon}{\varepsilon-1}}$$

F.O.C. w.r.t. $Q_i(k)$:

$$-[\phi(k)+(1-\phi(k))\beta_i]p_i^{T*}(k) - R_i\phi(k)p_i^{T*}(k) + \mu\left[\int_{k\in J_i}Q_i(k)^{\frac{\varepsilon-1}{\varepsilon}}dk\right]^{\frac{1}{\varepsilon-1}}Q_i(k)^{\frac{-1}{\varepsilon}} = 0$$

$$\mu\left(\frac{Q_i(k)}{y_i}\right)^{\frac{-1}{\varepsilon}} = \tilde{R}_i p_i^{T*}(k) \tag{5.1}$$

where $\tilde{R}_i \equiv \left[(1+R_i)\phi(k)+\beta_i(1-\phi(k))\right]$. By substituting 5.1 into 4.1 , we solve for the shadow price:

$$\mu = \tilde{R}_i(P_i^*) = P_i^*\left[(1+R_i)\phi(k)+\beta_i(1-\phi(k))\right] \tag{5.2}$$

Thus, the demand equation is

$$Q_i(k) = y_i(p_i^*(k)/P_i^*)^{-\varepsilon}.$$

5.2 Solving the Exporter's Problem

A firm producing product k from country j faces the following problem:

$$\max_{p_i^*(k),b(k)} \quad p_i^*(k)e_iQ_i(k)[\phi(k)+(1-\phi(k))\beta_i] - a(k)wQ_i(k) - fw - \beta_i b(k)r_i(k) \tag{5.3}$$

s.t.

$$Q_i(k) = [(1-\phi(k))\beta_i + (1+R_i+\bar{\lambda})\phi(k)]^{-\varepsilon}(p_i^*(k))^{-\varepsilon}y_i \tag{5.4}$$

$$\phi(k)p_i^*(k)e_iQ_i(k) + b(k) \geq a(k)wQ_i(k) + fw \tag{5.5}$$

where e_i is the exchange rate (Chinese RMB/ importer currency), f is the fixed costs, $r_i(k)$ is the firm-level interest rate in the exporter's country and $b(k)$ is the borrowing from banks. $1-\beta_i$ is the default probability.

$$L = p_i^*(k)e_iQ_i(k)[\phi(k) + (1-\phi(k))\beta_i] - a(k)wQ_i(k) - fw - \beta_i b(k)r_i(k)$$
$$+ \mu_k[\phi(k)p_i^*(k)e_iQ_i(k) + b(k) - a(k)wQ_i(k) - fw]$$

F.O.C.(1)

$$\frac{\partial L}{\partial p_i^*(k)} = e_iQ_i(k)[\phi(k) + (1-\phi(k))\beta_i] + p_i^*(k)e_i\frac{\partial Q_i(k)}{\partial p_i^*(k)}[\phi(k) + (1-\phi(k))\beta_i] \tag{5.6}$$
$$- a(k)w\frac{\partial Q_i(k)}{\partial p_i^*(k)} + \mu_k\phi(k)e_iQ_i(k) + \mu_k\phi(k)p_i^*(k)e_i\frac{\partial Q_i(k)}{\partial p_i^*(k)} - \mu_k a(k)w\frac{\partial Q_i(k)}{\partial p_i^*(k)} \tag{5.7}$$

Given $\frac{\partial Q_i(k)}{\partial p_i^*(k)} = -\varepsilon\frac{Q_i(k)}{p_i^*(k)}$

$$p_i^*(k) = e_i^{-1}\frac{1+\mu_k}{[\phi(k) + (1-\phi(k))\beta_i] + \mu_k\phi(k)}\frac{\varepsilon}{\varepsilon-1}a(k)w \tag{5.8}$$

F.O.C(2)

$$\frac{\partial L}{\partial b(k)} = -\beta_i r_i(k) + \mu_k = 0 \tag{5.9}$$

$$u_k = \beta_i r_i(k) \tag{5.10}$$

Plug 5.10 into 5.8, we have the equilibrium price

$$p_i^*(k) = e_i^{-1}\frac{1+\beta_i r(k)}{[\phi(k) + (1-\phi(k))\beta_i] + \beta_i r_i(k)\phi(k)}\frac{\varepsilon}{\varepsilon-1}a(k)w \tag{5.11}$$

5.3 Solving the Bank's Problem

The non-arbitrage condition bank faces is:

$$\beta_i r_i(k)b(k) + (1-\beta_i)mr_i(k)b(k) = r_f b(k) \tag{5.12}$$

m is the recovery rate of the loan interest if the exporter defaults and it is smaller than 1. r_f is the risk-free rate. Then the interest rate is

$$r_i = r_i(k) = \frac{r_f}{\beta_i + (1-\beta_i)m} \tag{5.13}$$

5.4 Computing the ERPT Equation

$$\log p_i^*(k) = -\log e_i + \log(1+\beta_i r_i(k)) - \log\big([\phi(k)+(1-\phi(k))\beta_i] + \beta_i r_i(k)\phi(k)\big) + \log[a(k)w\frac{\varepsilon}{\varepsilon-1}] \tag{5.14}$$

$$\frac{\partial \log p_i^*(k)}{\partial \log e_i} = -1 + \frac{1}{1+\beta_i r_i}\left(\beta_i \frac{\partial r_i}{\partial \log e_i} + r_i \frac{\partial \beta_i}{\partial \log e_i}\right) \tag{5.15}$$

$$- \frac{1}{[\phi(k)+(1-\phi(k))\beta_i] + \beta_i r_i \phi(k)}\left(\beta_i \phi(k)\frac{\partial r_i}{\partial \log e_i} + (r_i\phi(k) - \phi(k) + 1)\frac{\partial \beta_i}{\partial \log e_i}\right) \tag{5.16}$$

Based on Equation 5.13,

$$\frac{\partial r_i}{\partial \log e_i} = \frac{r_f(1-m)}{(\beta_i + (1-\beta_i)m)^2} \cdot \frac{\partial \beta_i}{\partial \log e_i} \tag{5.17}$$

Let

$$A_i = \frac{r_f(1-m)}{(\beta_i + (1-\beta_i)m)^2} = \frac{r_i(1-m)}{\beta_i + (1-\beta_i)m} = \frac{(1-m)r_i^2}{r_f} \tag{5.18}$$

$$B_i(k) = r_i\phi(k) - \phi(k) + 1 = \phi(k)(r_i - 1) + 1 \tag{5.19}$$

Therefore,

$$\frac{\partial \log p_i^{T*}(k)}{\partial \log e_i} = -1 + \frac{1}{1+\beta_i r_i}\left(\beta_i A_i \frac{\partial \beta_i}{\partial \log e_i} + r_i \frac{\partial \beta_i}{\partial \log e_i}\right) - \frac{1}{\phi(k)+\beta_i B_i(k)}\left(\beta_i \phi(k) A_i \frac{\partial \beta_i}{\partial \log e_i} + B_i(k)\frac{\partial \beta_i}{\partial \log e_i}\right) \tag{5.20}$$

$$= -1 + \frac{\beta_i A_i + r_i}{1+\beta_i r_i}\frac{\partial \beta_i}{\partial \log e_i} - \frac{\beta_i\phi(k)A_i + B_i(k)}{\phi(k)+\beta_i B_i(k)}\frac{\partial \beta_i}{\partial \log e_i} \tag{5.21}$$

$$= -1 + \left(\frac{\beta_i A_i + r_i}{1+\beta_i r_i} - \frac{\beta_i\phi(k)A_i + B_i(k)}{\phi(k)+\beta_i B_i(k)}\right)\frac{\partial \beta_i}{\partial \log e_i} \tag{5.22}$$

$$= -1 + \frac{(1-\phi(k))(\beta_i^2 A_i - 1)}{(1+\beta_i r_i)(\phi(k)+\beta_i B_i(k))}\frac{\partial \beta_i}{\partial \log e_i} \tag{5.23}$$

$$= -1 + \frac{1-\phi(k)}{\phi(k)+\beta_i B_i(k)} \cdot \frac{\beta_i^2 A_i - 1}{1+\beta_i r_i}\frac{\partial \beta_i}{\partial \log e_i} \tag{5.24}$$

$\frac{1-\phi(k)}{\phi(k)+\beta_i B_i(k)}$ is positive and increases with decreasing $\phi(k)$.

$$\beta_i^2 A_i - 1 = \beta_i^2 \frac{r_f(1-m)}{(\beta_i + (1-\beta_i)m)^2} - 1 = \left(\frac{\beta_i}{\beta_i + (1-\beta_i)m}\right)^2 \cdot r_f(1-m) \tag{5.25}$$

Since $(\beta_i + (1-\beta_i)m) - \beta_i = (1-\beta_i)m \geq 0$, $\frac{\beta_i}{\beta_i+(1-\beta_i)m} \leq 1$. Then $\beta_i^2 A_i - 1 \leq 0$.
Since $\frac{\partial \beta_i}{\partial \log e_i} > 0$, as a result, equation 5.24 is smaller than -1 and decreases with $\phi(k)$.