Bank Loans, Trade Credit and Export Prices: Evidence from Exchange Rate Shocks in China

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Motivation

- Fundamental question: What drives the international price response to bilateral exchange rate shocks (Exchange rate pass-through)?
  - What firm-specific factors influence the exchange rate pass-through?
- Little attention on the role of the financial relationship between exporters and foreign buyers: trade credit
  - Trade credit: short-term financing in which seller allows buyer to delay part of the payment to a later date
  - Potential interactions between trade credit in international markets and domestic bank loans
    - ⋆ Exporters are becoming more reliant on working capital as cross-border trade expands.
    - ⋆ Exporters extending trade credit require domestic bank financing to meet their working capital needs.
- In domestic firm-to-firm transactions:
  - Product price includes an implicit interest rate if the seller issues trade credit (Amberg et al., 2021).
  - But, how is this relationship in international markets? How does this contribute to the transmission of shocks?

This paper: What is the effect of trade credit on international prices and pass-through of shocks?

This paper: effect of trade credit on international prices and pass-through of shocks

1. Novel facts with transaction level exports data + exporters' financial statements China (2000-2011)
   - Fact 1: Larger exporter trade credit share indicates a more complete exchange rate pass-through to importer prices
   - Fact 2: Firm-level interest rate decreases in response to home currency depreciation
   - Fact 3: Higher trade credit share is associated with higher bank loans level
2. Model $\begin{cases} \text{working capital constraint: trade credit + bank loan} \\ \text{endogenous firm-level interest rate: borrower's default probability} \end{cases}$
   - Predictions I: Exporter pricing includes marginal financing costs ($\uparrow$ with trade credit share & firm-level interest rate)
   - Prediction II: Firm-level interest rate in equilibrium $\uparrow$ with trade credit share & home currency appreciation
   - Prediction III: ERPT is more complete with a higher degree of trade credit issued by the exporter.

Mechanism: Marginal financing cost adjusts to changes in the ER, increasing shocks pass-through

★ Home currency depreciates $\rightarrow$ Banks expect exporter profit $\uparrow$ $\rightarrow$ Exporter less likely to default $\rightarrow \downarrow$ marginal financing costs

★ Higher trade credit share $\rightarrow$ More borrowing from bank $\rightarrow$ Marginal financing costs more sensitive to ER shocks

Related Literature

1. **Firm characteristics and ERPT**
   - Markup adjustment, local costs, barriers to prices adjustment
     (Berman et al., 2012; Strasser, 2013; Chaney, 2016; Amiti et al., 2014; Gopinath et al., 2010)
   - This paper: firm-level trade credit share impacts ERPT
2. **Firm finance and pricing behavior**
   - Liquidity-constrained firms increased prices in 2008, and unconstrained firms decreased prices
     (Gilchrist et al., 2017)
   - Firms issuing more trade credit increase product prices significantly more in 2008
     (Amberg et al., 2021)
3. **Trade credit and firm decisions**
   - Factors influencing firms' decisions to extend or use trade credit
     (Antras and Foley, 2015; Ma and Schmidt-Eisenlohr, 2023; Benguria et al., 2023)
   - Trade credit effects on default, monetary policy transmission, economic growth
     (Jacobson and Von Schedvin, 2015; Barrot, 2016; Nilsen, 2002; Adelino et al., 2023; Fisman and Love, 2003)
   - This paper: Investigate the interplay between trade credit and bank loans under exchange rate shocks

Data

Annual Chinese Data 2000-2011

1. **Firm-level balanced sheet data (National Bureau of Statistics of China)**
   - Trade credit share = Trade credit (receivables)/Total sales
   - Bank loans and interest costs → firm-level interest rate
   - Employment
2. **Transaction-level Customs data for universe of Chinese Exporters**
   - Exporter ID
   - 10-digit HS product level
   - Country of destination
   - Weight, FOB value, quantities → export price (unit value)
3. **Nominal bilateral exchange rates (IMF)**

Empirical Evidence

Baseline Specification

$$\Delta p_{i,j,k,t} = \underbrace{[\alpha + \beta\phi_{i,0}]}_{1-ERPT} \Delta e_{k,t} + n_{i,t} + \underbrace{\varphi_{j,k} + \varphi_i + \varphi_t}_{Fixed\ \ Effects} + \varepsilon_{i,j,k,t} \quad (1)$$

i: exporter, j: sector, k: destination, t:time

- $\Delta p_{i,j,k,t}$ is log change in producer-currency (Chinese RMB) price
- $\Delta e_{k,t}$ is log bilateral exchange rate change (RMB per 1 unit of destination k's currency).
  - e.g. $\uparrow$ e is depreciation of Chinese RMB relative to the destination-k currency.
- $\phi_{i,0}$ is trade credit (receivables) at time $t = 0$ over total sales in year t.
- $n_{i,t}$ is log of employment

Fact I: Exporters with larger trade credit share have more complete ERPT

Table: Trade Credit Share and Exchange Rate Pass-through

Dependent Variables: $\triangle p_{i,j,k,t}$	(1)	(2)	(3)	(4)	(5)	(6)
$\triangle e_{k,t}$	0.0500***	0.0734***	0.0812***		0.0682***	0.135***
	(0.0111)	(0.0126)	(0.0146)		(0.0200)	(0.0497)
$\phi_{i,0}$		-0.0703***	-0.0615***	-0.0668***	-0.103***	-0.103***
		(0.00856)	(0.00805)	(0.00866)	(0.0117)	(0.0117)
$\triangle e_{k,t} \times \phi_{i,0}$		-0.192***	-0.143***	-0.156***	-0.197***	-0.204***
		(0.0404)	(0.0343)	(0.0439)	(0.0526)	(0.0531)
$n_{i,t}$					-0.00596***	-0.00620***
					(0.00189)	(0.00185)
$\triangle e_{k,t} \times n_{i,t}$						-0.0103
						(0.00628)
Fixed Effects:						
$\varphi_{j,k} + \varphi_i + \varphi_t$	Yes	Yes	No	No	Yes	Yes
$\varphi_{j,t} + \varphi_i + \varphi_k$	No	No	Yes	No	No	No
$\varphi_{j,k,t} + \varphi_i$	No	No	No	Yes	No	No
N	2368425	2368425	2430135	2160217	1644295	1644295
R^2	0.119	0.119	0.0902	0.208	0.150	0.150

Complete exchange rate pass-through: no change in RMB price ($\alpha + \beta\phi = 0$).
$\rightarrow$ With trade credit, an increase in the ER increases the price in RMB less (decreases that in USD more).

10% $\uparrow$ trade credit share, 1.92% $\uparrow$ ERPT. $\begin{cases} \text{No trade credit , ERPT: 92.66\% (= 1 - 0.0734)} \\ \text{20\% trade credit share, ERPT 96.5\% (= 1 - 0.0734 + 0.192} \times \text{ 0.2)} \end{cases}$

▸ Robustness

Fact II: Firm-specific interest rate decreases with home currency depreciation

$$r_{i,t} = \alpha + \beta \Delta e_{i,t} + \varphi_i + \varphi_t + \epsilon_{i,t} \tag{2}$$

- $r_{i,t}$ is the approximated bank loan interest rate of firm i in year t

$$r_{i,t} = \frac{\text{financing costs or interest costs}}{\text{total debt balance outstanding}}$$

- $\Delta e_{i,t}$ is the firm-level exchange rate shocks ($\uparrow$ e is RMB depreciation)

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

  - $\Gamma_{i,k,t}$ is 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.

Fact II: Firm-specific interest rate decreases with home currency depreciation

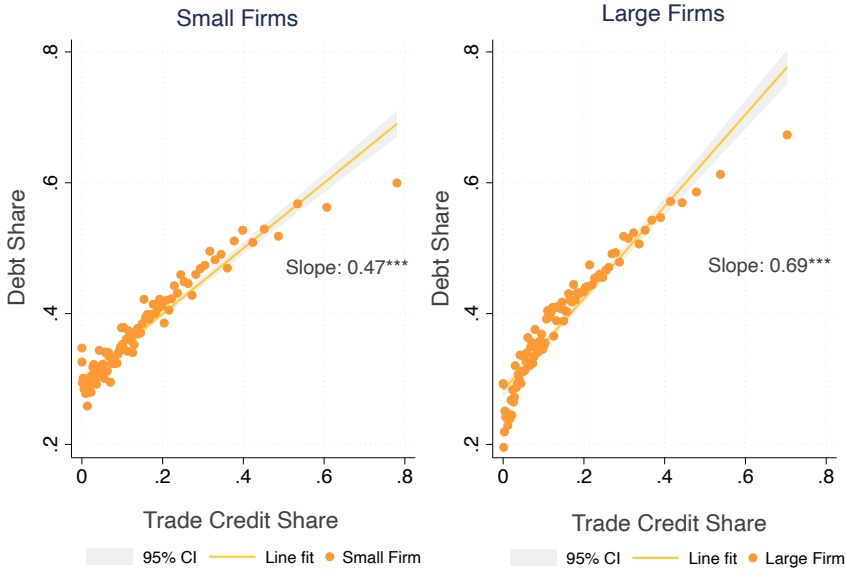
Table: Firm-level Interests and Exchange Rate Shocks

Dependent Variables:	$r^F_{i,t}$ (1)	$r^F_{i,t}$ (2)	$r^F_{i,t}$ (3)	$r^I_{i,t}$ (4)	$r^I_{i,t}$ (5)
$\triangle e_{i,t}$	-0.556***	-0.498***	-0.474**	-0.155*	-0.211**
	(0.158)	(0.163)	(0.203)	(0.0838)	(0.106)
$\triangle e_{i,t-1}$			-0.287		-0.00896
			(0.219)		(0.114)
Fixed Effects:					
$\varphi_i + \varphi_t$	Yes	No	Yes	No	No
$\varphi_i + \varphi_{j,t}$	No	Yes	No	Yes	Yes
N	347197	346850	196791	360111	202865
R^2	0.511	0.523	0.544	0.595	0.634

- Takeaway: Exporter's firm-level bank loan interest rate decreases with home currency depreciation.

▸ No change in TC

Fact 3: Exporter's trade credit share is positively correlated with bank loan



The Model: A Glance

Open economy model with exporters, importers and domestic banks

Three Agents

- Importers in foreign countries k
- Exporters i in sector s in the home country (China m)
- Bank in the home country

Two Key Sections:

1. Monopolistically competitive export market
   - Exporters maximize expected profits facing liquidity shocks after production and borrowing decisions are made
     - ⋆ Goods: prices and quantities
     - ⋆ Borrowing: borrowing amount and default probability
   - Demand: importers demand goods and borrow trade credit from exporters
2. Perfectly competitive banking sector
   - Firm finances destination-specific exporting activity with domestic bank
   - Bank sets firm-level interest rates according to the default probability of exporter

A story of bank loans and international trade credit

- No trade credit: importer pays full amount in advance to finance for exporters' production activities
- Trade credit: exporter receives prepayment ($<$ variable costs) and finance remaining with the local banks

1. **Firm finance variable costs by working capital**

$$\underbrace{(1-\phi_i)p_{ik}^{*}e_{mk}q_{ik}}_{Prepayment=(1-\phi)\cdot Sales} + \underbrace{b_{ik}}_{Bank\ Loan} \geq \underbrace{\tau_{mk}c_{ms}q_{ik}}_{Firm's\ Variable\ Costs} \qquad \textit{Working Capital Constraint} \tag{3}$$

- ★ ϕ_i : trade credit share (prepayment share=1-ϕ_i)
- ★ p_{ik}^{*}: variety i price of destination k in destination currency
- ★ q_{ik}: quantity demanded for goods i in k
- ★ e_{mk}: bilateral exchange rate (RMB per 1 unit of k's currency)
- ★ c_{ms}: input bundle cost to produce one unit of output
- ★ τ_{mk}: iceberg costs of shipment from China (m) to country k

Timeline

Period t: exchange rate level is realized and trade credit share is determined

Stage 1	**Bank** decides interest rate for each loan, anticipating the default probability of borrower.
Stage 2	**Exporter** chooses price, production and loan (max profit given ER shock & expected liquidity shock).
Stage 3	**Importers** choose demand.
Stage 4	**Liquidity shock** is realized.
Stage 5	**Exporter** decides whether to default on bank loan or not.

Period t + 1: new exchange rate level is realized

Exporter's Problem

- Expected Profit Maximization:

$$\max_{p^*_{ik}} \quad \Pi_{ik} = \underbrace{(1-\lambda_{ik})}_{P(\text{No Default})} \underbrace{(p^*_{ik} e_{mk} q_{ik} - \tau_{mk} c_{ms} q_{ik} - r_{ik} b_{ik}}_{\pi_{ik}} - \underbrace{\bar{F}}_{E[\text{Liquidity}]}) + \underbrace{\lambda_{ik}}_{P(\text{Default})} \cdot \underbrace{0}_{\Psi(\text{Default})}$$

subject to importer demand

$$q_{ik} = \frac{\gamma_{ik} p^{*-\epsilon}_{ik} \theta_{sk} Y_k}{P^{1-\epsilon}_{sk}}$$

working capital constraint

$$\underbrace{(1-\phi_i) p^*_{ik} e_{mk} q_{ik}}_{\text{Prepayment}=(1-\phi)\cdot\text{Sales}} + \underbrace{b_{ik}}_{\text{Bank Loan}} = \underbrace{\tau_{mk} c_{ms} q_{ik}}_{\text{Firm's Variable Costs}}$$

default probability

$$\lambda_{ik} = Pr[\underbrace{p^*_{ik} e_{mk} q_{ik}}_{\text{sales}} - \underbrace{\tau_{mk} c_{ms} q_{ik}}_{\text{variable costs}} - \underbrace{r_{ik} b_{ik}}_{\text{interest costs}} - \underbrace{F_{ik}}_{\text{liquidity shock}} < 0] = 1 - G(\pi_{ik})$$

Bank determines interest rate

- Perfectly competitive bank market
- Bank chooses interest rate to equate the expected return of lending to the exporter to an alternative risk-free return r_f(normalize recovery amount$= 0$).

$$\underbrace{b_{ik}(1+r_f)}_{\textit{Risk free return}} = \underbrace{(1-\lambda_{ik})(1+r_{ik})b_{ik}+\lambda_{ik}\cdot 0}_{\textit{Expected return}} \tag{4}$$

- Interest Rate:

$$r_{ik} = \frac{r_f+\lambda_{ik}}{1-\lambda_{ik}} \tag{5}$$

$\rightarrow$ If bank perceives the exporter has a lower default probability, then sets a lower interest rate.

We can then solve for equilibrium r_{ik} by using first-order approximation.

Equilibrium Outcome

- Equilibrium export prices

$$p_{ik}^{*} = e_{mk}^{-1} \underbrace{\frac{\epsilon}{\epsilon - 1}}_{\text{Mark up}} \times \underbrace{\tau_{mk} c_{ms}}_{\text{Marginal Costs}} \times \underbrace{\frac{1 + r_{ik}}{1 + (1 - \phi_i) r_{ik}}}_{\text{Marginal Financing Costs}}$$

- Equilibrium interest rate

$$r_{ik} = \frac{\xi_{ik} e_{mk}^{-\epsilon} - 1}{2 - \epsilon \phi_i} \tag{6}$$

  - Assume liquidity shock $F_{ik} \sim U[0, F^H]$.
  - ξ_{ik} is the inverse of a positive combination of exogenous country, sectoral, and variety demand shocks, excluding the exchange rate shock.

Proposition 1

Interest Rate Sensitivity to Exchange Rate Movements and Trade Credit Share

In a perfectly competitive banking market, the bank sets the interest rate based on the exporter's default probability. Under mild regularity conditions, the equilibrium interest rate decreases with a depreciation of the home currency and increases with the trade credit share extended by the exporter to buyers.

$$\frac{\partial r_{ik}}{\partial e_{mk}} < 0, \quad \frac{\partial r_{ik}}{\partial \phi_i} > 0$$

Trade Credit Impact on the Level of ERPT

$$\frac{\partial}{\partial \phi}\underbrace{\frac{\partial \log p^*}{\partial \log e}}_{ERPT} = \frac{\partial}{\partial \phi}\frac{\partial \log(1+r)}{\partial \log e} - \frac{\partial}{\partial \phi}\frac{\partial \log(1+(1-\phi)r)}{\partial \log e}$$

$$= \underbrace{\frac{\partial}{\partial \phi}\left(\frac{\phi}{(1+r)(1+(1-\phi)r)}\right)}_{<0} e \underbrace{\frac{\partial r}{\partial e}}_{<0} - \frac{\phi}{(1+r)(1+(1-\phi)r)} e d \underbrace{\frac{\partial}{\partial \phi}\left(\frac{\partial r}{\partial e}\right)}_{<0}$$

Proposition 2

Exporters who grant higher trade credit to foreign buyers respond less intensively on pricing in home currency given exchange shocks.

$$\frac{\partial}{\partial \phi}\frac{\partial \log p^*}{\partial \log e} < 0$$

$\rightarrow$ Maps with Fact I: Firms with larger trade credit share have more complete ERPT

Quantitative Results

- Equilibrium export price

$$p_{ik}^{*} = e_{mk}^{-1} \frac{\epsilon}{\epsilon - 1} \tau_{mk} c_{ms} \frac{1 + D_{ik} - \epsilon \phi_i}{2 - \epsilon \phi_i + (1 - \phi_i)(D_{ik} - 1)} \tag{7}$$

  where $D_{ik} = \xi_{ik} e_{mk}^{-\epsilon}$ is the inverse of demand shifter

- Take log and first-order approximate D_{ik} and ϕ_i around $\bar{D}$ and $\bar{\phi}$

$$\Psi_{ik}^{*} = \left[-1 + g\left(\bar{\phi}\right) - g'\left(\bar{\phi}\right)\bar{\phi} \right] + g'\left(\bar{\phi}\right)\phi_i \tag{8}$$

  where

$$g\left(\bar{\phi}\right) = -\frac{\epsilon \bar{D}}{1 + \bar{D} - \epsilon \bar{\phi}} + \frac{\left(1 - \bar{\phi}\right)\epsilon \bar{D}}{2 - \epsilon \bar{\phi} + \left(1 - \bar{\phi}\right)\left(\bar{D} - 1\right)}$$

$$g'\left(\bar{\phi}\right) = -\frac{\epsilon^2 \bar{D}}{\left(1 + \bar{D} - \epsilon \bar{\phi}\right)^2} + \frac{-\epsilon \bar{D}(2 - \epsilon)}{\left[2 - \epsilon \bar{\phi} + \left(1 - \bar{\phi}\right)\left(\bar{D} - 1\right)\right]^2}$$

Parameterization

- Goal: calibrate ϵ and $\bar{D}$ using coefficient estimated in baseline result
- Reduced-form equation

$$\triangle \log p_{ik} = \left[\left(g\left(\bar{\phi}\right) - g'\left(\bar{\phi}\right)\bar{\phi} \right) + g'\left(\bar{\phi}\right)\phi_i \right] \triangle \log e_{mk} + \varepsilon_{ik} \tag{9}$$

- Closed-form expressions for the coefficients α and β in the main specification

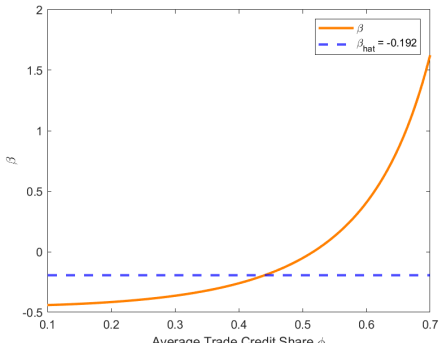
$$\alpha = g\left(\bar{\phi}\right) - g'\left(\bar{\phi}\right)\bar{\phi}, \quad \beta = g'\left(\bar{\phi}\right) \tag{10}$$

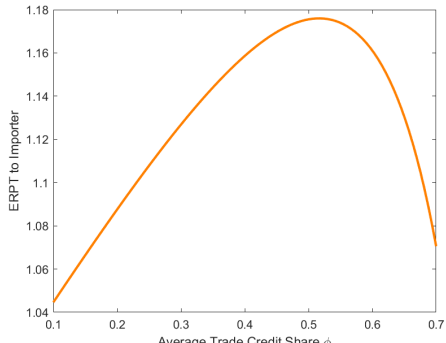
- Substitute $\bar{\phi} = 0.4$ (from dataset), $\alpha = 0.0734$, $\beta = -0.192$ (from estimates), we have

$$\epsilon = 2.723, \quad \bar{D} = 10$$

Application: Quantification of Exchange Rate Pass-Through

Figure: ERPT Change with Trade Credit and Overall Level





Notes: The panel on the left shows the path of β with ϕ increasing. The panel on the right shows the exchange rate pass-through to importer price for each ϕ level. Both graphs are based on model simulation.

Conclusions

- Firms that grant trade credit to their buyers set higher prices
  - Exporters charge a price premium that is equal to the marginal financing costs to importers for delayed payment
- Transmission of exchange rate shocks is stronger, the higher the level of trade credit
  - Note: In a world with incomplete ERPT, this still does not bring more than complete pass-through
- For exporters, trade credit and bank loans are positively correlated

Thank you!

(Comments or suggestions to leticiaj@umich.edu)

Fact 1: Robustness Check

Table: Robustness With Payables Controls

Dependent Variable: $\triangle p_{i,j,k,t}$	(1)	(2)	(3)
$\triangle e_{k,t}$	0.0784***	0.106***	0.109***
	(0.0195)	(0.0194)	(0.0197)
$\triangle e_{k,t} \times NetReceivables_{i,t}$	0.0413*		
	(0.0227)		
$\triangle e_{k,t} \times \phi_{i,0}$		-0.152***	-0.180***
		(0.0384)	(0.0380)
$\phi_{i,0}$			-0.0154***
			(0.00330)
$\triangle e_{k,t} \times Payables_{i,t}$		-0.0372**	-0.0368**
		(0.0159)	(0.0159)
Fixed Effects: $\varphi_{j,k} + \varphi_t$	Yes	Yes	Yes
N	2588698	2376396	2376396
R^2	0.0761	0.0787	0.0787

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Fact 1: Robustness Check (cont.)

Table: Robustness With Alternative Measures of Trade Credit Share

	Time-varying	Lagged Time-varying	First-year	Mean
Dependent Variable: $p_{i,j,k,t}$	(1)	(2)	(3)	(4)
$\triangle e_{k,t}$	0.0796***	0.0807***	0.0937***	0.0907***
	(0.0134)	(0.0159)	(0.0141)	(0.0154)
ϕ_i	0.0103**	-0.00509	0.00781**	0.00571
	(0.00429)	(0.00571)	(0.00332)	(0.00376)
$\triangle e_{k,t} \times \phi_i$	-0.192***	-0.235***	-0.229***	-0.218***
	(0.0454)	(0.0476)	(0.0465)	(0.0549)
Fixed Effects:				
$\varphi_{j,k} + \varphi_i + \varphi_t$	Yes	Yes	No	No
$\varphi_{j,k} + \varphi_t$	No	No	Yes	Yes
N	2356766	1777240	2353309	2376396
R^2	0.119	0.138	0.0791	0.0787

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Fact 1: Robustness Check (cont.)

Table: Robustness With Alternative Samples

Dependent Variable: $\triangle p_{i,j,k,t}$	2006-2011 (1)	2000-2007 (2)	w/out US (3)	Top 20 (4)
$\triangle e_{k,t}$	0.0578***	0.0644***	0.0722***	0.114***
	(0.0218)	(0.0159)	(0.0127)	(0.0165)
$\phi_{i,0}$	-0.0539***	-0.109***	-0.0683***	-0.0752***
	(0.0138)	(0.0122)	(0.00896)	(0.00975)
$\triangle e_{k,t} \times \phi_{i,0}$	-0.135*	-0.147***	-0.200***	-0.220***
	(0.0781)	(0.0506)	(0.0405)	(0.0564)
Fixed Effects: $\varphi_{j,k} + \varphi_i + \varphi_t$	Yes	Yes	Yes	Yes
N	1411588	1383170	2271157	1808657
R^2	0.169	0.101	0.123	0.105

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Fact 1: Robustness Check (DCP)

Table: Robustness With DCP

Dependent Variables: $\triangle p_{i,j,k,t}$	USD ER (1)	2000-2011 (2)	2006-2011 (3)	2000-2005 (4)	Dollarized (5)
$\triangle e^{\$}_{k,t}$	0.0500***	0.0756***	0.0633***		
	(0.0111)	(0.0128)	(0.0226)		
$\phi_{i,0}$		-0.0677***	-0.0520***	-0.0795***	-0.0940***
		(0.00849)	(0.0133)	(0.0135)	(0.0147)
$\triangle e^{\$}_{k,t} \times \phi_{i,0}$		-0.210***	-0.197***		
		(0.0402)	(0.0719)		
$\triangle e_{k,t}$				0.0611***	0.0717***
				(0.0132)	(0.0245)
$\triangle e_{k,t} \times \phi_{i,0}$				-0.175***	-0.167**
				(0.0498)	(0.0814)
Fixed Effects:					
$\varphi_{j,k} + \varphi_i + \varphi_t$	Yes	Yes	Yes	Yes	No
$\varphi_{j,t} + \varphi_i + \varphi_k$	No	No	No	No	Yes
N	2368425	2368425	1411588	918028	327333
R^2	0.119	0.119	0.169	0.124	0.185

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Exchange Rates have no effect on Trade Credit

Table: Regression Results

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

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