Trade Credit and Exchange Rate Risk Pass Through *

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Abstract

We show that trade credit mitigates exchange rate risk pass through along supply chains. We develop a theory of trade credit provision along supply chains that involve large intermediate-good suppliers and small final-good producers, both of which face bank borrowing constraints. Motivated by empirical findings, we assume that large suppliers borrow in foreign currency, while small final-good producers borrow in domestic currency at higher rates. Trade credit loosens borrowing constraints and allows for higher production scale. Additionally, the model predicts that unconstrained suppliers fully absorb increasing costs of borrowing in foreign currency when domestic currency depreciates: specifically, suppliers settle for lower profits but maintain unchanged trade credit lines with their trade partners. In contrast, financially-constrained sellers cut trade credit and pass through XR shocks via trade credit. We verify the model's predictions using firm-level data for 11,000 large firms in 19 emerging markets that experience currency depreciations over the 2004-2020 period. We find that non-exporters, who are not shielded by a natural hedge, pass on only 30% of the decline in profits to trade credit partners.

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1 Introduction

Trade credit (accounts payable and accounts receivable) are the single most important source of short-term financing for a typical firm. Using firm-level data from the Orbis database that covers the majority of firms within a country, Hardy et al. (2022) document that accounts payable represent 88% of short-term liabilities for the median firm over the 2009-2019 period in a typical emerging market. Due to its bilateral nature, trade credit is oftentimes more flexible than any form of debt—late payments are frequent and penalty-free and it is common for producers to pay their suppliers based on inventory sold (see Hardy et al. (2022) for discussion and references). The majority of firms have both accounts payable and accounts receivable at a point in time, but typically, larger firms are net credit providers. Additionally, unlike small and medium-sized enterprises (SMEs), large firms have access to debt denominated in foreign currency and at lower rates than domestic-currency denominated debt (see Salomao and Varela (2021) among others).

In this paper, we argue that large firms that are less financially-constrained borrow at low rates in foreign currency and pass on those funds in domestic currency to their small and more financially-constrained suppliers. Hence, they act as financial intermediaries. Moreover, when they experience an increase in the cost of borrowing in the form of a depreciation of their domestic currency, they shield their trade partners along the supply chain by maintaining trade credit lines and taking a cut in their profits. Hence, they absorb exchange rate risks. This suggests that trade credit can mitigate exchange rate shocks to balance sheets along the supply chain.

We make the argument in two steps: theoretically and empirically. We develop a stylized two-period model that features a large intermediate-good supplier (seller) and a small final-good producer (buyer) who sources the intermediate good from the seller and converts it into a final good, which she sells to a consumer. This is a typical supply chain that we observe in manufacturing—consider a specialized tire producer who serves a number of car companies; or in retail—picture a car producer who sells to a large number of dealerships.[1] Motivated by the empirical literature, we assume that the large seller can borrow in foreign currency at a low interest rate, while the small buyer only has access to the domestic credit market at a higher rate. The large seller incurs exchange rate risk since debt repayment occurs in foreign currency in the second period after the exchange rate shock has been realized. Credit markets are frictional, and both firms are potentially financially constrained and born with zero wealth. Working capital needs require that both firms make payments in advance, which requires raising debt in the first period in the absence of other sources of funding. We begin by characterizing production scale in an environment in the absence of trade credit where the large supplier makes a take-it-or-leave-it offer to the small final-good producer, and we find that debt and scale are constrained below the optimum when either firm's debt-repayment constraint binds.

We introduce trade credit to this environment—that is, we allow final-good producers to make payments to suppliers before receiving the intermediate good in the first period (i.e. to extend trade credit to the supplier), as well as after selling the final good in the second period (i.e. receive trade credit from the supplier). Motivated by the documented flexibility in trade credit, we model trade credit as state contingent—that is, the second-period payment that the final-good producer makes to the supplier can depend on the realization of the exchange rate. In particular, if the domestic currency depreciates (appreciates), which makes it more difficult (easy) for the supplier to repay debt, the final-good producer can pay a higher (lower) price for the intermediate good. One interpretation of the state-contingent structure is that the scenario in which trade credit repayment varies with the exchange rate is one in which the supplier extends trade credit to her trade partner in foreign currency. The degree of exchange rate pass through via trade credit informs us about the effective currency of

[1]The environment that we describe is a polar opposite of Walmart—a large retailer who sources from a large number of small producers.

trade credit invoicing.

We show that trade credit allows firms to raise more debt and attain a higher scale of production. Hence, trade credit alleviates financial constraints. More interestingly, we find that, when the large supplier is unconstrained, she offers trade credit to the small producer that is independent of the exchange rate realization. Hence, the supplier shields her trade partner from the adverse exchange rate shock, and instead takes a cut in her profits. When constrained, the large supplier extends less trade credit and passes through a portion of the cost shock, which implies that at least part of the extended trade credit is invoiced in foreign currency. These findings imply that large firms potentially absorb a significant portion of exchange rate risk along the supply chain.

We test the dual role of trade credit—alleviator of financial constraints and exchange-rate shock absorber—using quarterly firm-level data for over 11,000 large firms in 19 emerging markets during the 2004-2020 period from the Capital IQ database. A key feature of the database is that it contains observations on accounts payable and receivable as well as on the currency composition of debt. In line with the theoretical prediction of the model, we find that larger and less financially-constrained firms with more external debt extend more trade credit. This finding emphasizes the role that trade credit plays in alleviating financial constraints. Furthermore, focusing attention on non-exporting firms, we find that firms with a higher foreign-currency debt exposure see lower profits after a depreciation of the local currency, but that not all firms pass on that shock to their trading partners via their trade credit. Firms that lend a lot via trade credit (more than they borrow via trade credit) maintain their trade credit lending despite the negative hit to their profits. Among the other firms that do pass on the shock (by reducing their trade credit lending), they absorb the shock more (pass it on less) if they have good access to external short-term debt or face low borrowing costs (representing less financially constrained firms). A key take away statistic from our analysis is that non-exporters pass on only 30% of the decline in profits to trade credit partners, which suggests that trade credit absorbs a significant portion of the exchange rate shocks along the supply chain.

Our paper fits in two strands of literature that we discuss in detail in the following section; one that examines the degree of exchange rate pass through along the supply chain and another that studies the propagation and stabilization effects of trade credit. To our knowledge, our paper is the first to examine the pass through of exchange rate shocks to balance sheets via trade credit, both theoretically and empirically. We contribute to these strands of literature by developing a theory of state-contingent trade credit provision in an environment where firms have access to debt denominated in different currency. We estimate the degree of exchange rate pass through via trade credit using a unique firm-level dataset that features trade credit as well as observations on the currency composition of debt.

The remainder of the paper is organized as follows. In Section 2 we describe some basic stylized facts about trade credit and debt in emerging markets and we discuss the existing literature. In Section 3, we develop a theory of trade credit provision along supply chains in the presence of exchange rate risk. We test the model's predictions in Section 4, and we conclude in Section 5.

2 Trade Credit and Debt Facts for Large Firms

We utilize the Capital IQ dataset for our analysis. This dataset consists of both private and public firms, primarily the largest firms in the economy. Capital IQ is unique in that it provides a cross-country dataset with information on the currency composition of the firm's liabilities. We compute the currency composition from line-by-line data in each firm's capital structure (i.e. each individual debt). We keep only observations where the sum of these individual debt obligations is within 5% of the total debt reported on the firm's balance sheet. We focus on firms from 19 emerging market economies over 2000-2020, spanning over

11,000 unique firms. We further complement this data with information from Capital IQ on the geographic distribution of the firm's revenues and assets. We use this to classify firms as exporters, as well as proxy for foreign currency assets. This data covers roughly 85% of the firm-quarter observations.

Table 1 shows summary statistics for standard balance sheet data as well as our measures of foreign currency debt and assets, exports, and interest rates.

Table 1: Summary Statistics

	N	**Mean**	**Std. dev.**	**10th**	**90th**
AR/Assets	203,346	0.166	0.143	0.022	0.360
AR/ST Assets	200,754	0.356	0.216	0.087	0.654
AP/Liab	203,346	0.213	0.189	0.025	0.486
AP/ST Liab	203,346	0.318	0.216	0.061	0.634
(AR-AP)/Assets	203,346	0.069	0.128	-0.046	0.226
Liab/A	203,346	0.515	0.341	0.175	0.808
ST Debt/Assets	203,346	0.217	0.207	0.046	0.427
Profit/Assets	203,346	0.004	0.051	-0.024	0.039
Sales/Assets	203,346	0.211	0.187	0.021	0.422
Cash/Assets	203,346	0.092	0.115	0.005	0.226
Inventory/Assets	203,346	0.076	0.117	0	0.248
log(Assets)	203,346	5.034	1.965	2.780	7.718
FXDebt/Debt	152,022	0.215	0.338	0	0.876
FXAssets/Assets	112,059	0.070	0.184	0	0.258
(FXD-FXA)/Assets	90,608	-0.007	0.202	-0.173	0.165
Exports/Sales	145,383	0.179	0.284	0	0.668
FX Interest Rate	2,754	5.649	3.488	2.34	9.528
LC Interest Rate	5,752	7.570	4.821	3.300	12.773

Statistics are computed after winsorizing outliers at the 1% level, except for log(assets) and FXDebtShare. Statistics are computed on the sample shown in Table 2. FX and local currency interest rates are reported as firm averages (one observation per firm). Sample spans 2000-2020.

Trade credit is a key part of firm financing and balance sheets, even for large firms. For the firms in our sample, trade credit borrowing accounts for 21% of total liabilities and 32% or short term liabilities. Trade credit lending is also significant, making up 16% of total and 36% of short term assets. For the large firms in our sample, they tend to lend via trade credit more than they borrow: accounts receivable minus accounts payable is roughly 7% of assets. Trade credit is a more important source of firm financing for firms in emerging and developing economies, and for smaller firms (Hardy et al. (2022)).[2]

Larger firms also tend to have better access to FX debt. In our sample, the correlation of size (log assets) with the share of FX liabilities is 0.27. On average, FX debt accounts for 22% of total firm debt, but over 85% for firms in the 90th percentile. Excluding firms in Korea, Malaysia, and Thailand, the average rises to 31%.

The basic statistics above suggest that large firms can act as financial intermediaries for other firms, which is consistent with arguments in Huang et al. (2018) and Caballero et al. (2016). These firms can utilize their access to external debt, especially FX debt, to finance their extension of accounts receivable (Hardy and Saffie (2019); Petersen and Rajan (1997)).

While large firms are important trade credit lenders, they can also use their size and market power in order to borrow and receive better terms from their suppliers (Klapper et al. (2011); Murfin and Njoroge (2015)). Firms with higher markups supply more trade credit and longer bilateral relationships support more trade credit (Garcia-Marin et al. (2020)). But these large firms have also been shown to protect their trade partners in the event of shocks (Hardy et al. (2022); Hardy and Saffie (2019); Ersahin et al. (2021)).

External finance is critical to support supply chains and the accompanying trade credit. Kim and Shin (2023) develop a model of supply chains where longer supply chains require more working capital (inventories and receivables) to bridge the gap between when costs are incurred and when payment is received. Easier external financing conditions help support longer supply chains. Bruno et al. (2018) and Hardy and Saffie (2019) empirically connect exchange rate fluctuations – which can serve as a proxy for dollar/global credit conditions (Bruno and Shin, 2015) – and dollar-peso interest rate spreads with changes in accounts

[2] For instance, in the World Bank Enterprise Surveys, the share of Large firms with access to external credit from a financial institution decreases from 66% in high income countries down to 46% in low income countries. In Upper Middle Income countries (where many emerging markets are classified), access ranges from 65% for large firms down to 38% for small firms.

receivables, payables, and inventories, showing these contract with a stronger dollar or tighter dollar credit. Bruno and Shin (2022) similarly find that a stronger dollar reduces dollar credit, and exporters more reliant on dollar funding and/or with higher working capital needs (part of longer supply chains) see a greater drop in exports.

In general, large firms' access to external debt, especially in foreign currency, matters for their extension of trade credit to their suppliers. But this exposes them to FX risk (Bruno and Shin, 2019; Hardy, 2018). While firms can propagate shocks via their trade credit links (Alfaro et al. (2021a); Kalemli-Ozcan et al. (2014); Love et al. (2007); Esposito and Hassan (2023); Shao (2017); Miranda-Pinto and Zhang (2022); Mateos-Planas and Seccia (2021); Bocola and Bornstein (2023)), their ability to absorb these shocks plays a key role in smoothing their own output (Garcia-Appendini and Montoriol-Garriga (2013)). Firms can use trade credit to manage their liquidity (Amberg et al. (2021)), smooth prices (Shapiro et al. (2018)), stabilize their trade partners (Ersahin et al. (2021)), and stabilize the economy on aggregate (Hardy et al. (2022)). We focus on a new dynamic in the present paper: the role that trade credit plays in transmitting FX shocks.

Traditionally, exchange rate pass through has been largely examined by the international trade literature. A small related literature examines firms' currency hedging decisions. Amiti et al. (2022) find some evidence that more financially-constrained firms invoice their sales in foreign currency. Lyonnet et al. (2022) report that large firms are more likely to use hedging instruments, especially those pricing in a foreign currency. Alfaro et al. (2021b) find similar evidence that relates firm size to their use of hedging instruments. Finally, Barbiero (2021) argues that large firms absorb valuation shocks in their cash flows. None of these papers examine firms' financing decisions nor do they address the trade credit channel.

3 Theory of Trade Credit with Currency Risk

The economy consists of three types of agents: a large intermediate-good producer who can borrow in foreign currency, a small firm that uses the intermediate good to produce and deliver a final product to the consumers and can only borrow in domestic currency at a higher rate, and a perfectly-competitive bank that provides firms with credit. We label the intermediate-good producer (who sells goods to the final good producer) as "seller" and we label the final-good producer as "buyer". The time horizon consists of two periods. In period 1, there is uncertainty regarding the realization of the exchange rate, which affects the debt-repayment value of the large seller. Let $e = 1$ denote the period 1 exchange rate expressed as domestic currency per one unit of foreign currency. $e^{'}$ is the exchange rate in period 2 and can take on two values: e_h and e_l, where $E(e^{'}) = 1$, $e_h > 1 > e_l$. Let $p_h \in (0, 1)$ denote the probability that $e^{'} = e_h$.

In period 1, the seller uses labor in order to produce the intermediate good according to a production function $X = L^{\alpha}$, where X denotes the quantity of intermediate good produced, $\alpha \in (0, 1)$, and L denotes the amount of labor units employed at wage rate w. The seller begins the period with zero net worth, so in order to hire labor, she needs to raise funds. Let s denote a given seller. She can borrow an amount D_s from a bank in foreign currency, which needs to be repaid in period 2 at interest rate r^*. Any amount saved between period 1 and 2 earns the same rate of interest, r^*. The seller also incurs a borrowing cost ψD_s^2, where a higher value of $\psi > 0$ implies a more debt-constrained seller. The buyer obtains the intermediate good from the seller in period 1 and transforms it into a final good using a linear technology, where a unit of input yields a unit of final good. Like the seller, the buyer begin period 1 with zero net worth and needs to raise funds in order to purchase the intermediate good. The buyer deposits a payment $T^{'}$ in a bank account in period 1, but the seller does not receive the payment until period 2. Unlike the seller, the buyer is small and does not have access to foreign currency debt. Let b denote a given buyer. She can raise debt D_b in domestic currency to be repaid in period 2 at interest rate $r > r^*$ up to the borrowing limit $\bar{D}$.[3]

We add trade credit to the benchmark environment described above. A seller may obtain (trade) credit from a final-good producer to whom she sells the intermediate product if the buyer pre-pays for the intermediate good before production begins. Alternatively, the buyer can be a recipient of trade credit if she makes the bank deposit in period 2 after she sells the final good to the consumer. We allow this latter payment to be state contingent: namely, the buyer can pay an amount $T_h^{'}$ when $e^{'} = e_h$ and $T_l^{'}$ when $e^{'} = e_l$, with $T_h^{'} > T_l^{'}$. In this case, the large seller passes through (a part of) the exchange rate shock onto the buyer via trade credit. This can occur if the seller extends (a portion of) trade credit in foreign currency. If $T_h^{'} = T_l^{'}$, then the large seller shields the buyer from the exchange rate shock. This case could be equivalent to the seller extending all trade credit to their partner in domestic currency. We assume that making trade credit provision state contingent (e.g. denominating it in foreign currency) incurs a fixed cost, $\kappa > 0$. Intuitively, this can be the case whenever the supplier has at least a portion of production costs/inputs denominated in domestic currency.

We assume that the structure described above applies to pairs of suppliers and final good producers within a country. If either firm is selling products across borders, then the natural assumption is that those exports are denominated in foreign currency–i.e. U.S. dollars in the case of a typical emerging market. In this case, a depreciation of the domestic currency offers a natural hedge to the exporter since both their receipts/assets and liabilities/outflows are denominated in dollars. As we show in our empirical section, these firms effectively are not exposed to exchange rate shocks, so we cannot identify the degree of exchange rate risk pass through from their behavior. Instead, we infer exchange rate pass through from exposed

[3]The asymmetry in the nature of financial constraints for the two agents is not critical, but it allows for a characterization of the problem in closed form. In particular, the buyer's problem is linear, which greatly simplifies the solution method. Hardy et al. (2022) explore trade credit in a model with convex borrowing costs for both types of agents as well as endogenous market power due to search-and-matching frictions.

firms, which are non-exporters.

3.1 Model Without Trade Credit

We assume that the large seller makes a take-it-or-leave-it offer to the small buyer. The seller's problem is given by:

$$\max_{D_b, D_s, T', L} D_s - \psi D_s^2 - wL + \beta[T' - \tilde{e}' D_s(1+r^*)] \text{ s.t.}$$

$$D_b - T' + \beta[pL - D_b(1+r)] - \Gamma \geq 0$$

$$D_b - T' \geq 0$$

$$D_s - \psi D_s^2 - wL \geq 0$$

$$pL \geq D_b(1+r)$$

$$T' \geq e_h D_s(1+r^*)$$

$$\bar{D} \geq D_b$$

In the above problem, $\tilde{e}' \equiv p_h e_h + (1-p_h)e_l = 1$ is the expected exchange rate in period 2, $p > 0$ is the (exogenous) price of the final good and $\Gamma > 0$ is buyer's outside option. We assume that the saving rate r^* satisfies $\beta(1+r^*) = 1$, which implies that there are no savings in the economy.

The first constraint reflects the fact that the buyer's surplus must exceed her outside option, $\Gamma > 0$. The next two constraints capture the borrowing needs of the buyer and the seller in the first period, while the last three summarize the repayment constraints for the two agents. For the seller, the only relevant repayment constraint is in the case when she faces an unfavorable exchange rate next period, e_h, which makes the domestic-currency equivalent of her debt payment very high.

Notice that the first constraint must always bind because the seller extracts all surplus from the buyer, while the next two bind due to the assumed parameter restriction above. It follows that the fourth constraint will never bind as long as $\Gamma > 0$.

The solution consists of three cases which are combinations of scenarios in which either agent is constrained or unconstrained with respect to borrowing.

3.1.1 Case 1: Unconstrained Agents

Assuming that the last two constraints are not binding and taking FOCs allows us to characterize the unconstrained optimal debt for the seller and buyer as well as scale of production:

$$\begin{aligned} D_{s,1} &= \frac{\beta p - (1+r)w}{2\psi\beta p} \\ L_1 &= \frac{D_s - \psi D_s^2}{w} \\ D_{b,1} &= \frac{pL - \frac{\Gamma}{\beta}}{1+r} \end{aligned}$$

3.1.2 Case 2: Constrained Buyer and Unconstrained Seller

When the buyer's borrowing constraint binds, $D_{b,2}$ and L_2 are determined from the buyer's borrowing and participation constraints, which yield:

$$\begin{aligned} D_{b,2} &= \bar{D} \\ L_2 &= \frac{\bar{D}(1+r) + \frac{\Gamma}{\beta}}{p} \end{aligned}$$

Using these expressions into the seller's first-period constraint yields a quadratic equation that characterizes the seller's debt. The unique root that yields debt that does not exceed the maximum of $1/(2\psi)$:

$$D_{s,2} = \frac{1}{2\psi} - \frac{\sqrt{1 - 4\psi\left(\frac{w\Gamma}{\beta p} + \frac{w\bar{D}(1+r)}{p}\right)}}{2\psi} \quad \text{if} \quad \frac{\beta p}{w4\psi} > \Gamma + \bar{D}(1+r)\beta$$

3.1.3 Case 3: Unconstrained Buyer and Constrained Seller

When the seller's repayment constraint is binding, we can combine it with the buyer's first-period as well as participation constraints to express L_3 in terms of $D_{s,3}$. Using this expression into the seller's first-period constraint yields a quadratic expression for $D_{s,3}$ whose unique positive root is:

$$D_{s,3} = \frac{1}{2\psi}\left\{1 + \frac{we_h(1+r^*)}{p(1+r)} + \frac{1}{p(1+r)}\sqrt{p^2(1+r)^2 - 2we_h(1+r^*)p(1+r) + w^2e_h^2(1+r^*)^2 - \frac{\psi w\Gamma p}{\beta}}\right\}$$
$$\text{if} \quad p^2(1+r)^2 - 2we_h(1+r^*)p(1+r) + w^2e_h^2(1+r^*)^2 - \frac{\psi w\Gamma p}{\beta} \geq 0$$

The buyer's debt and scale are in turn given by:

$$D_{b,3} = e_h D_{s,3}(1+r^*)$$
$$L_3 = \frac{e_h D_{s,3}(1+r^*)}{p(1+r)} + \frac{\Gamma}{\beta(1+r)^2 p}$$

Finally, since the first-period constraints for both agents always bind, a scenario in which the last two constraints are jointly binding is not feasible because it would imply that the buyer's participation constraint would need to be slack. In that case, the seller can always reduce the production scale and the amount that she borrows, thus relaxing her debt repayment constraint, which would lead to a contradiction.

3.2 Model With Trade Credit

In the above framework, agents are constrained in that the only source of credit is debt. We now allow each agent to issue trade credit to her trade partner. Assuming the large seller makes a take-it-or-leave-it offer to the small buyer, the seller's problem becomes:

$$\max_{D_s, D_b, L, T, T_h{'}, T_l{'}} D_s + T - \psi D_s^2 - wL + \beta[\tilde{T}' - \tilde{e}' D_s(1+r^*)] - \mathbf{I}_{T_h{'} \neq T_l{'}} \kappa \text{ s.t.}$$

$$D_b - T + \beta[pL - D_b(1+r) - \tilde{T}'] - \Gamma \geq 0 \tag{1}$$

$$D_b - T \geq 0 \tag{2}$$

$$D_s + T - \psi D_s^2 - wL \geq 0 \tag{3}$$

$$T_h^{'} - D_s(1+r^*)e_h \geq 0 \tag{4}$$

$$T_l^{'} - D_s(1+r^*)e_l \geq 0 \tag{5}$$

$$pL - D_b(1+r) \geq T_h^{'} \tag{6}$$

$$\bar{D} \geq D_b \tag{7}$$

$$T_h{'} \geq T_l^{'} \tag{8}$$

In the above formulation, T denotes the payment that the buyer makes to the seller in the first period; i.e. the buyer pre-pays for the intermediate-good purchase and therefore extends the seller trade credit. Furthermore, as described above, $T_l^{'} \equiv T^{'}(e_l)$ and $T_h^{'} \equiv T^{'}(e_h)$ denote the state-contingent payments in the second period, where $\tilde{T}' \equiv p_h T_h^{'} + (1-p_h)T_l^{'}$. These payments represent trade credit that the seller extends to the buyer, since the latter pays for the input only after she had made the final-good sale to the consumer. Finally, $\mathbf{I}_{T_h{'} \neq T_l{'}}$ denotes an indicator function that takes on the value of 1 when trade credit is state contingent–i.e. at least partially denominated in foreign currency.

As in the more restricted problem described above, the first constraint reflects the fact that the buyer's surplus must exceed her outside option, $\Gamma > 0$, while the next two constraints capture the borrowing needs of the buyer and the seller in the first period. The subsequent two are the repayment constraints for the seller in two states of the world government by the realization of the exchange rate. Expression (6) is the only relevant repayment constraint for the buyer in the second period and may bind when the exchange rate realization is unfavorable and given by e_h. The remaining two constraints are the buyer's borrowing constraint and the constraint that defines the magnitudes of the state-contingent payments, where the payment in the poor state of the world is higher due to the higher domestic-currency equivalent of the debt due.

Once again, the first three constraints will always bind as no agent wants to borrow more than necessary to cover the first-period costs, and the seller will extract all surplus from the buyer. Next, observe that, in the poor state of the world, the repayment constraints for the buyer and the seller, expressions (4) and (6) must bind jointly because otherwise either agent can relieve her trade partner if she has slack when repaying debt.

Next, observe that, since the seller faces a convex cost of borrowing, while the buyer's problem is linear, the buyer will either borrow exactly to the limit, $\bar{D}$, or not at all, depending on whether she can borrow at a lower rate on the margin than her larger trade partner. The solution then consists of two possibilities: one in which the large seller is unconstrained and one in which she is constrained. We describe each in turn below.

3.2.1 Unconstrained Seller and No Exchange Rate Risk Pass Through

When repayment constraints are not binding, the FOCs give the following optimal choice for the seller's debt level and production scale:

$$D_s^{TC} = \frac{\beta p - w}{2\psi\beta p} \tag{9}$$

$$L^{TC} = \frac{D_s^{TC} - \psi\left(D_s^{TC}\right)^2 + D_b^{TC}}{w} \tag{10}$$

Furthermore, the unconstrained seller chooses a mean transfer next period of $\tilde{T}^{TC'}$ to extract the entire surplus from the buyer. From expression (1) it follows that any linear combination of transfer payments that satisfies $\tilde{T}^{TC'} \equiv p_h {T_h}^{'} + (1-p_h){T_l}^{'}$ and constraint (8) is optimal. However, since the seller incurs cost $\kappa > 0$ to provide state-contingent payments, ${T_h}^{'} \neq {T_l}^{'}$, it follows that $\tilde{T}^{TC'} = {T_h}^{'} = {T_l}^{'}$, and is given by:

$$\tilde{T}^{TC'} = pL^{TC} - D_b^{TC}(1+r) - \Gamma/\beta \tag{11}$$

Finally, substituting the optimal solution in the seller's objective function and comparing the maximized value at the two debt levels for the buyer, $\bar{D}$ and 0, yields the following solution:

$$D_b^{TC} = \begin{cases} \bar{D} & \text{if } r \leq \frac{p}{w} - 1 \\ 0 & \text{if } r > \frac{p}{w} - 1 \end{cases}$$

Two observations follow. First, notice that there exists an equilibrium in which the buyer does not raise any debt, but production still occurs. This can only occur because the seller has high debt capacity and can cover all costs of production. Second, focus attention on the case in which sellers are unconstrained. Comparing the solution with trade credit to the one without trade credit, it is clear that the seller raises more debt when she extends trade credit, and production scale is higher when there is trade credit. This must mean that the large supplier's extension of trade credit allows the constrained small buyer to raise more debt. Hence, trade credit provision loosens financial constraints and raises production scale. We summarize this result in the first testable prediction below.

Testable Prediction 1. Larger and more profitable unconstrained firms with more debt extend more trade credit. To see this, from expression (10), differentiating optimal labor with respect to the seller's optimal debt gives a positive sign as long as debt is below the maximum level of $1/(2\psi)$. In addition, expression (11) is increasing in labor.

Next, we explore how firms respond to changes in the exchange rate. First, we observe that the seller's profits are state contingent:

$$\Pi(e^{'}) = \tilde{T}^{TC'} - e^{'} D_s^{TC}(1 + r^*)$$

Exchange rate pass through is zero in this case since the second-period transfer is not state contingent in equilibrium, but the profit is declining in the exchange rate. Hence, the large firm insulates its small supplier from exchange rate risk via trade credit. Next, we characterize the possibility of incomplete but positive exchange rate pass through.

3.2.2 Constrained Seller and Positive Exchange Rate Risk Pass Through

To fully characterize the model, it remains to solve the case in which the seller is constrained. Notice that constraint (5) never binds. Assuming that (1), (2) and (3) are binding, suppose that (5) is binding. Then, we can raise both D_s and $T_l^{'}$ to raise the seller's profits. To ensure that (1) is not violated, $T_h^{'}$ would need to decrease. This would continue until constraint (4) binds. Substituting constraints (5) and (4) in the objective function yields profits of $-\kappa$. This cannot be a solution because the seller is better off not producing. If profits had been maximized before constraint (4) binds, then this solution corresponds to the unconstrained case described in the previous section.

To characterize the seller's debt, combine constraints (4), (6) and (3) to obtain a quadratic equation in D_s, for given D_b. In this case, $D_b^C = \bar{D}$, and the unique positive root that characterizes the seller's optimal debt is given by:

$$D_s^C = \frac{1}{2\psi}\left[\frac{w(1+r^*)e_h}{p} - 1 + \sqrt{\left(1 - \frac{w(1+r^*)e_h}{p}\right)^2 + 4\psi\left(1 - \frac{w(1+r)}{p}\right)\bar{D}}\right],$$

where the C superscript denotes a constrained solution.[4] This equilibrium requires that $\frac{p}{w} > (1+r)$. The second-period transfers are state contingent and pinned down, together with the production scale, from constraints (1), (4) and (6) and satisfy:

$$
\begin{aligned}
T_h^{'} &= D_s^C(1+r^*)e_h \\
T_l^{'} &= T_h^{'} - \frac{\Gamma}{\beta(1-p_h)} \\
L^C &= \frac{T_h^{'} + \bar{D}(1+r)}{p}
\end{aligned}
$$

Notice that, in this case, the large seller's accounts receivable are a function of the exchange rate, so the seller passes through the exchange rate shock. Since trade credit, $\tilde{T}^{TC,C'} = T_h^{'} - \frac{\Gamma}{\beta}$, the degree of exchange rate pass through into trade credit is above one if D_s^C is increasing in e_h. Using the implicit function theorem,

$$
\frac{dD_s}{de_h} = -\frac{1 - \frac{w(1+r^*)e_h}{p} - 2\psi D_s^{TC,C}}{-\frac{w(1+r^*)}{p}}
$$

This expression is positive if the numerator is positive. Substituting the solution for $D_s^{TC,C}$ into the numerator yields the following parameter restriction

$$
\frac{3(1 - \frac{w(1+r^*)e_h}{p})^2}{4\psi(1 - \frac{w(1+r)}{p})} > \bar{D}.
$$

Finally, to compare the solutions for a constrained and an unconstrained seller, focus on the space in which $D_b = \bar{D}$ (i.e. $\frac{p}{w} > (1+r)$). It is clear that $\tilde{T}^{TC'}$ and $\tilde{T}^{TC,C'}$ are recovered from constraint (1), and L^{TC} and $L^{TC,C}$ follow from constraint (3). From (1), $\tilde{T}'$ is increasing in L, and since $D_s < \frac{1}{2\psi}$ in all cases, L is increasing in D_s. Namely, if the seller's debt level is higher, then so is the scale of production and trade credit extended. To understand

[4] If $D_b^C = 0$, then $D_s^C = 0$.

whether trade credit extended is higher for unconstrained sellers, it remains to show that unconstrained sellers raise more debt.

Substituting the unconstrained seller debt and trade credit into the seller's repayment constraint yields the following parameter restriction which ensures that D_s^{TC} violates the repayment constraint:

$$\frac{1}{\psi}\left[\frac{p}{4w}+\frac{1}{\beta}-\frac{e_h}{2\beta}+\frac{e_h w}{2\beta^2 p}-\frac{w}{4p\beta^2}\right]+\left(\frac{p}{w}-(1+r)\right)\bar{D}<\frac{\Gamma}{\beta}$$

In that case, the equilibrium is the constrained equilibrium. This means that if ψ is high enough, the equilibrium is one where the seller is constrained, which is intuitive since ψ regulates the cost of borrowing of a seller.

Finally, $D_s^{TC} > D_s^{C}$ if and only if

$$\frac{1}{\psi}\left[\frac{3p}{4w}-\frac{1}{\beta}-\frac{1}{2}\frac{e_h}{\beta}+\frac{w}{4p\beta^2}(1+2e_h)\right]>\left(\frac{p}{w}-(1+r)\right)\bar{D}$$

This puts an upper bound on ψ, so that if it is low enough, debt and trade credit are higher in the unconstrained than in the constrained case. The testable prediction below summarizes results regarding exchange rate pass through.

Testable Prediction 2. More constrained sellers raise less debt, extend less trade credit and pass through more exchange rate shocks via trade credit.

4 Empirical Analysis

In this section, we test the three key testable predictions using firm level data described in Section 2 above.

Testable Prediction 1. Larger and more profitable unconstrained firms with more debt extend more trade credit.

To test this prediction, we estimate the following equation:

$$AR_{icst} = \alpha_i + \alpha_{cst} + \beta_d Debt_{icst} + \beta_s Sales_{icst} + \beta_p Profits_{icst} + \beta_r IR_{icst} + \zeta X_{icst} + \epsilon_{icst}$$

The dependent variable is a firm's accounts receivable (trade credit extended), normalized by assets. Thus we examine how much of a firm's resources are allocated to extending trade credit. The independent variables of interest are different indicators of the financial constraints of the firm: short-term debt excluding accounts payable (captures access to short-term funds like commercial paper, which are typically matched with accounts receivables), sales (which measures production scale), and profits (higher profits indicate that a firm is less financially constrained). For a more limited sample, we also consider a dummy for if the firm's average interest rate on their bank debt is lower than their country-sector average, indicating that their borrowing is less constrained.[5] The vector X includes other firm-level controls such as accounts payables, inventories, cash holdings, and log assets (size). All variables in the regression are normalized by the firm's assets, except the interest rate dummy and log assets. Each observation is at level of a firm, country, sector, and quarter of a given year, so we can saturate the model with country (c) - sector (s) - time (t) fixed effects. This allows us to create better comparison groups among firms, comparing firms in the same sector, country and quarter. Thus, if we assume that trade partners are similar for firms in these buckets, trade credit variation would mostly corresponds to differences in the independent variables. Moreover, this interaction also absorbs any common quarterly variation at the industry-country level. We present specifications with different levels of fixed effects, including one with firm fixed effects to examine changes within a firm over

[5] While not available for every debt instrument or in every period, many firms have at least some data on the interest rate that they pay on their debt. Thus, we consider firm averages compared to country-sector averages in order to maintain a wide sample. FX debt typically carries a lower interest rate than local currency debt, so we consider these separately and classify a firm as low interest rate if either their FX or local currency debt interest rate is below the respective averages.

time. The theory predicts that β_d, β_s, β_p and β_r should be positive as firms with more (access to external) debt, larger production, more profits, or lower interest rates are less financially constrained and lend more to their trade partners.

Table 2 presents the results of this first specification. Columns 1-4 show that our variables of interest all have the expected sign, and are robust to including no fixed effects (column 1) up through country-sector-time fixed effects (column 4). Column 5 adds the dummy variable for if the firm's interest rate on their borrowing is lower than average, which also shows a positive sign. Lastly, column 6 includes firm fixed effects, showing that when the firm increases its short-term debt, its sales, or its profits, it also increases the share of resources going to trade credit lending. Thus, the data confirms the basic predictions of the model with large and more profitable firms intermediating more trade credit thorough their supply chains.

Testable Prediction 2. A negative shock to firm balance sheets, such as via FX mismatch and a depreciation of the domestic currency, will be passed through more by more constrained firms. Furthermore, more constrained firms raise less debt and extend less trade credit.

To test this prediction we first need to define our balance sheet shock. We follow the literature on FX balance sheet shocks, and define the shock as FX liabilities in excess of FX assets interacted with the depreciation of the local currency. This interaction reflects that the depreciation of the local currency means that the firm's liabilities will rise relative to its assets if $FXL > FXA$. More formally, we examine

$$FXExposure_{it} = \frac{FXL_{it} - FXA_{it}}{Assets_{it}}$$

In the Capital IQ data, we have a good measure for the foreign currency debt of most firms. We do not have a direct measure of foreign currency assets. We proxy for this with

Table 2: Trade Credit Lending and Bank Debt

	(1)	(2)	(3)	(4)	(5)	(6)
ST Debt$_{it}$	0.0839***	0.0699***	0.0678***	0.0680***	0.0640***	0.0318***
	(0.00358)	(0.00297)	(0.00289)	(0.00296)	(0.00268)	(0.00198)
Profit$_{it}$	0.302***	0.294***	0.291***	0.294***	0.258***	0.0888***
	(0.0140)	(0.0118)	(0.0118)	(0.0122)	(0.0143)	(0.00797)
Sales$_{it}$	0.115***	0.149***	0.158***	0.160***	0.153***	0.150***
	(0.00490)	(0.00405)	(0.00386)	(0.00394)	(0.00436)	(0.00458)
Low IR$_i$					0.00436***	
					(0.000596)	
Acc Pay$_{it}$	0.516***	0.471***	0.441***	0.443***	0.452***	0.272***
	(0.0112)	(0.00929)	(0.00882)	(0.00888)	(0.00926)	(0.00577)
Cash$_{it}$	-0.0695***	-0.0973***	-0.107***	-0.107***	-0.0929***	-0.120***
	(0.00294)	(0.00231)	(0.00225)	(0.00226)	(0.00288)	(0.00257)
Inventory$_{it}$	-0.0634***	-0.0598***	-0.0544***	-0.0547***	-0.0507***	-0.0412***
	(0.00645)	(0.00540)	(0.00441)	(0.00451)	(0.00453)	(0.00345)
Size$_{it}$	-0.0153***	-0.0121***	-0.0126***	-0.0127***	-0.0133***	-0.0100***
	(0.000240)	(0.000224)	(0.000215)	(0.000221)	(0.000232)	(0.000609)
Observations	203346	203346	203173	201465	169262	200615
R^2	0.296	0.271	0.264	0.265	0.263	0.159
CountryFE	No	Yes	-	-	-	-
IndustryFE	No	Yes	-	-	-	-
TimeFE	No	Yes	-	-	-	-
CountryTimeFE	No	No	Yes	-	-	-
IndustryTimeFE	No	No	Yes	-	-	-
CountryIndustryFE	No	No	Yes	-	-	-
CountryIndustryTimeFE	No	No	No	Yes	Yes	Yes
FirmFE	No	No	No	No	No	Yes

Dependent variable is accounts receivable relative to assets, winsorized at 1%. Controls include short-term debt (excluding accounts payable), profits, sales, accounts payable, cash, and inventories, all normalized by assets and winsorized at 1%; and log(assets), and in column 5 a dummy for if the firm's average interest rate on external debt is below the country-industry average for either local currency debt or foreign currency debt. R^2 is within R^2. Errors are clustered at the industry-year level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

the value of the firm's foreign assets.[6]

For exchange rate shocks, it is important to also account for natural hedges such as export revenues. These typically rise with an exchange rate depreciation and so offset the shock from the firm's open FX position. Indeed, since exchange rate movements are central to exporter business models, these firms tend to be more sophisticated in how they manage their FX risk. We define an exporter dummy if the firm's foreign revenue is greater than 20% of their total revenues, and examine outcomes for exporters compared to non-exporters.

Our theory is structured as a large "seller" and a small "buyer". In reality, most firms (especially the large firms in our data) are both buyers and sellers, both extending and receiving trade credit as part of their operations. We examine if firms that tend to extend more trade credit (accounts receivable = AR) than they receive (accounts payable = AP) on average (and so are closer to our "sellers") behave differently from other firms regarding how they pass through shocks to trade credit. Formally, we define a firm as a seller if $AR - AP > 0$ on average. We also consider a broader view by sector, to see if sectors that act like sellers to a greater degree (average $AR - AP$ is larger than other sectors) show more or less pass through of a shock.

Lastly, we examine the role of financial constraints. We compute dummy variables for if the firm average is greater than the country-industry average for the following variables: short-term debt to assets (excluding accounts payable), profits to assets, sales to assets, and (below average) interest rate on foreign or local currency debt. Thus these dummies take a value of 1 for firms that should be less financially constrained.

[6]This comes from a separate data package in Capital IQ that captures the geographic location of firm revenues and assets. These are then classified as foreign vs domestic. This data is available for 85% of the sample.

We examine the shock impact in the following regression:

$$\begin{aligned}Y_{icst} =& \alpha_i + \alpha_{cst} + \gamma_1 FXExposure_{it-1} + \gamma_2 FXExposure_{it-1} \times XRDepr_{ct} + \\ & \gamma_3 FXExposure_{it-1} \times Type_i + \gamma_4 XRDepr_{ct} \times Type_i + \\ & \gamma_5 FXExposure_{it-1} \times XRDepr_{ct} \times Type_i + \epsilon_{icst}\end{aligned}$$

The outcome variable Y is either Profits/Assets (to confirm the balance sheet shock to the firm) or Accounts Receivable/Assets (to examine how the firm passes on the shock via trade credit). $XRDepr$ is the quarter-on-quarter depreciation rate of the local currency vis-a-vis the US dollar. $Type$ is a dummy variable that identifies firms by various characteristics, such as exporter status, "seller firms", or financially unconstrained firms (eg "high profits"). The key coefficients we are interested in are γ_2 and γ_5, capturing the impact of the shock and the differential impact of the given subgroup of firms.

Table 3 examines the impact on profits. Column 1 shows that profits generally fall for firms after being hit by an exchange rate shock. Columns 2-4 shows that this is primarily driven by non-exporters, as exporters see a significantly smaller impact on their profits from the shock. For a 10% depreciation of the local currency, a firm with an open exposure that is 8.5% of assets (90th percentile) will see quarterly profits decline by 0.2% of assets. This is sizeable compared to the median quarterly profit of 0.7% of assets.

Columns 5-7 examine "seller" firms, or net trade credit lenders. These firms also see a significant impact to their profits, with non-exporters among this group seeing a large impact and exporters seeing a much smaller impact, similar in magnitude to columns 1-2. Column 7 shows that firms in sectors that overall tend to do more trade credit lending tend to also see an even larger impact on their profits. From this table, we see that exporters tend to be minimally impacted by the shock, while profits of seller firms are just as impacted, possibly more so, than other firms.

Table 4 examines the impact of the shock on trade credit lending. Column 1 shows that there is not a general impact of the shock on trade credit for our full sample of firms. Columns 2-4 show that this is due to exporters, which show no pass through, whereas non-exporters appear to have some pass through of the shock. Since exporters' profits are minimally impacted, this lack of pass through is expected, so we focus on non-exporters in our remaining analysis. Comparing column 4 of Table 4 to column 4 of Table 3, we estimate that on average non-exporters pass on 30% of the profit loss to their trade credit partners (i.e. trade credit lending drops by 30% of the profit decline).

Columns 5-7 examine pass through of seller firms compared to other firms. Column 5 does not reveal a significant difference between seller firms and others.[7] Column 6 narrows the seller group to just those in the top quartile of firms (for average $(AR - AP)/Assets$). We see that the firms outside this group tend to pass on the shock on average, while the firms in the narrower seller group pass on the shock less, possibly not at all given the magnitude of the coefficient.[8] Lastly, firms in sectors that tend to be higher providers of trade credit than other sectors also do not show a pass through of the shock to their accounts receivable. Thus, firms that match better as "sellers" in our model tend not to pass on the shock via their trade credit lending. This is despite them having an equal or greater decline in their profits.

Finally, we examine the role of financial constraints in Table 5. Column 1 shows that firms that can generally borrow a lot short-term show less pass through of the shock to their trade credit lending. If taken at face value, this suggests that firm with good access to short term debt pass on 15% of the profit decline, whereas those without such debt to support their trade credit lending pass on nearly half the profit decline. Column 2 shows the opposite: high profit firms tend to pass on the shock more. Columns 3 and 4 show

[7]The direct effect for other firms becomes insignificant likely due to a smaller sample size, as most firms in our sample lend more in trade credit than they borrow.

[8]The net effect is not statistically different from 0.

no significant difference for high sales and low borrowing cost firms. Including all of these interactions together in column 5, high access to short-term debt is the most robust.

Since seller firms tend to show less of a pass through to trade credit lending, column 6-8 drop these firms to see if financial constraints play a stronger role. Firms that have $AR - AP < 0$ on average (column 6) see less pass through to their trade credit lending when they have strong access to short-term debt or if they can borrow at low interest rates.[9] Excluding just the top quartile of firms in terms of $AR - AP$, we see high profit firms still appear to pass on more of the shock, but low borrowing cost firms pass on less. Finally, excluding sectors that tend to have high $AR - AP$ shows greater pass through for high profit firms, but lower pass through for low borrowing cost and high short-term debt firms. While the profit grouping of firms doesn't match the theory, in general it appears that firms that are less financially constrained (as evidenced by low borrowing costs and high short-term debt borrowing) pass on the shock less.

[9] Recall that while $AR - AP < 0$, these are still large firms with significant trade credit lending in addition to their trade credit borrowing.

Table 3: Exchange rate shock and profits

			Exporters	Non-exporters	Net TC Lender		Non-exporters
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
FX $\text{Exposure}_{it-1} \times$ XR Depr_t	-0.112***	-0.244***	-0.0642***	-0.248***	-0.103***	-0.235***	-0.136***
	(0.0198)	(0.0394)	(0.0211)	(0.0413)	(0.0181)	(0.0425)	(0.0448)
FX $\text{Exposure}_{it-1} \times$ XR $\text{Depr}_t \times \text{Exporter}_i$		0.178***				0.180***	
		(0.0360)				(0.0397)	
FX $\text{Exposure}_{it-1} \times$ XR $\text{Depr}_t \times$ Seller Industry_s							-0.248***
							(0.0779)
FX Exposure_{it-1}	-0.000970	-0.00287	0.00238	-0.00141	0.000722	-0.00124	-0.00596
	(0.00164)	(0.00275)	(0.00213)	(0.00276)	(0.00178)	(0.00295)	(0.00385)
FX $\text{Exposure}_{it-1} \times \text{Exporter}_i$		0.00400				0.00376	
		(0.00346)				(0.00378)	
XR $\text{Depr}_t \times \text{Exporter}_i$		-0.0225**				-0.0116	
		(0.00982)				(0.00816)	
FX $\text{Exposure}_{it-1} \times$ Seller Industry_s							0.00798
							(0.00546)
Observations	171083	171083	39327	129607	133695	133695	129607
R^2	0.000625	0.00116	0.000621	0.00125	0.000545	0.00102	0.00156
CountryIndustryTimeFE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
FirmFE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Dependent variable is profits relative to assets, winsorized at 1%. Independent variables include (FX Debt - Foreign Assets)/Assets, winsorized at 1%, and lagged one quarter; the quarter on quarter depreciation rate of the period average exchange rate; dummies for if the firm is an exporter (foreign revenue/total revenue > 20%) or in a sector with high average accounts receivable relative to accounts payable (Manufacturing, Services, Construction, and unclassified firms); and the interaction of these variables. Column (3) includes just exporting firms. Columns (5) and (6) include just firms that on average have accounts receivable > accounts payable. Columns (4) and (7) include just non-exporting firms. R^2 is within R^2. Errors are clustered at the industry-year level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4: Exchange rate shock and pass through to trade credit lending

	All		Exporters	Nonexporters			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
FX Exposure$_{it-1}$ × XR Depr$_t$	-0.0201	-0.0706*	0.00571	-0.0771**	-0.0843	-0.108***	-0.137**
	(0.0174)	(0.0367)	(0.0241)	(0.0378)	(0.0613)	(0.0383)	(0.0581)
FX Exposure$_{it-1}$ × XR Depr$_t$ × Exporter$_i$		0.0664					
		(0.0425)					
FX Exposure$_{it-1}$ × XR Depr$_t$ × Net TC Seller$_i$					0.00509		
					(0.0594)		
FX Exposure$_{it-1}$ × XR Depr$_t$ × Top TC Seller$_i$						0.267*	
						(0.152)	
FX Exposure$_{it-1}$ × XR Depr$_t$ × Seller Industry$_s$							0.137*
							(0.0746)
FX Exposure$_{it-1}$	-0.0117***	-0.00647*	-0.0146***	-0.00705*	-0.0212***	-0.00872**	-0.0108**
	(0.00243)	(0.00383)	(0.00327)	(0.00392)	(0.00500)	(0.00384)	(0.00527)
FX Exposure$_{it-1}$ × Exporter$_i$		-0.00863*					
		(0.00492)					
XR Depr$_t$ × Exporter$_i$		-0.00684					
		(0.0104)					
XR Depr$_t$ × Net TC Seller$_i$					-0.000251		
					(0.0109)		
FX Exposure$_{it-1}$ × Net TC Seller$_i$					0.0174**		
					(0.00718)		
FX Exposure$_{it-1}$ × Top TC Seller$_i$						0.00521	
						(0.0137)	
XR Depr$_t$ × Top TC Seller$_i$						-0.0165	
						(0.0184)	
FX Exposure$_{it-1}$ × Seller Industry$_s$							0.00655
							(0.00768)
Observations	167432	167432	39306	125978	125293	125293	125978
R^2	0.000214	0.000260	0.000912	0.0000884	0.000143	0.000168	0.000133
CountryIndustryTimeFE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
FirmFE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Dependent variable is accounts receivables relative to assets, winsorized at 1%. Independent variables include (FX Debt - Foreign Assets)/Assets, winsorized at 1%, and lagged one quarter; the quarter on quarter depreciation rate of the period average exchange rate; dummies for if the firm is an exporter (foreign revenue/total revenue $>$ 20%), has on average more accounts receivable than accounts payable, has average accounts receivable less accounts payable in the top quartile, or in an industry with high average accounts receivable relative to accounts payable (Manufacturing, Services, Construction, and unclassified firms); and the interaction of these variables. Column (3) includes just exporting firms (foreign revenue/total revenue $>$ 20%). Columns (4)-(7) include just non-exporting firms. R^2 is within R^2. Errors are clustered at the industry-year level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 5: Exchange rate shock, financial constraints and pass through to trade credit lending

	(1)	(2)	(3)	(4)	(5)	(6) Excl. Net Sellers	(7) Excl. Top Sellers	(8) Excl. Seller Industries
FX Exposure$_{it-1}$ × XR Depr$_t$	-0.123**	-0.0354	-0.0719	-0.0929*	-0.135	-0.524***	-0.170*	-0.257**
	(0.0490)	(0.0448)	(0.0479)	(0.0543)	(0.0829)	(0.179)	(0.0891)	(0.127)
FX Exposure$_{it-1}$ × XR Depr$_t$ × High ST Debt$_i$	0.0867*				0.106*	0.430***	0.0685	0.205**
	(0.0474)				(0.0586)	(0.150)	(0.0619)	(0.0825)
FX Exposure$_{it-1}$ × XR Depr$_t$ × High Profit$_i$		-0.0922*			-0.0640	-0.0277	-0.115**	-0.129*
		(0.0502)			(0.0602)	(0.127)	(0.0536)	(0.0759)
FX Exposure$_{it-1}$ × XR Depr$_t$ × High Sales$_i$			0.00966		0.000242	-0.0186	-0.0132	0.0296
			(0.0509)		(0.0586)	(0.110)	(0.0586)	(0.0734)
FX Exposure$_{it-1}$ × XR Depr$_t$ × Low IR$_i$				0.000121	0.0598	0.203**	0.135**	0.192**
				(0.0619)	(0.0687)	(0.0917)	(0.0610)	(0.0898)
FX Exposure$_{it-1}$	-0.00340	-0.0226***	-0.0104**	-0.0131***	-0.0201**	-0.0276**	-0.0151*	-0.0166*
	(0.00432)	(0.00609)	(0.00475)	(0.00495)	(0.00794)	(0.0116)	(0.00810)	(0.00929)
FX Exposure$_{it-1}$ × High ST Debt$_i$	-0.00962				-0.00404	0.0195*	0.00883	-0.0264***
	(0.00750)				(0.00849)	(0.0110)	(0.00798)	(0.00877)
XR Depr$_t$ × High ST Debt$_i$	-0.00324				-0.0103	-0.0209	-0.00710	-0.0183
	(0.00921)				(0.00955)	(0.0163)	(0.0105)	(0.0139)
FX Exposure$_{it-1}$ × High Profit$_i$		0.0288***			0.00821	0.0332***	-0.000862	-0.0273***
		(0.00687)			(0.00827)	(0.0119)	(0.00849)	(0.00834)
XR Depr$_t$ × High Profit$_i$		-0.00928			-0.0220**	-0.0217	-0.0164*	-0.00646
		(0.00988)			(0.0112)	(0.0162)	(0.00958)	(0.0132)
FX Exposure$_{it-1}$ × High Sales$_i$			0.0144*		0.0132	-0.0444***	-0.0326***	0.0570***
			(0.00782)		(0.00847)	(0.0103)	(0.00774)	(0.00948)
XR Depr$_t$ × High Sales$_i$			0.000754		0.00251	-0.0157	-0.00113	0.00451
			(0.00809)		(0.00934)	(0.0182)	(0.0129)	(0.0121)
FX Exposure$_{it-1}$ × Low IR$_i$				0.0179**	0.0225***	0.0406***	0.0492***	0.0447***
				(0.00724)	(0.00740)	(0.0103)	(0.00708)	(0.0109)
XR Depr$_t$ × Low IR$_i$				-0.0138	-0.0140	-0.0125	-0.0182*	-0.0198*
				(0.0107)	(0.00998)	(0.0198)	(0.0101)	(0.0119)
Observations	123015	125967	121357	104156	100288	18791	76757	42382
R^2	0.000139	0.000273	0.000108	0.000202	0.000406	0.00476	0.00166	0.00210
CountryIndustryTimeFE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
FirmFE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Dependent variable is accounts receivables relative to assets, winsorized at 1%. Independent variables include (FX Debt - Foreign Assets)/Assets, winsorized at 1%, and lagged one quarter; the quarter on quarter depreciation rate of the period average exchange rate; and dummies for if the (winsorized) firm average is greater than the country-industry average for the following variables: short-term debt to assets (excluding accounts payable), profits to assets, sales to assets, and (dummy for below average) interest rate on foreign or local currency debt. Sample includes just non-exporting firms (foreign revenue/total revenue $>$ 20%). Column (6) excludes firms that on average have accounts receivable $>$ accounts payable. Column (7) excludes firms in the top quartile of average accounts receivable less accounts payable. Column (8) excludes firms in industries with high average accounts receivable relative to accounts payable (Manufacturing, Services, Construction, and unclassified firms). R^2 is within R^2. Errors are clustered at the industry-year level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

5 Conclusion

We developed a stylized model of trade credit provision between a large supplier and her small trading partner who produces final goods. Motivated by the international finance literature, we assume that both firms face borrowing constraints, but the large supplier can borrow at low interest rates in foreign currency, while the small producer can only access domestic-currency debt at a high rate. A key feature in the model is that trade credit is state contingent—namely, the amount of trade credit extended is directly linked to the realization of the exchange rate, which affects the large firm's liabilities. According to the model, trade credit provision loosens partners' financial constraints and raises both parties' debt levels as well as production scale. As a corollary, the model predicts that unconstrained firms with larger scale and more debt extend more trade credit. When firms experience a rise in their cost of borrowing, characterized by a depreciation of the domestic currency, more constrained firms pass through the exchange rate shock more to their trade partners. We verify these predictions using firm-level data for large firms in emerging markets.

The theory that we provide above features complete as well as incomplete exchange rate pass-through via trade credit—a channel that has not been explored by the existing literature. More importantly, the empirical analysis suggests that the degree of exchange rate risk pass through is rather low–roughly 30%. A natural question then is whether the large firms, which carry this exchange rate risk on their balance sheets, insulate the overall economy from negative shocks. We explore the aggregate effects of trade credit in the propagation of shocks in parallel work.

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