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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. We verify the model's predictions using firm-level data for over 11,000 large firms in 19 emerging markets over the 2004-2020 period.

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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, who 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 features a stabilizing role in an emerging market economy.

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 domestic credit markets at higher rates. 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. 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 passes through a portion of the cost shock. These findings imply that large firms absorb shocks along the supply chain rather

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

than propagating them via trade credit.

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 debt extend more trade credit. This finding emphasizes the role that trade credit plays in alleviating financial constraints. Furthermore, focusing attention on the non-manufacturing sector, we find that firms with a higher foreign-currency debt exposure reduce their leverage, investment and profits, but do not change their accounts payable or accounts receivable more than their less-exposed peers. In the manufacturing sector, where firms are more likely to be exporters who have a natural hedge, firms that are more exposed to the depreciation shock raise leverage and investment, but take a cut in profits once again, while maintaining trade credit unchanged. These two results support the prediction of the model that unconstrained firms shield their partners from exchange rate shocks by decreasing profits. Hence, large firms use trade credit as a tool to absorb exchange rate risk along supply chains rather than passing it through the economy.

Our paper fits in a large literature that examines both propagation and stabilization effects of trade credit, which we discuss in detail in the following section. We contribute to this 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 test the key feature of our theory that points to a stabilizing role of trade credit using unique firm-level data that features trade credit as well as observations on the currency composition of debt. Rather than relying on large financial shocks for identification, we exploit exogenous variation in exchange rates for emerging markets, which has largely been overlooked by the existing literature.

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 2004-2020, spanning over 11000 unique firms. Table 1 shows summary statistics for both non-manufacturing and manufacturing firms, where the latter are more likely to import/export.

Trade credit is a key part of firm financing and balance sheets. For emerging market firms, it can constitute a large part of the firm's short term assets (Hardy et al. (2022)). Trade credit is especially important for smaller firms or firms in less developed countries, as they have less access to external finance.[2] Larger firms tend to have better access to external debt, including access to FX debt. The correlation of size (log assets) with the share of FX liabilities is 0.28. On average, firms in our sample have 13% of their liabilities in foreign

[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.

Table 1: Summary Statistics

Panel A: Non-Manufacturing Firms					
	N	**Mean**	**Std. dev.**	**10th**	**90th**
AR/Assets	212,470	0.174	0.175	0.013	0.432
AR/ST Assets	195,727	0.376	0.252	0.059	0.741
AP/Assets	183,570	0.104	0.128	0.005	0.270
(AR-AP)/Assets	173,100	0.067	0.150	-0.065	0.259
Debt/Assets	162,096	0.256	0.288	0.001	0.549
BankDebt/Assets	162,096	0.182	0.219	0	0.424
FXDebtShare	264,410	0.128	0.285	0	0.632
Sales/Assets	174,501	0.205	0.226	0.011	0.481
Profit/Assets	231,336	-0.005	0.075	-0.038	0.040
Cash/Assets	167,004	0.111	0.153	0.004	0.274
Liabilities/Assets	234,152	0.503	0.465	0.050	0.853
log(Assets)	234,150	4.405	2.760	0.864	7.778
Panel B: Manufacturing Firms					
	N	**Mean**	**Std. dev.**	**10th**	**90th**
AR/Assets	213,037	0.185	0.133	0.038	0.358
AR/ST Assets	196.677	0.355	0.193	0.112	0.606
AP/Assets	186,199	0.116	0.106	0.019	0.247
(AR-AP)/Assets	181,610	0.068	0.129	-0.063	0.223
Debt/Assets	168,036	0.253	0.263	0.007	0.518
BankDebt/Assets	168,036	0.217	0.220	0.003	0.473
FXDebtShare	269,950	0.134	0.276	0	0.608
Sales/Assets	182,194	0.241	0.187	0.029	0.458
Profit/Assets	219,091	-0.000	0.062	-0.032	0.039
Cash/Assets	145,400	0.095	0.127	0.004	0.239
Liabilities/Assets	221,196	0.483	0.434	0.099	0.799
log(Assets)	221,196	4.240	2.075	1.822	6.790

Statistics are computed after winsorizing outliers at the 1% level, except for log(assets) and FXDebtShare. Sample spans 2004-2020.

currency.

Large firms can act as financial intermediaries for other firms (Huang et al. (2018); 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)). In our sample of firms, for both manufacturing and non-manufacturing firms, firms are on average net lenders via trade credit: accounts receivable minus accounts payable is roughly 7% of assets. Accounts receivable make up 37% of these firms' short term assets, on average (18% of total assets).

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 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. (2021); 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)), 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. Specifically, while supply chains may contract and expand with exchange rate movements, firms taking hits to their balance sheets with those movements due to their exposure to dollar borrowing do not differentially adjust their trade credit relative to other firms. They absorb the financial risk of carrying a dollar exposure on their balance sheet. We next present a model that illustrates how large firms borrow in FX, provide trade credit, and absorb shocks from exchange rate movements.

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,

[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.

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. If $T_h^{'} = T_l^{'}$, then the large seller shields the buyer from the exchange rate shock.

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 four cases which are combinations of scenarios in which either agent is constrained or unconstrained with respect to debt repayment.

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:

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

3.1.2 Case 2: Constrained Buyer and Unconstrained Seller

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

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

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 $1/(2\psi)$:

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

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:

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

3.1.4 Case 4: Constrained Agents

When both agents are constrained, the debt repayment constraints bound the amount of debt raised. Debt levels are given by:

$$D_{b,4} = \bar{D}$$
$$D_{s,4} = \frac{\bar{D}}{e_h(1+r^*)}$$

For given level of debt, the seller wants to minimize scale and extract all surplus; therefore, labor is determined by the buyer's participation constraint:

$$L_4 = \frac{\bar{D}(1+r) + \frac{\Gamma}{\beta}}{p}$$

Since scale is pinned down by the buyer's borrowing constraint, combining this case together with Case 2 above implies that the seller will choose the minimum of the two debt levels.

3.2 Model With Trade Credit

In the above framework, agents are constrained in that the only source of credit if 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:

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

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

$$D_b - T \geq 0 \quad (2)$$

$$D_s + T - \psi D_s^2 - wL \geq 0 \quad (3)$$

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

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

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

$$\bar{D} \geq D_b \quad (7)$$

$$T_h{}' \geq T_l{}' \quad (8)$$

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. 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:

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

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

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

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

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:

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

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. Two testable predictions follow.

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.

Testable Prediction 2. When the foreign currency appreciates ($e^{'} = e_h^i$), the large firm's profit declines, but the payment that it requires from its trade partner, i.e. the value of accounts receivable for the large firm, is unchanged.

To see this, derive the seller's profits, and observe that they are state contingent:

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

The large seller shields the small buyer from the exchange rate shock, 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.

We will test the above two predictions using firm-level data in the following section. Before we do so, we characterize the full solution of the problem and discuss the possibility of incomplete insurance.

3.2.2 Constrained Seller and Imperfect 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) cannot bind at the same time as constraints (1), (4) and (7). In fact, this constraint never binds. To characterize the seller's debt, combine constraints (4), (7) and (3) to obtain a quadratic equation in D_s.

The unique positive root that characterizes the seller's optimal debt is given by:

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

where the C superscript denotes a constrained solution. The second-period transfers are state contingent and pinned down, together with the production scale, from constraints (1), (4) and (6) and satisfy:

$$T_h^{'} = D_s^C(1+r^*)e_h$$
$$T_l^{'} = \frac{\Gamma}{\beta(1-p_h)} - T_h^{'}$$
$$L = \frac{T_h^{'} + D_b^C(1+r)}{p}$$

Finally, substituting the optimal solutions 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:

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

Notice that, in this case, the large seller's accounts receivable are a function of the exchange rate, so the seller does not fully insure the buyer from the exchange rate shock.

4 Empirical Analysis

In this section, we test the two 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:

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

The dependent variable is a firm's accounts receivables (trade credit extended). The variable is normalized by the firm's short-term assets, as current assets are the most relevant for trade creditand comparable across firms (ie firms with different needs for fixed investment).[4] The three variables of interest are the firm's total debt, sales (which measures scale) and profits, where high profits indicate that a firm is less financially constrained. The vector X includes other firm-level controls such as accounts payables, inventories, and log assets. All variables in the regression are normalized by the firm's assets, except trade credit (normalized by short-term assets) and log assets. Each observation is at level of a firm, country, sector, and quarter of a given year, so we include country (c) - sector (s) - time (t) fixed effects. The triple differentiation ensures that we compare 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 less or more stringent fixed effects. We also explore specifications with firm fixed effects where a firm is compared to itself over time. The theory predicts that β_d, β_s and β_p should be positive as firms with more debt, larger production and more profits (or less-severe financial constraints) lend more to their trade partners.

Table 2 presents the results of this first specification. Columns 1-4 show that our variables

[4]Short term assets are more fungible with each other and can address similar purposes such as working capital management. Firms are less likely to sell fixed assets to finance accounts receivable, and those assets can scale differently.

Table 2: Trade Credit Lending and Bank Debt

	(1)	(2)	(3)	(4)	(5)
Debt_{it}	0.0240***	0.0228***	0.0263***	0.0284***	0.0265***
	(0.00299)	(0.00301)	(0.00285)	(0.00282)	(0.00283)
Sales_{it}	0.156***	0.189***	0.193***	0.194***	0.134***
	(0.00607)	(0.00507)	(0.00463)	(0.00467)	(0.00427)
Profits_{it}	0.0934***	0.133***	0.132***	0.133***	-0.000460
	(0.0171)	(0.0151)	(0.0151)	(0.0154)	(0.0117)
Observations	203435	203435	203430	202310	201357
R^2	0.109	0.117	0.115	0.116	0.0661
Country FE	No	Yes	-	-	-
Industry FE	No	Yes	-	-	-
Time FE	No	Yes	-	-	-
Country×Time FE	No	No	Yes	-	-
Industry×Time FE	No	No	Yes	-	-
Country×Industry FE	No	No	Yes	-	-
Country×Industry×Time FE	No	No	No	Yes	Yes
FirmFE	No	No	No	No	Yes

Dependent variable is accounts receivable relative to short term assets. Controls include bank debt, profits, and sales, all normalized by assets; and accounts payables (normalized by short term assets), log assets, and inventories/assets. All variables are winsorized at 1%. Sample spans 2004-2020. R^2 is within R^2. Errors are clustered at the industry-year level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

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 firm fixed effects, to examine within firm changes. The coefficient on profits becomes insignificant, but debt and sales remain positive. This indicates that when the firm increases its external debt or its sales, that on average it also increases its 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 foreign borrowing, such as a depreciation of the domestic currency, does not change trade credit extended, but lowers the profits of a large unconstrained firm.

To test this prediction, we estimate the following specification:

$$
\begin{aligned}
Y_{icst} = &\alpha_i + \alpha_{cst} + \gamma FXDebt_{it-1} + \beta FXDebt_{it-1} \times XRDepr_{ct} + \\
&\zeta X_{icst} + \eta X_{icst} \times XRDepr_{ct} + \epsilon_{icst}
\end{aligned}
$$

Dependent variables include firm level bank debt, net investment (CAPEX), profits, and account receivables and they are normalized by assets (or short term assets for receivables). XR Depr is the quarter on quarter depreciation rate of the domestic currency against the US dollar.[5] FXDebt is the foreign currency liabilities (relative to assets) for each firm. The vector of controls, X, includes cash holdings, total liabilities, and inventory, all normalized by assets, along with size (log assets); as well as the interaction of each of these with XR depreciation (to capture other channels by which the depreciation could impact the firm). All specifications include country-industry-quarter fixed effects and firm fixed effects. Note that γ captures the level difference in the dependent variable when we compare firms with high versus low FX debt within a country, industry, and quarter bin. While level differences

[5] The results are robust to defining a large currency shock dummy which takes on a value of 1 when the depreciation exceeds 30%.

are relevant, the key coefficient of interest is β as it captures how firms that are more exposed to exchange rate risk adjust the dependent variable when compared to other firms with less FX exposure in their balance sheet in the same industry, country, and time period. The model predicts that when firms provide exchange rate insurance to their partners, we should see differential responses in profits but not in trade related accounts.

Table 3 shows the results of this second empirical analysis. Non-manufacturing firms, which are less directly connected to international trade and less likely to have revenues correlated with the exchange rate, demonstrate cleanly the main results. Firms with higher FX exposure typically hold more bank debt, invest less, are less profitable and participate less in trade credit relative to their size. Consistent with the literature, the exchange rate shock affects more firms that are more exposed. Firms with exposure to foreign currency debt see decreases, after an adverse exchange rate movement, in their bank debt, capital expenditures, and profits. However, the difference in their trade credit lending (compared to non-shocked firms) is not distinguishable from 0. For manufacturing firms where natural hedges are more likely to offset some of the shock, firms increase their bank borrowing and investment (perhaps to take advantage of a shift in the terms of trade), but they still face the decline in their profits from the balance sheet shock. However, these firms likewise do not adjust their trade credit lending, despite the hit to their profits. Therefore, consistent with the model prediction, exposed firms insulate their trade partners by absorbing most of the exchange rate shock.

Table 3: Exchange rate shocks and trade credit

	Non-Manufacturing				Manufacturing			
	(1) Bank Debt	(2) CAPEX	(3) Profits	(4) AR	(5) Bank Debt	(6) CAPEX	(7) Profits	(8) AR
FX Debt_{it-1}	0.387***	-0.00324**	-0.00841**	-0.0370***	0.400***	-0.00365***	-0.0148***	-0.0269***
	(0.0130)	(0.00129)	(0.00359)	(0.00744)	(0.0100)	(0.00109)	(0.00344)	(0.00555)
FX Debt_{it-1} × XR Depr_{ct}	-0.301**	-0.0214*	-0.184***	-0.107	0.184***	0.0268*	-0.288***	-0.0112
	(0.118)	(0.0126)	(0.0336)	(0.0800)	(0.0610)	(0.0145)	(0.0505)	(0.0591)
Observations	113954	104436	115636	108178	108783	102723	110171	106446
R^2	0.204	0.00538	0.0283	0.0741	0.233	0.00744	0.0196	0.0784
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country×Industry×Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Dependent variable is shown in the columns, each normalized by assets (AR normalized by short term assets) and winsorized at 1%. XR Depr is the quarter on quarter depreciation rate of the local currency vis-a-vis the US dollar. Controls include cash holdings, total liabilities, and inventory, all normalized by assets, along with size (measured as log assets). All variables are winsorized at 1%, except for size. Sample spans 2004-2020. R^2 is within R^2. Errors are clustered at the industry-year level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

The impact of the exchange rate shock on the firm's operations may play out over multiple quarters. Table 4 examines the same specification, but includes additional lags of FX debt holdings (and other controls) and their interaction with the relevant period's depreciation. The results point broadly in the same direction. Non-manufacturing firms see a sustained decline in bank debt and profits, and an initial decline in investment. While the impact on their trade credit lending is not significantly different from 0 for each lag, the cumulative impact is negative.

This contrasts with manufacturing firms, which see a temporary increase in bank debt and temporary decline in profits, but an increase in investment. Manufacturing firms do not show any evidence of passing on the exchange rate shock. The difference between manufacturing and non-manufacturing firms may lie in the former's better access to external finance. Manufacturing firms were able to maintain or perhaps increase their bank borrowing, which enabled them to maintain their trade credit lending and make further investments, despite the temporary hit to their profits. Their ability to maintain external borrowing may reflect their position in global value chains and revenues which correlate better with the exchange rate. On the other hand, non-manufacturing firms lost external financing and so had fewer resources to support trade credit lending. The magnitude of the drop in bank debt is larger than that of accounts receivable, so non-manufacturing firms may yet be absorbing some of the shock and smoothing it out over time for their trading partners.

Table 4: Exchange rate shocks and trade credit - Cumulative Impact

	Non-Manufacturing				Manufacturing			
	(1) Bank Debt	(2) CAPEX	(3) Profits	(4) AR	(5) Bank Debt	(6) CAPEX	(7) Profits	(8) AR
FX Debt_{it-1}	0.506***	-0.0188***	0.00588	-0.0473	0.520***	-0.0191***	-0.0115	-0.0432
	(0.0532)	(0.00532)	(0.0158)	(0.0289)	(0.0474)	(0.00387)	(0.0121)	(0.0310)
FX Debt_{it-2}	-0.0670	0.00334	-0.000400	-0.00965	-0.102	-0.00234	-0.0151	0.0187
	(0.0696)	(0.00749)	(0.0261)	(0.0421)	(0.0650)	(0.00597)	(0.0204)	(0.0523)
FX Debt_{it-3}	-0.117**	0.00423	-0.00911	0.0367	-0.123**	0.0109	0.0471**	0.00104
	(0.0550)	(0.00662)	(0.0245)	(0.0365)	(0.0590)	(0.00714)	(0.0186)	(0.0490)
FX Debt_{it-4}	0.0522	0.00720*	-0.00221	-0.0123	0.0558	0.00670	-0.0363***	-0.00382
	(0.0342)	(0.00424)	(0.0136)	(0.0233)	(0.0342)	(0.00457)	(0.0115)	(0.0284)
FX $\text{Debt}_{it-1} \times$ XR Depr_t	-0.223	-0.0213*	-0.176***	-0.0984	0.166**	0.0233**	-0.327***	-0.0705
	(0.136)	(0.0110)	(0.0380)	(0.0943)	(0.0666)	(0.0109)	(0.0540)	(0.0702)
FX $\text{Debt}_{it-2} \times$ XR Depr_{t-1}	-0.340***	0.0209**	0.0250	-0.0297	-0.0119	0.0186**	0.0958	0.0608
	(0.127)	(0.0102)	(0.0481)	(0.0767)	(0.0712)	(0.00880)	(0.0725)	(0.0845)
FX $\text{Debt}_{it-3} \times$ XR Depr_{t-2}	-0.165	0.00803	0.0564	-0.106	0.0579	0.0257	0.0995*	0.0100
	(0.122)	(0.0107)	(0.0403)	(0.0790)	(0.0722)	(0.0159)	(0.0541)	(0.0758)
FX $\text{Debt}_{it-4} \times$ XR Depr_{t-3}	-0.0997	0.0107	-0.0384	-0.149	0.0233	0.000827	0.0544	-0.0659
	(0.114)	(0.00977)	(0.0469)	(0.0918)	(0.0601)	(0.0146)	(0.0469)	(0.0572)
Observations	95144	88460	97285	91460	93007	88679	94805	91710
R^2	0.221	0.0133	0.0332	0.0822	0.260	0.0229	0.0256	0.0917
FirmFE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
CountryIndustryTimeFE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
CumulativeImpact	-0.828***	0.018	-0.133*	-0.383**	0.235	0.068***	-0.077	-0.066

Dependent variable is shown in the columns, each normalized by assets (AR normalized by short term assets) and winsorized at 1%. XR Depr is the quarter-on-quarter depreciation rate vis-a-vis the US dollar. Controls include FX Debt, cash holdings, total liabilities, and inventory, all normalized by assets, along with size (measured as log assets). All variables are winsorized at 1%, except for size. Controls are interacted with the XR shocks. CumulativeImpact is the sum of the interaction coefficients of FX Debt and XR Depr. Sample spans 2004-2020. 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 these firms experience a rise in their cost of borrowing, characterized by a depreciation of the domestic currency, they do not change the amount of trade credit extended, but instead they lower their profits. 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. Future exercises of interest include characterizing the types of firms that provide/receive full versus incomplete insurance in the theory and in the data. This would allow us to understand whether trade credit propagates or insulates shocks on aggregate. We plan to explore these dimensions in future drafts.

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