Trade Credit and Exchange Rate Risk Pass Through *

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August 31, 2024

Abstract

Large firms borrow in foreign currency and are net providers of trade credit to firms in their supply chains. We model the transmission of exchange rate risk via firm balance sheets along the supply chain. Trade credit loosens borrowing constraints and allows for higher production scale. Furthermore, firms are more likely to pass-though exchange rate shocks to their balance sheets onto their partners the more they are financially constrained. Meanwhile, unconstrained suppliers settle for lower profits, but maintain unchanged trade credit lines with their partners, when cost of borrowing in foreign currency rises. We validate these predictions using a quarterly firm panel for 19 emerging markets. We demonstrate empirically that trade credit constitutes a significant transmission mechanism of exchange rate shocks via supply chains.

Keywords: trade credit, financial constraints, supply chains, exchange rate volatility, imperfect pass through
JEL Classification Numbers: E32, G21, G32, F31, F34

*We thank seminar participants at AEA 2023 and 2024, SED 2023, BSE 'Firms in the Global Economy' Workshop 2023, Banca d'Italia 'Trade, Value Chains and Financial Linkages in the Global Economy' Workshop 2023, 2023 BFI International Macro-Finance Conference, UNSW conference on networks, St. Louis Fed and UCSD for comments and suggestions. We acknowledge valuable comments by Oleg Itskhoki, Loukas Karabarbounis, Annie Lee, and Tim Schmidt-Eisenlohr, and excellent discussions by Matteo Cacciatore, Luisa Carpinelli, Steve Wu, and Gang Zhang. The views are those of the authors and not necessarily those of the Bank for International Settlements.

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1 Introduction

Trade credit – firm-to-firm lending in the form of delayed payment for goods and services – is the principal short-term liability of a firm (Petersen and Rajan, 1997). While trade credit flows in both directions along supply chains (Hardy et al., 2022), large firms are important providers of trade credit to smaller counterparts, and often provide more trade credit than they receive. Additionally, large firms have access to debt denominated in foreign currency and at lower rates than domestic-currency denominated debt (Salomao and Varela, 2021). This access can introduce currency risk into supply chains even for firms with no direct FX linkages (e.g., non exporters and domestic borrowers). On the one hand, because foreign currency borrowing backs trade credit provisions, exchange rate risk can be propagated along value chains. On the other hand, as trade credit is potentially more flexible than bank loans, large firms could insulate their trade partners from currency fluctuations.

We study the extent of exchange rate risk pass-through along supply chains from a financial perspective. For example, even two firms that do not export can be subject to exchange rate risk when one of the parties borrows in FX markets, affecting their trade credit and production. The link between FX borrowing and trade credit provision provides a financial, rather than a trade based channel, for exchange rate risk to affect the economy, and to our knowledge, we are the first to explore this transmission mechanism theoretically and empirically. Young and small firms, which finance working capital needs primarily from trade credit borrowing, can be particularly exposed to this type of financial FX risk. As these firms constitute the pillar of growth in a typical economy (ex. Haltiwanger et al. (2013)), the aggregate consequences of XR shocks transmitted via financing channels can be substantial.

We argue that firms are heterogeneous in their trade credit provision and are more likely to pass-though their financial exchange rate risk to their partners the more they are financially constrained. We use Capital IQ data to build a quarterly panel of 13,000 firms in 19

emerging markets between 2000 and 2020. We show that firms borrow in foreign currency to fund accounts receivable. Moreover, cheap dollar funding is correlated with more trade credit provision. Therefore, FX borrowing is an important source of trade credit provision.

Motivated by our empirical evidence, 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. 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. Because debt repayment occurs in the second period after the exchange rate shock has been realized, the large seller incurs exchange rate risk. In an economy without trade credit, working capital needs require that both firms make payments in advance, which requires both firms to raise debt in the first period. The exchange rate risk is fully absorbed by the seller, and production capacity is constrained by the borrowing capacity of both agents.

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). Moreover, 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. When the state of the world is governed by the realization of the exchange rate, one can interpret state-contingent trade credit provision as trade credit issued in foreign currency.

We show that trade credit allows firms to raise more debt and attain a higher scale of production. Thus, 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 exchange rate shock. This can occur ex ante—when at least part of the trade credit is invoiced in foreign currency and so repayment is mechanically linked to the exchange rate—or ex post—when the lending firm retains currency mismatch and becomes constrained due to the exchange rate shock, forcing it to either reduce trade credit lending or adjust other activities on the balance sheet. These findings imply that large and less constrained firms potentially absorb a significant portion of exchange rate risk along the supply chain.

We derive two key predictions from the model. First, firms that sell more and are more profitable raise more debt and provide more trade credit. Second, firms that are more financially constrained (e.g. exposed to exchange rate risk) provide less trade credit, asking for more cash in advance. These firms also pass though more exchange rate risk along their supply chain.

We use our rich quarterly panel to validate these predictions. First, firms with more short-term debt, larger sales, lower costs of financing, and more profits, provide more trade credit. Second, firms that are more exposed to an exchange rate depreciation provide less trade credit. In the event of a depreciation, these firms also cut relatively more their trade credit provision and increase their cash holdings. This behavior is consistent with firms adjusting their invoicing to request that more of the purchase be paid for up front (more cash paid in advance) and less paid on trade credit (lower account receivable).

Our empirical and theoretical results suggest that FX-fueled trade credit can increase the scale of production of the economy, but potentially expose value chains to exchange rate risk even among firms that do not have direct access to foreign markets. This novel financial channel for exchange rate pass-through is particularly damaging in an economy where large trade credit providers are financially constrained or already highly exposed to currency risk.

Related Literature

A recent and growing literature has explored the role of trade credit in the macroeconomy (Giannetti et al., 2021; Love et al., 2007; Kalemli-Ozcan et al., 2014). The literature has studied how shocks can propagate through trade credit networks (Reischer, 2019; Mateos-Planas and Seccia, 2021; Miranda-Pinto and Zhang, 2022; Alfaro et al., 2021), and how trade credit relationships can help absorb shocks and mitigate their propagation (Hardy et al., 2022; Esposito and Hassan, 2023).[1] Indeed, trade credit likely plays both of these roles, potentially depending on the size of the shock (Shao, 2017) or the access to bank credit of the suppliers of trade credit (Bocola and Bornstein, 2023). The key novelty of our study is to include FX borrowing and exchange rate risk into a model of trade credit and supply chains. Our model provides a novel mechanism where exchange rate risk has a financial rather than a trade nature. In fact, we study the incentives of large firms to absorb or pass through their financial exchange rate risk to their partners.

Our examination of the transmission of exchange rate shocks via trade credit is relevant for the literature on exchange rate pass through. Trade credit is linked to sales and prices, and exchange rates can affect both margins. Ma and Schmidt-Eisenlohr (2023) find that import prices rise (and quantities fall) as the dollar strengthens, more so if dollar borrowing is more prevalent. Closer to our study, Cui et al. (2022) explore how exchange rate shocks transmit to export prices when trade credit is involved. They find exchange rate shocks affect exporters' financial costs and thus the implicit interest rate they offer on their trade credit lending. Our model complements this by focusing on how domestic trade credit contracts might vary with the exchange rate and what the implications are for the economy.

[1] On a microeconomic scale, Cuñat (2007) examines how, in a context of limited enforceability of contracts, suppliers act as liquidity providers insuring against liquidity shocks that could endanger the survival of their customer relationships. Consistent with this, firms have been shown to protect their trading partners (Hardy and Saffie, 2019; Ersahin et al., 2021). Firms' ability to absorb shocks can play 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) or smooth prices (Shapiro et al., 2018), while Barbiero (2021) argues that large firms absorb valuation shocks in their cash flows.

Recently, Kim and Lee (2024) and Kim et al. (2024) show that FX balance sheet shocks can impact prices, both domestically and for exports. Kim and Lee (2024) show that greater FX exposure leads to higher domestic prices, as small firms pass on rising costs and large firms strategically extract more profits. Kim et al. (2024) show that greater FX exposure among exporters is associated with a decline in exports as well as domestic sales, a rise in export prices, and a fall in imports and other inputs of production. Our paper shows how an important channel – trade credit financing enabling these sales – can connect FX risk in large firms to lower production throughout the economy in the wake of a balance sheet shock. Hence, we provide evidence for how the FX shock moves beyond those directly exposed to it.

Currency choice in invoicing and debt is crucial for exchange rate shock transmission. The gap between contract and payment introduces currency risk into the payment when not in the producer's currency, while a mismatch between the currency of debt and that of assets/revenues can expose firms to exchange rate risk (Hardy, 2023; Bruno and Shin, 2019), potentially affecting their capacity to provide trade credit. Colacito et al. (2023) connect the currency of debt and currency of invoicing to the geography of firm sales.[2] Hardy and Saffie (2019) show that Mexican firms use FX borrowing to provide trade credit, likely in local currency, accumulating currency mismatch on their balance sheets in the process. Bruno et al. (2018) similarly connect exchange rate fluctuations with changes in accounts receivable, payable, and inventories. Bruno and Shin (2022) 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. We theoretically explore the incentives for firms to build FX exposure and provide trade credit. Empirically, we show that firms with more exposure to the exchange rate shock (non-exporters with FX debt)

[2] Amiti et al. (2022) find some evidence that more financially-constrained firms invoice their sales in foreign currency. Firms may also select into FX debt simply because it is so much cheaper than local currency debt (Hardy, 2023), because they are more productive and so can bear the risk (Salomao and Varela, 2021) or to signal their type (Eren et al., 2023).

pass on the shock by reducing their trade credit lending, whereas less exposed firms (e.g., exporters) do not.

The remainder of the paper is organized as follows. Section 2 describes the database and shows that FX borrowing is related to trade credit provision. Section 3 develops a theory of trade credit provision along supply chains in the presence of exchange rate risk. Section 4 confirms the main predictions in the data and Section 5 concludes.

2 Trade Credit and FX Debt

This section presents the database used to support key modeling assumptions and to test the main theoretical predictions. In a nutshell, we use firm-level data across a set of emerging markets to document that i) trade credit is an important component of firms' balance sheets, ii) large firms are net providers of trade credit, and iii) foreign currency borrowing is linked to the provision of trade credit. Our empirical analysis is based on the Capital IQ dataset. This dataset captures primarily large firms (both publicly listed and private) across multiple countries. Capital IQ is unique in that it provides a cross-country dataset with information on the currency composition of firms' liabilities. We compute the currency composition from line-by-line data in each firm's capital structure (i.e., each individual debt).[3] Our quarterly panel contains more than 13,000 unique firms across 19 emerging market economies spanning between 2000 and 2020.[4] In most cases, we restrict our sample by time period or to firms with data for certain control variables, making the effective sample in most of our analysis between 5,000-9,000 firms, depending on the specification.

[3]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 do this using annual statements, where the match between the capital structure and balance sheet debt totals matches for nearly the entire sample. To get to quarterly observations for FX debt, we do the following: we compute currency shares of debt, and linearly interpolate those between the annual observations. We then apply these shares to the quarterly debt total to get quarterly values for FX and local currency debt.

[4]These include AR, BR, CL, CO, CZ, HU, ID, IL, IN, KR, MX, MY, PE, PH, PL, RU, TH, TR, ZA.

We further complement this financial data with information on the geographic distribution of the firm's revenues and assets that we later use to detect exporters and estimate the portion of assets denominated in foreign currency. 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	211,915	0.166	0.143	0.022	0.360
AR/ST Assets	209,189	0.355	0.216	0.086	0.653
AP/Liab	211,915	0.213	0.189	0.026	0.485
AP/ST Liab	211,915	0.318	0.216	0.062	0.633
(AR-AP)/Assets	211,915	0.069	0.128	-0.047	0.225
Liab/A	211,915	0.515	0.340	0.175	0.806
ST Debt/Assets	211,915	0.218	0.208	0.047	0.427
Profit/Assets	211,915	0.005	0.050	-0.024	0.039
Sales/Assets	211,915	0.211	0.187	0.021	0.423
Cash/Assets	211,915	0.092	0.116	0.005	0.227
Inventory/Assets	211,915	0.077	0.118	0	0.250
log(Assets)	211,915	5.040	1.969	2.781	7.729
FXDebt/Debt	151,590	0.215	0.338	0	0.871
FXAssets/Assets	111,773	0.070	0.184	0	0.258
(FXD-FXA)/Assets	90,288	-0.007	0.203	-0.173	0.165
Exports/Sales	145,142	0.179	0.284	0	0.669
FX Interest Rate	2,753	5.650	3.495	2.331	9.528
LC Interest Rate	5,776	7.585	4.811	3.310	12.755

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 5. FX and local currency interest rates are reported as firm averages (one observation per firm). Sample spans 2000-2020.

First, 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% of short term liabilities. Trade credit lending is also significant, making up 16% of total assets and 36% of short term assets. Second, firms in our sample are on average net trade credit lenders: accounts receivable minus accounts payable is roughly 7% of assets. In

contrast, trade credit is a much more important source of firm financing for smaller firms, especially in emerging and developing economies (Hardy et al. (2022)).[5] 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%.

Third, these simple statistics 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 (Petersen and Rajan (1997)), especially FX debt, to finance their extension of accounts receivable. To provide direct evidence of this behavior we document that FX debt finances the extension of trade credit. To document this fact in our sample, we follow the empirical design used by Hardy and Saffie (2019) for a sample of firms in Mexico. In particular, we use an accounting based regression to decompose changes in short-term assets into sources of funding:

$$\Delta STA_{it} = \alpha_i + \alpha_t + \beta_1 CashFlow_{it} + \beta_2 \Delta FXDebt_{it} + \beta_3 \Delta LCDebt_{it} + \beta_4 \Delta OtherLiab_{it} + \epsilon_{it}.$$

Each variable is normalized by lagged total assets. The dependent variable is short-term assets or one of its components: cash, accounts receivables, inventories, or other short-term assets. Cash flow is the internal sources of funds (retained earnings). External sources of funds are divided into FX debt, local currency debt, and other liabilities. Note that, the dependent variable captures changes in assets while the independent variables capture practically every source of finance backing the asset change. In this sense, more than a regression with causality pretensions, this approach consist of an accounting decomposition

[5]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.

that captures that every asset change has to be financed either by internal funds (retained earnings) or by external sources (e.g. debt).

Table 2 shows the results of this analysis. Column (1) shows that, for every dollar of FX debt, 57 cents are destined towards short-term assets. Column (2) shows that 13 cents of these 57 cents back up increases in cash holdings. Column (4) shows that another 14 cents are used to accumulating inventories. Interestingly, as seen in Column (3), 26% of FX currency borrowing is destined to the provision of trade credit (15 cents out of 57).

Table 2: FX liabilities and short-term assets

	(1) Total	(2) Cash	(3) AR	(4) Inv	(5) Oth
Cash Flow$_{it}$	0.490***	0.103***	0.169***	0.0470***	0.0328***
	(0.0171)	(0.00758)	(0.00780)	(0.00701)	(0.00528)
Δ FX Debt$_{it}$	0.568***	0.127***	0.147***	0.135***	0.0601***
	(0.0283)	(0.0142)	(0.0122)	(0.0129)	(0.00645)
Δ LC Debt$_{it}$	0.457***	0.0738***	0.138***	0.0999***	0.0433***
	(0.0199)	(0.00909)	(0.00770)	(0.00742)	(0.00432)
Δ Other Liab$_{it}$	0.385***	0.0718***	0.139***	0.0605***	0.0243***
	(0.0108)	(0.00365)	(0.00507)	(0.00496)	(0.00183)
Observations	115429	115429	115429	115429	115429
R^2	0.261	0.0262	0.119	0.0107	0.0125
Firms	5193	5193	5193	5193	5193
FirmFE	Yes	Yes	Yes	Yes	Yes
TimeFE	Yes	Yes	Yes	Yes	Yes

Firms reports the number of firms in each regression. Dependent variable in column (1) is change in short term assets, column (2) is change in cash and financial assets, column (3) is change in accounts receivable, column (4) is change in inventories, and column (5) is change in other short term assets. Cash flow is net income over the previous quarter; FX Debt is the change in FX debt liabilities over the previous quarter; LC Liab is change in local currency debt liabilities over the previous quarter; and Oth Liab is the change in other (residual) liabilities over the previous quarter. All variables are normalized by lagged assets and winsorized at 1%. Errors are clustered at the firm level. * p < 0.10, ** p < 0.05, *** p < 0.01

To further strengthen the link between FX borrowing and trade credit provision, we exploit time series variation on the cost of FX credit. In particular, we show that firms take

advantage of cheap FX credit, and use that credit to expand their trade credit lending.[6] We implement this analysis with the following regression:

$$\Delta Y_{icst} = \alpha_i + \alpha_{st} + \theta \Delta IRD_{ct} + \zeta X_{icst} + \epsilon_{icst},$$

where IRD is the average interest rate on local currency loans minus the average interest rate on FX loans for firms in each country.[7] The change in IRD is normalized by the standard deviation of the daily local currency depreciation rate over the quarter, as is standard in the carry trade literature to capture that there is less incentive to take on FX risk when the exchange rate is more volatile (Bruno and Shin, 2017). The outcome variables of interest include FX and local currency borrowing, trade credit provided (accounts receivable), and sales.

Table 3 summarizes these results. Columns (1) and (2) shows that relatively cheap foreign currency debt triggers more FX currency borrowing and less local currency borrowing. Interestingly, Columns (3) and (4) show that cheaper FX lending also supports more sales and more trade credit. Thus, cheap FX currency debt is associated with more FX borrowing, more sales, and more trade credit provision.

As it is clear from Table 2, the predominance of accounts receivable is not exclusive to FX borrowing, as every source of funds is strongly related to the provision of trade credit. What is unique about FX-backed accounts receivable is the potential currency mismatch that the trade credit provider accumulates. In fact, if trade credit is non-contingent and denominated in local currency, then the provider of trade credit absorbs the currency risk isolating its supply chains from the adverse effects of a potential currency depreciation.

The share of trade credit denominated in FX is a good indicator of the pass-through of

[6] Our empirical design follows Hardy and Saffie (2019) extending their results beyond the Mexican economy.

[7] Within firms, the interest rate is computed as a weighted average by loan size. Then a simple average across firms within a country-quarter is taken.

Table 3: Carry Trade and Trade Credit

	(1) FX Loans	(2) LC Loans	(3) Acc. Rec.	(4) Sales
Δ IRD$_{ct}$	0.00506*	0.00317	0.0187***	0.0384***
	(0.00302)	(0.00537)	(0.00532)	(0.00887)
Observations	116544	116544	132623	132836
R^2	0.00319	0.00851	0.0123	0.0181
Firms	5182	5182	5858	5788
FirmFE	Yes	Yes	Yes	Yes
SectorTimeFE	Yes	Yes	Yes	Yes
FirmControls	Yes	Yes	Yes	Yes

Firms reports the number of firms in each regression. Sample spans 2010-2020. Dependent variables, each normalized by lagged assets and expressed in percent, are as follows: in column (1), the change in FX loans, winsorized at 1%; in column (2), the change in local currency loans, winsorized at 1%; in column (3), the change in accounts receivable, winsorized at 1%; in column (4), the change in sales (proxied by total revenue), winsorized at 1%. IRD is the average interest rate on local currency loans minus the average interest rate on FX loans in each quarter. Interest rates are loan weighted averages of all firm loans up to the firm level, and then a simple average across firms in each country. Δ IRD is normalized by the standard deviation of the daily local currency depreciation rate over the quarter, then winsorized at 1%. Firm Controls include one quarter lags of: firm size (log assets), cash to assets ratio, total liabilities to assets ratio winsorized at 1%, inventory to assets winsorized at 1%, equity to assets winsorized at 1%, year-on-year sales growth winsorized at 1%, and profits to assets winsorized at 1%. Errors are clustered at the firm level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

FX currency debt along supply chains via trade credit. An important limitation of Capital IQ is that it does not detail the share of trade credit given or received in foreign currency. However, Table 4 compiles statistics from other studies. Hardy and Saffie (2019), who use data on listed firms in Mexico, show that roughly one third of trade credit owed is in foreign currency.[8] For the perspective of the lending firm, Lee and Wu (2022) show that the average Korean firm has one quarter of its accounts receivable in foreign currency. We take one quarter to one third to be a reasonable benchmark for how much trade credit is denominated in foreign currencies for emerging market firms.[9]

Table 4: Share of Trade Credit in Foreign Currency

	(1) Hardy and Saffie (2019) Acc. Payable Mexico	(2) Lee and Wu (2022) Acc. Receivable Korea
Foreign Currency	2.41	6.3
Local Currency	4.99	19.3
Share Foreign	0.33	0.25

Average trade credit as a percent of total assets.

Given these estimates, a 10% depreciation of the local currency against the dollar would increase the local currency value of trade credit by 2.5-3.3% for the average firm. State contingent contracts that are linked to the exchange rate could manifest in other ways besides foreign currency invoicing, but this example provides a concrete reference.[10] The

[8] Among exporters, the figure is closer to 50%, while for non-exporters it is 22%. Hence, this is not just driven by the natural hedge of exporters.

[9] Licandro and Mello (2019) find that Uruguayan firms invoice 24% of their domestic sales in USD, in part driven from dollar denominated inputs and matching dollar debts. Drenik et al. (2022) shows theoretically that this choice will depend on the price risk in each currency and how these prices comove with consumption needs. Monetary policy credibility thus affects incentives to invoice in the local currency.

[10] Trade credit contracts typically include a discount for paying early and a penalty for paying late. It can be more flexible than bank credit, as firms face fewer regulations on their balance sheet management and recognition of delinquent debts. The ability to selectively enforce late payment penalties can make trade credit repayment state contingent. Wilner (2000) show theoretically that, in the context of repeated interactions, trade creditor firms grant more concessions to a customer in financial distress in order to maintain an enduring product market relationship. Yang and Birge (2018) model firms as sharing inventory risk with suppliers by basing repayment on portion of goods actually sold to customers, making trade credit

next section presents a simple framework that links FX borrowing, sales, and trade credit provision. In the model, a large firm with access to FX-denominated debt engages in bilateral trade credit with a smaller partner that has no access to FX debt. Trade credit can be freely contingent on the realization of the exchange rate, providing an endogenous exchange rate pass-through that is rooted on the financial role, rather than on the commercial role, of the dollar.

3 A 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 financial system 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 $e^{'} = e_h$.

We first describe an economy without trade credit arrangements. 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

effectively state contingent. Suppliers accept this arrangement and do not impose late penalties because it enables larger volumes to be purchased. Late payments of trade credit can be quite common (Wu et al., 2020), as is not enforcing late penalties. See Hardy et al. (2022) for further discussion. Selective enforcement of late penalties could thus provide flexibility for firms to adapt to exchange rate shocks.

with zero net worth, so in order to hire labor, she needs to raise funds. We use the subscript s to refer to the seller. She can borrow an amount D_s from the financial system 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 $\psi > 0$ captures a seller with more costly access to foreign debt. 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.[11] Unlike the seller, the buyer is small and does not have access to foreign currency debt. We use the subscript b to denote the buyer. The buyer can raise debt D_b in domestic currency to be repaid in period 2 at interest rate $r > r^*$ up to the borrowing limit $\bar{D}$.[12]

Secondly, we modify the benchmark environment to allow for the possibility of bilateral trade credit. 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 payment to the seller in period 2 after selling the final good to the consumer. Because the seller is exposed to exchange rate risk when repaying her loan in the second period, we allow the second period payment of the buyer to the seller 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

[11] This is akin to a letter of credit where a bank keeps the amount paid by one party until the effective delivery of the goods takes place. Thus, these funds are not available for the seller to pay her workers and the buyer needs to borrow in order to post this payment as the consumer is not paying in advance for the goods.

[12] 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 general equilibrium model with convex borrowing costs for both types of agents as well as endogenous market power due to search-and-matching frictions.

large seller passes through a portion the exchange rate shock onto the buyer via trade credit. This ex ante pass through creates a link from the exchange rate to trade credit repayment. This is a flexible contract that can capture partial FX denomination of trade credit, among other forms of flexibility (e.g., early payment discounts). Alternatively, the seller might chose to retain all the currency risk. In this case, $T_h^{'} = T_l^{'}$, and 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 small non-pecuniary fixed cost, $\kappa > 0$. This small cost brakes potential marginal indifference between contingent and non-contingent trade credit provision.[13]

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, because both their receipts/assets and liabilities/outflows are denominated in dollars, a depreciation of the domestic currency is naturally hedged for the exporter. Section 4 exploits this differential exposure to further validate the predictions of the model.

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:

[13]This could be rationalize as a small cost needed to verify the actual state of the economy in order to determine the contingent payment.

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

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

$$D_b - T' \geq 0 \tag{2}$$

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

$$pL \geq D_b(1+r) \tag{4}$$

$$T' \geq e_h D_s (1+r^*) \tag{5}$$

$$\bar{D} \geq D_b, \tag{6}$$

where $\tilde{e}' \equiv p_h e_h + (1-p_h)e_l = 1$ 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 $\beta(1+r^*) = 1 > \beta(1+r)$, which implies that agents have no incentives to save in this economy.

Constraint (1) is the incentive compatibility constraint capturing the fact that the buyer's surplus must be at least equal to her outside option, $\Gamma > 0$. Constraints (2) and (3) capture the borrowing needs of the buyer and the seller in the first period, respectively. The buyer borrows to post collateral that supports the promised transaction (letter of credit). while the seller borrows to pay the workers. Constraints (4) and (5) reflect the feasibility of the debt obligations by insuring repayment.[14] Constraint (6) captures the degree of financial constraint of the buyer in the domestic market.

Notice that the constraint (1) must always bind because the seller extracts all surplus from the buyer, constraints (2) and (3) also bind as there is no incentive for any agent to save. Imposing these restrictions, it is straight forward to see that constraint (4) will never bind as long as $\Gamma > 0$.

[14]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 relatively high.

The solution consists of three cases which are combinations determined by the slackness of constraints (5) and (6).

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:

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

Naturally, as borrowing becomes more expensive for the seller (ψ), debt and production decrease.

3.1.2 Case 2: Constrained Buyer and Unconstrained Seller

When constraint (6) 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 a positive debt level is given

by:

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

Note that, the maximum debt level in this case is given by $\frac{1}{2\psi}$.

3.1.3 Case 3: Unconstrained Buyer and Constrained Seller

When constraint (5) is binding, we can combine it with constraints (1) and (2) to express L_3 in terms of $D_{s,3}$. Substituting this expression into constraint (3) 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:

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

Note that, because constraints (2) and (3) always bind, a scenario in which the last two constraints are jointly binding is not optimal. In fact, under this scenario, the problem can be solved without using constraint (1), and thus, this constraint would have to be slack. In that case, the seller can always reduce the production scale (L in constraint (1)) and the amount that she borrows in constraint (3), while keeping the same D_b and T', thus, increasing her profits.

3.2 Model With Trade Credit

In the model without trade credit, agents are constrained in that the only source of credit is debt. Thus, we extend the model to allow each agent to issue trade credit to her trade partner when in need of funds. In this case, the take-it-or-leave-it offer done by the seller to the buyer, solves the following program:

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

$$D_b - T + \beta[pL - D_b(1+r) - \tilde{T}^{'}] - \Gamma \geq 0 \tag{7}$$

$$D_b - T \geq 0 \tag{8}$$

$$D_s + T - \psi D_s^2 - wL \geq 0 \tag{9}$$

$$T_h^{'} - D_s(1+r^*)e_h \geq 0 \tag{10}$$

$$T_l^{'} - D_s(1+r^*)e_l \geq 0 \tag{11}$$

$$pL - D_b(1+r) \geq T_h{}^{'} \tag{12}$$

$$\bar{D} \geq D_b \tag{13}$$

$$T_h{}' \geq T_l{}^{'}, \tag{14}$$

where, 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, $T_l{}^{'} \equiv T^{'}(e_l)$ and $T_h^{'} \equiv T^{'}(e_h)$ denote the state-contingent payments in the second period, and $\tilde{T}^{'} \equiv p_h T_h{}^{'} + (1-p_h)T_l{}^{'}$. Because the buyer pays for the input only after she had made the final-good sale to the consumer, $T_l{}^{'}$ and $T_h{}^{'}$ represent trade credit that the seller extends to the buyer. 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 on the realization of the exchange rate.

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 (12) 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, constraints (10) and (12) must bind jointly as, otherwise, either agent can relieve her trade partner if she has slack when repaying debt.

Because 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: No Exchange Rate Risk Pass Through

When repayment constraints are not binding, the first order conditions deliver the following optimal choice for the seller's debt level and production scale:

$$D_s^{TC} = \frac{\beta p - w}{2\psi\beta p} \tag{15}$$

$$L^{TC} = \frac{D_s^{TC} - \psi\left(D_s^{TC}\right)^2 + D_b^{TC}}{w}. \tag{16}$$

Furthermore, the unconstrained seller chooses a mean transfer next period equal to $\tilde{T}^{TC'}$ to extract the entire surplus from the buyer. From expression (7) 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 (14) is optimal. However, because the seller incurs a non-pecuniary cost $\kappa > 0$ to provide state-contingent payments, it follows that $\tilde{T}^{TC'} = T_h' = T_l'$, and is given by:

$$\tilde{T}^{TC'} = pL^{TC} - D_b^{TC}(1+r) - \Gamma/\beta \tag{17}$$

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 are in order. 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 the seller is 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. Therefore, 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 (16), 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 (17) 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:

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

Because the second-period transfer is not state contingent in equilibrium, the exchange rate pass through from the seller to the buyer is zero in this case. Thus, all the exchange rate risk is absorbed by the seller as her profit decreases in the exchange rate. Hence, the large seller insulates its small buyer 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: Exchange Rate Risk Pass Through

To fully characterize the model, it remains to solve the case in which the seller is constrained. Assume that constraints (7), (8), and (9) are binding, and suppose that (11) is binding. Then, the seller can increase both D_s and $T_l^{'}$ to raise the her profits. To ensure that constraint (7) is not violated, $T_h^{'}$ should be decreased. This process can be repeated until constraint (10) binds. Substituting constraints (11) and (10) 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 (10) binds, then this solution corresponds to the unconstrained

case described in the previous section. Thus, constraint (11) cannot bind.

To characterize the seller's debt, combine constraints (10), (12), and (9) to obtain a quadratic equation in D_s, for a 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.[15] 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 (7), (10) and (12) and satisfy:

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

In this case, the seller's accounts receivable is a function of the exchange rate, so the seller passes through part of the exchange rate shock. Because trade credit, $\tilde{T}^{TC,C'} = T_h' - \frac{\Gamma}{\beta}$, the degree of exchange rate pass through into trade credit is larger when 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 $D_s^{TC,C}$

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

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. $\frac{p}{w} > (1+r)$). Both, $\tilde{T}^{TC'}$ and $\tilde{T}^{TC,C'}$ are recovered from constraint (7), and L^{TC} and $L^{TC,C}$ follow from constraint (9). From constraint (7), $\tilde{T}'$ is increasing in L, and because $D_s < \frac{1}{2\psi}$ 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 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. Because ψ regulates the cost of borrowing of a seller, this is an intuitive result.

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 condition imposes an upper bound on ψ, so that if ψ 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. Sellers that are more vulnerable to an exchange rate depreciation raise less debt, extend less trade credit and pass through more exchange rate shocks via account receivables.

The connection between accounts receivable and exchange rate can be described with two complementary forces. First, as seen in Table 4, accounts receivable can be made contingent on the realization of the exchange rate. Thus, an exchange rate depreciation affects mechanically the value of the accounts receivable that were extended beforehand. Moreover, a seller that is more exposed to exchange rate risk (a depreciation is more likely to make a repayment constraint bind) chooses ex-ante trade credit contracts that are more contingent on exchange rate realizations. Second, an exchange rate depreciation effectively constrains the seller, making it more costly for her to access FX funding. In this case, similarly to the case when a seller faces a high ψ, the new sales contracted under an exchange rate depreciation will feature less trade credit (more cash in advance) and more exchange rate risk pass through. This second mechanism should be particularly acute for firms with large FX mismatches in their balance sheets.

4 Empirical Analysis

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

Testable Prediction 1. Higher profits, more short-term debt, larger sales, and better borrowing terms should be associated with more trade credit provision.

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. In the model, the amount of debt that a firm raises, and the firm's sales and profitability are directly related to the amount of trade credit that it extends. In this sense, more profitable firms with high sales volumes borrow more in order to provide trade credit. Because trade credit is a short-term contract, we focus on short-term debt excluding accounts payable (captures access to short-term funds like commercial paper, which are typically matched with accounts receivables).

In the model, debt, profits and sales all reflect the degree to which a firm is financially constrained. We recognize that these variables may reflect other factors in reality. Therefore, in order to directly capture the degree to which a firm is financially constrained, we perform an empirical exercise with a more limited sample of firms in our dataset for which we have information on interest rates at the level of an individual loan. In particular, the variable Low IR_t is a dummy variable that equals unity if the firm's average interest rate on their bank debt is lower than the country-sector average, indicating that the firm's borrowing is less constrained.[16]

The vector X includes other firm-level controls such as accounts payable, inventories, cash holdings, and log assets. All variables in the regression are normalized by the firm's assets, except the interest rate dummy and log assets. Each observation is at the 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 correspond to differences in the independent variables. Moreover, this interaction

[16]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 country-sector average.

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 time. The theory predicts that β_d, β_s, β_p and β_r should be positive.

Table 5 presents the results of our first empirical exercise. 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 that amounts to unity when the firm's interest rate on a loan is lower than the 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 that more profitable and less financially constrained firms intermediate more trade credit thorough their supply chains.

One concern with our empirical exercise is that the firms in our data may not correspond to the"sellers", or net trade credit providers, in our model. Moreover, in the next section, we will be examining how firms in our dataset react to increases in the cost of borrowing in foreign currency. Since we will study exchange rate shocks, it will be important to differentiate between firms that sell domestically and firms that export, since the latter group enjoy a natural hedge when domestic currency depreciates. As our dataset contains large firms, exporting is a natural concern. To address these concern, in Table 6 we repeat our exercise, but we split the sample of firms into subgroups: exporters vs. non-exporters and net trade credit lenders ("sellers") vs. net trade credit borrowers ("buyers").[17]

[17]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. 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") might behave differently from other firms regarding how they pass through shocks to trade credit (ex. their business model may be better equipped to sustain trade credit). Formally, we define a firm as a seller if $AR - AP > 0$ on average. Firms are classified as exporters if foreign revenue/total revenue $> 20\%$ on average, and non-exporters otherwise.

Table 5: Trade Credit Lending and Bank Debt

	(1)	(2)	(3)	(4)	(5)	(6)
ST Debt$_{it}$	0.0843***	0.0705***	0.0684***	0.0688***	0.0647***	0.0326***
	(0.00354)	(0.00296)	(0.00287)	(0.00294)	(0.00262)	(0.00194)
Profit$_{it}$	0.300***	0.292***	0.292***	0.294***	0.257***	0.0902***
	(0.0136)	(0.0115)	(0.0115)	(0.0118)	(0.0140)	(0.00776)
Sales$_{it}$	0.114***	0.148***	0.157***	0.158***	0.153***	0.150***
	(0.00476)	(0.00388)	(0.00369)	(0.00377)	(0.00426)	(0.00444)
Low IR$_i$					0.00535***	
					(0.000576)	
Acc Pay$_{it}$	0.521***	0.477***	0.448***	0.450***	0.455***	0.275***
	(0.0108)	(0.00904)	(0.00860)	(0.00864)	(0.00903)	(0.00570)
Cash$_{it}$	-0.0712***	-0.0977***	-0.106***	-0.106***	-0.0925***	-0.120***
	(0.00286)	(0.00221)	(0.00217)	(0.00219)	(0.00280)	(0.00248)
Inventory$_{it}$	-0.0674***	-0.0609***	-0.0528***	-0.0532***	-0.0498***	-0.0431***
	(0.00647)	(0.00537)	(0.00431)	(0.00441)	(0.00446)	(0.00341)
Size$_{it}$	-0.0152***	-0.0121***	-0.0126***	-0.0127***	-0.0132***	-0.0101***
	(0.000234)	(0.000218)	(0.000209)	(0.000214)	(0.000222)	(0.000600)
Observations	211915	211915	211741	210030	175274	209148
R^2	0.297	0.273	0.265	0.266	0.265	0.161
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 results in columns (1)-(4) demonstrate that the key correlations hold in all subsamples. Interestingly, the strength of the correlation of trade credit lending with external debt and profits is stronger for non-exporters, who will constitute the key sample of firms that we will examine in our next exercise. Similarly, net trade credit lenders, which correspond to "sellers" in our model, demonstrate considerably stronger relationship between trade credit lending and debt, sales and profitability, than do net trade credit borrowers.

Table 6: Trade Credit Lending and Bank Debt: By Firm Type

	(1) Exporters	(2) Non-Exporters	(3) Net TC Lenders	(4) Net TC Borrowers
ST Debt$_{it}$	0.0485***	0.0754***	0.0890***	0.00637**
	(0.00367)	(0.00340)	(0.00351)	(0.00283)
Profit$_{it}$	0.203***	0.321***	0.232***	0.0796***
	(0.0192)	(0.0128)	(0.0117)	(0.0112)
Sales$_{it}$	0.188***	0.153***	0.172***	0.0649***
	(0.00594)	(0.00415)	(0.00372)	(0.00383)
Acc Pay$_{it}$	0.444***	0.445***	0.703***	0.339***
	(0.00914)	(0.0101)	(0.00702)	(0.00891)
Cash$_{it}$	-0.0740***	-0.114***	-0.0868***	-0.0526***
	(0.00510)	(0.00266)	(0.00226)	(0.00342)
Inventory$_{it}$	-0.0414***	-0.0539***	-0.0451***	-0.0228***
	(0.00468)	(0.00561)	(0.00402)	(0.00409)
Size$_{it}$	-0.0112***	-0.0132***	-0.0125***	-0.00319***
	(0.000390)	(0.000250)	(0.000207)	(0.000234)
Observations	54592	152786	169365	37954
R^2	0.293	0.256	0.375	0.347
CountryIndustryTimeFE	Yes	Yes	Yes	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. Firms are classified as exporters if foreign revenue/total revenue $> 20\%$ on average, and non-exporters otherwise. Firms are classified as a net trade credit seller if on average accounts receivable $>$ accounts payable, and net trade credit buyers otherwise. R^2 is within R^2. Errors are clustered at the industry-year level. * p < 0.10, ** p < 0.05, *** p < 0.01

Testable Prediction 2. Firms that are more exposed to an exchange rate depreciation

should provide less trade credit. In the event of an exchange rate depreciation, these more exposed firms should experience sharper reductions in their accounts receivable.

In the model, firms that are exposed to FX risk can pass through exchange rate shocks before *and* after the realization of the shock. First, a firm that is more exposed to FX fluctuations, designs trade credit contracts that are more sensitive to exchange rate fluctuations from an ex-ante perspective. Thus, an exchange rate depreciation affects the value of these contracts more. Second, when the exchange rate depreciates, firms that are more exposed suffer larger losses and are less able to access financial markets. Thus, they reduce their provision of new trade credit favoring cash in advance payments.

To capture the degree of exposure of a firm to an exchange rate shock, we use balance sheet data to build the following variable:

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

where FXL corresponds to the liabilities denominated in FX and FXA to the assets denominated in FX. While the Capital IQ dataset provides detailed measures of the foreign currency debt for most firms, it does not have a direct measure of foreign currency assets. We proxy FXA with the value of the firm's foreign assets.[18] To account for natural hedges such as export revenues, we define an exporter dummy if the firm's foreign revenue is greater than 20% of their total revenue, and we examine outcomes for exporters compared to non-exporters. To study the interaction between trade credit lending and shocks to the cost of

[18]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. These data are available for 85% of the firms in the sample.

borrowing in FX, we estimate the following empirical model:

$$Y_{icst} = \alpha_i + \alpha_{cst} + \gamma_1 FXExposure_{it-1} + \gamma_2 FXExposure_{it-1} \times XRDepr_{ct} + \gamma_3 Controls_{it-1} + \gamma_4 Controls_{it-1} \times XRDepr_{ct} + \epsilon_{icst},$$

where $XRDepr$ is the quarter-on-quarter depreciation rate of the local currency vis-a-vis the US dollar. We consider several dependent variables. First, we examine Profits/Assets to validate the existence of a balance sheet shock to the firm. Second, we examine Accounts Receivable/Sales to see if exposed firms adjust the share of sales that they extend on credit. Third, we examine Cash Holdings/Assets, which may adjust as firms change their approach to their accounts receivable and demand more upfront payment. And last, we examine accounts Receivable/Assets to see how firms adjust the volume of accounts receivable in their portfolio. The key coefficients of interest are γ_1 and γ_2, which capture, respectively, the ex-ante and total effect of FX exposure on the variable of interest. We also include a set of lagged firm-level controls, and their interaction with $XRDepr$, to account for other channels by which exchange rate fluctuations might influence firm outcomes. These controls include profits, accounts payable, short-term liabilities, bank debt, issued bonds, issued equity, total liabilities, log assets, and sales.

Table 7 presents the results for the two key coefficients. Focusing first on non-exporters, from the second row of the Table, we see that we see that firms that are more exposed to FX risk provide less trade credit in their sales (column 2) and maintain larger cash holdings (column 3). Although not significantly, these firms also have lower levels of accounts receivable in their balance sheets (column 4). Turning to the effect of an exchange rate depreciation in the first row, column 1 shows that non-Exporters on average see a significant decline in profits when hit by an exchange rate 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 about 0.2% of assets. This is sizeable compared to the median quarterly profit of 0.7% of assets. Consequently, non-exporters hit by a shock tend to cut back on their trade credit lending (column 4). They decrease the share of sales given on credit (column 2), but also see an increase in cash holdings (column 3). For the same scenario, the firm sees a decline in accounts receivable of 0.14pp of assets (1% decline of the accounts receivable of the average firm) and a rise in cash holdings of 0.17pp of assets (a 2% increase for the average firm's cash holdings). This is consistent with these firms requesting more cash in advance when selling, given their decreased internal cash flow to service their existing debt. Furthermore, the decline in accounts receivable and the increase in cash is close to each other in magnitude, suggesting a direct tradeoff between the two types of short-term assets. Overall, the decline in accounts receivable is about 44% of the decline in profits.

Consistent with their natural hedge, exposed exporters see a much smaller drop in their profits. Interestingly, they appear to increase the share of sales made on credit, although the coefficient is not precisely estimated. This could reflect that exporters with the most exposure to FX debt are likely to benefit the most long-term from a depreciation. So even with a short-term hit to profits, their outlook is improved and revenues are rising, so these firms might take advantage of the opportunity to attract more customers with better terms on their sales. The adjustment of cash and trade credit are not significant, but point in the same direction as for non-exporters, and their absolute changes together also match closely each other.

Table 7: Exchange rate shock and trade Credit Adjustment

	Non-Exporters				Exporters			
	(1) Profits/ Assets	(2) AR/ Sales	(3) Cash/ Assets	(4) AR/ Assets	(5) Profits/ Assets	(6) AR/ Sales	(7) Cash/ Assets	(8) AR/ Assets
FX Exposure$_{it-1}$ × XR Depr$_t$	-0.228***	-0.469**	0.101*	-0.0838*	-0.0705**	0.1599	0.0378	-0.0358
	(0.0401)	(0.233)	(0.0526)	(0.0440)	(0.0341)	(0.2094)	(0.0482)	(0.0358)
FX Exposure$_{it-1}$	0.00527	-0.003**	0.0203***	-0.00574	0.00271	-0.0258	0.0157***	-0.00976**
	(0.00331)	(0.0281)	(0.00538)	(0.00440)	(0.00306)	(0.0203)	(0.00548)	(0.00414)
Observations	72407	69837	61114	71772	19299	18973	17577	19355
R^2	0.0372	0.0134	0.0320	0.0710	0.0579	0.00834	0.0596	0.0868
CountryIndustryTimeFE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
FirmFE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
FirmControls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Sample spans 2006q1-2021q1. Dependent variable in columns (1) and (5) is the ratio of profits to assets, winsorized at 1%; in columns (2) and (6) is the ratio of accounts receviables to sales, with large values capped at 2; in columns (3) and (7) is the ratio of cash to assets, winsorized at 1%; and in columns (4) and (8) is the ratio of accounts receivables to assets, winsorized at 1%. The primary independent variables is a one quarter lag of (FX Debt - Foreign Assets)/Assets, winsorized at 1%, and its interaction with the quarter on quarter depreciation rate of the period average exchange rate. Other controls include one quarter lags of the following variables, each normalized by assets, winsorized at 1%, and also include its interaction with the depreciation rate: profits, accounts payable, short-term liabilities, bank debt, bond debt, equity, total liabilities, and sales. Log assets and its interaction with the depreciation rate are also included. Exporters are defined as having foreign revenue/total revenue > 20%, otherwise firms are non-exporters. R^2 is within R^2. Errors are clustered at the industry-date level. * p < 0.10, ** p < 0.05, *** p < 0.01

Overall, the empirical results in this section suggest that firms that are more exposed to XR shocks to their balance sheet pass through a larger degree of the shocks to their trade partners via a decrease in trade credit or a worsening in the terms of trade credit extended.

What are the potential aggregate implications of an exchange rate shock? A back-of-the-envelope calculation can be useful to provide a benchmark. We take Peru as an example of an economy that has significant FX exposure (13% net exposure on average for our firms at end-2019). Considering a 10% depreciation event, we multiply this by our estimated coefficients in columns 4 and 8 and apply it to all Peruvian firms in our sample to get the total impact for these firms. This exercise suggests the aggregate accounts receivable of these firms would fall by 1% in this case. This is a small but meaningful impact. This analysis overlooks distributional impact of the recipients, many of whom are small firms out of our data sample.

5 Conclusion

We develop 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 more constrained firms tend to pass on the shock to their trade credit lending, while less constrained firms do not. The degree of exchange rate risk pass through thus depends on firm level exposure to exchange rate risk and their financial health. Future work should study the aggregate consequences of this behavior. In particular, can these large firms, which carry this exchange rate risk on their balance sheets, insulate the overall economy from negative shocks?

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