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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. Furthermore, firms are more likely to pass-through exchange rate shocks to their balance sheets onto their partners the more they are financially constrained. We validate these predictions using a quarterly firm panel for 19 emerging markets. Trade credit constitutes an important transmission mechanism of exchange rate shocks, but firms tend to protect their trading partners.

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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).[1] 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 engage in cross-border exchange of goods can be subject to exchange rate risk when one of the parties borrows in FX markets, thus affecting their trade credit provision and production along the supply chain. 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, if large firms do not

[1] The typical small firm has little access to short-term commercial credits and thus relies on credit from suppliers and clients. Their main bank relationship is a mortgage that does not finance short-term activities. These facts are highlighted every five years on the FED reports on the Availability of Credit to Small Businesses for the U.S. and are even more prevalent in less developed financial markets.

shield smaller trade partners from such shocks.

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) raise less debt, provide less trade credit, and ask 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 raise less debt, 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). However, the economic magnitudes of these impacts suggest that firms do not fully pass on the shock to their trading partners via trade credit, highlighting the motivation to insure trading partners outlined in the model. Nevertheless, this mechanism remains a relevant transmission channel if FX exposure rises or if the banking sector is constrained by the shock.

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-Özcan 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).[2] 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 theoretical 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-based 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

[2] 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, 2024; 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.

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. 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.[3] Hardy and Saffie

[3] 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).

(2024) 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) 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: Stylized Facts

In this section, we outline empirical patterns that motivate our key modeling assumptions. 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.

We begin by describing the new database that we use to establish the empirical patterns and to test the main theoretical predictions. 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).[4] Our quarterly panel contains more than 13,000 unique firms across 19 emerging market economies spanning 2006q1-2021q1.[5] 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.

We further complement these 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.

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, namely, Accounts Payable (AP), accounts for 22% of total liabilities and 32% of short term liabilities. Trade credit lending, namely, Accounts Receivable (AR), is also significant, making up 17% 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)).[6]

[4]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.

[5]These include AR, BR, CL, CO, CZ, HU, ID, IL, IN, KR, MX, MY, PE, PH, PL, RU, TH, TR, ZA. Note that the data extends back to 2000, but with poor coverage in earlier years.

[6]For instance, as Allen et al. (2013) report in Table 5 using data from the World Bank Enterprise Surveys during the 2002-2010 period, 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, Capital IQ

	N	Mean	Std. dev.	10th	Median	90th
AR/Assets	158,117	0.169	0.145	0.022	0.133	0.365
AR/ST Assets	155,966	0.359	0.218	0.087	0.336	0.659
AP/Liab	158,117	0.215	0.190	0.026	0.161	0.488
AP/ST Liab	158,117	0.321	0.217	0.063	0.285	0.638
(AR-AP)/Assets	158,117	0.071	0.129	-0.046	0.050	0.229
Liab/Assets	158,117	0.512	0.329	0.176	0.486	0.803
ST Debt/Assets	158,117	0.216	0.202	0.046	0.166	0.426
Profit/Assets	158,117	0.004	0.050	-0.024	0.008	0.038
Sales/Assets	158,117	0.211	0.189	0.018	0.175	0.424
Cash/Assets	158,117	0.092	0.115	0.005	0.054	0.225
Inventory/Assets	158,117	0.084	0.121	0	0.015	0.260
log(Assets)	158,117	5.080	1.971	2.818	4.878	7.756
FXDebt/Debt	133,649	0.217	0.340	0	0	0.880
FXAssets/Assets	95,624	0.070	0.184	0	0	0.255
(FXD-FXA)/Assets	81,854	-0.005	0.205	-0.168	0	0.172
Exports/Sales	124,989	0.180	0.284	0	0.001	0.672
FX Interest Rate	2,753	5.650	3.495	2.331	5	9.528
LC Interest Rate	5,776	7.585	4.811	3.310	6.409	12.755
FX IR (common sample)	2,391	5.608	3.527	2.320	5	9.473
LC IR (common sample)	2,391	8.185	5.403	3.564	6.665	14.554

Sample spans 2006q1-2021q1. Statistics are computed after winsorizing outliers at the 1% level, except for log(assets) and FXDebt/Debt. Statistics are computed on a sample where a number of key variables are non-missing (short-term debt, profits, sales, accounts receivable, accounts payable, cash, inventories, and assets). Foreign currency (FX) and local currency (LC) interest rates are reported as firm averages (one observation per firm). Sample spans quarterly data over 2000-2020. AR=accounts receivables; AP=accounts payable; ST=short term; FXD=foreign currency debt; FXA = foreign currency assets; IR=interest rate; common sample is the sample of firms with interest rate data for both FX and LC loans.

Third, larger firms tend to have better access to FX debt. In our sample, the correlation of log assets (which proxy firm size) with the share of FX liabilities is 0.27. On average, FX debt accounts for 22% of total firm debt, but the share is over 88% for firms in the top decile. Moreover, these firms pay lower interest rates on their FX debt than on their local currency (LC) debt—5.7% vs. 7.6% overall, or 5.6% vs 8.2% for firms that borrow in both currencies—which is consistent with findings by Salomao and Varela (2021) for Hungary and

Hardy (2023) for Mexico. 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. Specifically, we follow the empirical design used by Hardy and Saffie (2024) for a sample of firms in Mexico, and we apply it to our Capital IQ dataset. In particular, we use an accounting-based regression to decompose changes in short-term assets (STA) into sources of funding:

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

where i indexes firms and t indexes time periods (quarters). Each variable is normalized by lagged total assets. The dependent variable is short-term assets or one of its components: cash, accounts receivable, inventories, or other short-term assets. Cash flow is the internal source of funds (retained earnings). External sources of funds are divided into foreign currency (FX) debt, local currency (LC) debt, and other liabilities. Finally, α_i is a firm fixed effect, α_t is a time fixed effect, and ϵ_{it} is an error term. 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, instead of a regression with causality pretensions, this approach consist of an accounting decomposition 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: 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

Sample spans 2006q1-2020q4. Firms reports the number of firms in each regression. Dependent variable in column (1) is change in total 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. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

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).

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. 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 we introduce c to index countries and s to index sectors. IRD is the average interest rate on local currency loans minus the average interest rate on FX loans for firms in each country.[7] We take the change in IRD, to capture if the incentive for FX borrowing has changed, and normalize it by the standard deviation of the daily local currency depreciation rate over the quarter. This normalization 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). We start the sample in 2010 when we have a wider sample of firms with interest rate data against which to compute the IRD. We expect $\theta > 0$ for foreign currency debt, as firms respond to carry trade incentives, but not for local currency debt. If firms use this FX debt to extend trade credit, then we may see a positive coefficient for accounts receivable and sales also.

The outcome variables of interest include FX and local currency borrowing (ex. loans, bonds, exclusive of trade credit), trade credit provided (accounts receivable), and sales (again all variables normalized by lagged assets). As we now move beyond our accounting decomposition, we saturate the model with more stringent sector-time fixed effects α_{st} to capture shocks to specific sectors that could influence outcomes, but we avoid country-time fixed effects which would be co-linear with our variable of interest, IRD_{ct}. We control for other relevant firm factors in X_{icst}, including lags of firm size (log assets), cash, liabilities, inventories, equity, profits (each of these preceding 5 normalized by assets), and year-on-year sales growth.

[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 Debt	(2) LC Debt	(3) AR	(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

Sample spans 2010q1-2020q4. 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 for a given country. Interest rates at the country-time level for each currency (foreign and local) are computed by taking a weighted average within each firm-time-currency unit (weighted by loans size), and then taking a simple average across firms in each country-time unit for each currency. 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. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 3 summarizes these results. Columns (1) and (2) show 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 extended is not contingent on the realization of the exchange rate (for example, if it is denominated in local currency), then the provider of trade credit absorbs the currency risk, thus isolating firms along the supply chain from the adverse effects of a potential currency depreciation.

Thus, the share of trade credit denominated in FX is one indicator of the pass-through of FX currency debt along supply chains via trade credit, capturing a mechanical link. While some trade credit will be denominated in FX because it is for exports or imports, FX invoicing can occur within domestic sales as well. For example, Licandro and Mello (2019) find that Uruguayan firms invoice 24% of their *domestic* sales in USD, in part driven by matching their own dollar invoiced inputs and dollar debts (and shifting the currency risk to their trading partner). Drenik et al. (2022) show theoretically that this choice will depend on the risk in each currency and how the pricing in each currency comoves with consumption needs. Monetary policy credibility thus affects incentives to invoice in the local currency.

Table 4: Share of Trade Credit in Foreign Currency

	(1) Hardy and Saffie (2024) AP Mexico	(2) Lee and Wu (2022) AR Korea
Foreign Currency	2.41	6.3
Local Currency	4.99	19.3
Share Foreign	0.33	0.25

Average of trade credit by currency as a percent of total assets.

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 in order to provide some benchmarks. Hardy and Saffie (2024), who use data on listed firms in Mexico, show that roughly one third of trade credit owed is in foreign currency. Among exporters, the figure is closer to 50%, as may be expected since they are also typically more intensive importers (Blaum, 2024), while for non-exporters it is 22%. Hence, this is not just driven by the natural hedge of exporters. 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.

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.[8] The 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

[8] Trade credit contracts typically include a discount for paying early and a penalty for paying late. Trade credit 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) shows 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 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 are quite common (Wu et al., 2020), as is failure to enforce late penalties. See Hardy et al. (2022) for further evidence. Selective enforcement of late penalties could thus provide flexibility for firms to adapt to exchange rate shocks.

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".[9] 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 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 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 begins 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.[10] Unlike the seller, the

[9] This setup does not reflect a "Walmart-style" supply chain structure, where a large buyer has many sellers. Rather, one could think of it as firms having one supplier for a given product. The assumption that the seller firm can borrow in foreign currency reflects that large firms in the data tend to be net lenders of trade credit and also have greater access to FX debt.

[10] 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.

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 $\bar{D}$.[11]

We introduce bilateral trade credit into this benchmark environment. 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 large seller passes through a portion of 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.[12]

[11] 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.

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

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:

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

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

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

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

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

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

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

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 the buyer's (exogenous) outside option. We assume that agents with access to foreign markets can borrow and save at the rate r^* that satisfies $\beta(1 + r^*) = 1$, while agents with only access to the domestic financial market can borrow at a rate $r > r^*$ and save at a rate $\underline{r} < r^*$. Thus, no agent in this economy has incentives to save.

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 ensuring repayment.[13] Constraint (6) captures the degree of financial

[13] 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 higher.

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 straightforward to see that constraint (4) will never bind as long as $\Gamma > 0$. Finally, in Appendix A.1, we show that constraint (5) never binds because the seller makes a take-it-or-leave-it-offer and extracts all surplus from the buyer, so she drives the buyer to her borrowing limit before reaching her repayment constraint.

The solution then consists of two cases, one in which constraint (6) is slack and the other when it is binding. We describe these two cases below.

3.1.1 Unconstrained Borrowing and Scale

Assuming that constraints (5) and (6) 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:

$$D_{s,1} = \frac{\beta p - (1+r)w}{2\psi\beta p} > 0 \quad \text{if } 1 > \beta > \beta_1 \equiv \frac{(1+r)w}{p} \tag{7}$$

$$L_1 = \frac{D_{s,1} - \psi D_{s,1}^2}{w} \tag{8}$$

$$D_{b,1} = \frac{pL_1 - \frac{\Gamma}{\beta}}{1+r} \qquad \text{if } \beta_2 \equiv \beta_1(1+2\beta_1) \geq \beta > 0. \tag{9}$$

The lower bound on the parameter β ensures that the seller's optimal choice of debt is positive. The upper bound, in turn, ensures that the buyer's optimal choice of debt is feasible (i.e. it doesn't not violate constraint (6)). Hence, this case occurs when $\beta \in (\beta_1, \beta_2]$. Naturally, as borrowing becomes more expensive for the seller (higher ψ), debt and production decrease.

3.1.2 Constrained Borrowing and Scale

When constraint (6) binds, $D_{b,2}$ and L_2 are determined from the buyer's borrowing and participation constraints, which yield:

$$D_{b,2} = \bar{D} \quad \text{if } 1 > \beta > \beta_2$$
$$L_2 = \frac{\bar{D}(1+r) + \frac{\Gamma}{\beta}}{p}$$

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 a positive debt level is:

$$D_{s,2} = \frac{1}{2\psi} - \frac{\sqrt{1 - 4\psi\left(\frac{w\Gamma}{\beta p} + \frac{w\bar{D}(1+r)}{p}\right)}}{2\psi} \quad \text{if } \psi < \psi_2 \equiv \frac{1}{4\left(\frac{w\Gamma}{\beta p}\right) + \bar{D}\beta_1}$$

Note that the maximum debt level is given by $\frac{1}{2\psi}$. More importantly, note that, the seller needs to have high enough debt capacity in order for this equilibrium to exist; namely, the parameter that governs her borrowing cost, ψ, needs to be low enough. This parameter restriction effectively imposes a borrowing constraint on the seller, and drives borrowing by both agents to zero. Debt raised and production scale are lower compared to the unconstrained scenario above, which is intuitive, so we relegate the proof to Appendix A.1.

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 seller makes a take-it-or-leave-it offer to the buyer, which solves the following program:

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

$$D_b - T + \beta[pL - D_b(1+r) - \tilde{T}'] - \Gamma \geq 0 \tag{10}$$

$$D_b - T \geq 0 \tag{11}$$

$$D_s + T - \psi D_s^2 - wL \geq 0 \tag{12}$$

$$T_h' - D_s(1+r^*)e_h \geq 0 \tag{13}$$

$$T_l' - D_s(1+r^*)e_l \geq 0 \tag{14}$$

$$pL - D_b(1+r) \geq {T_h}' \tag{15}$$

$$\bar{D} \geq D_b \tag{16}$$

$$T_h' \geq {T_l}', \tag{17}$$

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 trade credit to the seller. As described above, ${T_l}'$ (T_h') denotes the payment that the buyer makes to the seller in the second period if the exchange rate realization is e_l (e_h), and $\tilde{T}' \equiv p_h {T_h}' + (1-p_h){T_l}'$. Hence, trade credit is state-contingent. 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 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 the two states of the world governed by the realization of the exchange rate. Expression (15) 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 (13) and (15) must bind jointly as, otherwise, either agent can relieve her trade partner if she has slack when repaying debt. Finally, in Appendix A.2, we show that expression (14) which corresponds to the repayment constraint for the seller in the good state of the world never binds.

In a nutshell, 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 in the poor state of the world. We describe each in turn below.

3.2.1 Unconstrained Seller and Zero XR 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:

$$D_s^{TC} = \frac{\beta p - w}{2\psi\beta p} \quad \text{if } \; 1 > \beta > \beta_3 \equiv \frac{w}{p} \tag{18}$$

$$L^{TC} = \frac{D_s^{TC} - \psi\left(D_s^{TC}\right)^2 + D_b^{TC}}{w}. \tag{19}$$

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 (10) 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 (17) 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:

$$\tilde{T}^{TC'} = pL^{TC} - D_b^{TC}(1+r) - \Gamma/\beta \tag{20}$$

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:

$$D_b^{TC} = \begin{cases} \bar{D} & \text{if } 1 \geq \beta_1 \\ 0 & \text{if } 1 < \beta_1 \end{cases} \tag{21}$$

Three observations are in order. First, there exists an equilibrium in which the buyer does not raise any debt, but production still occurs and is entirely financed by the seller, since the parameter restrictions that support this solution, $1 < \beta_1 \equiv \frac{w(1+r)}{p}$ and $1 > \beta > \beta_3 \equiv \frac{w}{p}$, can occur jointly. This can only occur because the seller has high debt capacity and can cover all costs of production.

Second, the model with trade credit always yields higher debt for the seller–compare expressions (18) and (7)–and higher production scale (see Appendix A.2). Moreover, expression (20) is increasing in labor, which confirms that trade credit extended by the seller rises as production and debt increase. Therefore, trade credit provision loosens financial constraints and improves scale. Third, since the seller's profit constitutes her objective function, it must be that profits increase with debt raised by the seller (up to the optimal amount of debt). We summarize these results below.

Testable Prediction 1. Financially unconstrained firms raise more debt, have higher scale and higher profits, and extend more trade credit.

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

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

Because the second-period transfer, $\tilde{T}^{TC'}$, 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 and unconstrained seller insulates the 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 and Positive XR Risk Pass-Through

To characterize the seller's debt, combine constraints (13), (15), and (12) to obtain a quadratic equation in D_s, for a given D_b. In this case, the buyer's debt satisfies:

$$D_b^C = \bar{D} \quad \text{if } \ 1 \geq \beta_1,$$

and the seller's debt is given by:

$$D_s^C = \frac{1}{2\psi}\left[\frac{w(1+r^*)e_h}{p} - 1 + \sqrt{\left(1 - \frac{w(1+r^*)e_h}{p}\right)^2 + 4\psi\left(1 - \frac{w(1+r)}{p}\right)\bar{D}}\right], \qquad (22)$$

where the C superscript denotes a constrained solution. In contrast to the case in which the seller is unconstrained, an equilibrium in which the buyer does not raise any debt is no longer supported. As it is clear from expression (22), when the buyer's debt is zero, the seller's debt also collapses to zero. This result follows from the fact that, in this equilibrium, the seller does not have a large enough capacity to finance all production. To see this, substitute the unconstrained seller debt from expression (18) and trade credit from expression (20) into the seller's repayment constraint (13) to obtain the following parameter restriction, which ensures that D_s^{TC} violates the seller's repayment constraint:

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

When the parameter that regulates the seller's borrowing cost, ψ, is high enough, the seller's repayment constraint is binding, and the equilibrium is the constrained one—an intuitive result. In Appendix A.2, we show that debt raised, trade credit extended and production scale are lower in this constrained equilibrium compared to the scenario in which the seller is not financially constrained. More interestingly, when the seller is constrained, the second-period transfers are state-contingent and pinned down, together with the production scale, from constraints (10), (13) and (15), and they satisfy:

$$T_h^{C'} = D_s^C(1+r^*)e_h \tag{23}$$

$$T_l^{C'} = T_h^{C'} - \frac{\Gamma}{\beta(1-p_h)} \tag{24}$$

$$L^C = \frac{T_h^{C'} + \bar{D}(1+r)}{p}.$$

In this case, the seller's accounts receivable are a function of the exchange rate, so the seller passes through part of the exchange rate shock. What is the magnitude of this pass-through? We can evaluate the deviation in trade credit from its mean, $\tilde{T}^{C'} \equiv p_h T_h^{C'} + (1-p_h)T_l^{C'}$, due to a deviation in the exchange rate from its respective mean, $\tilde{e}'$. Without loss of generality, focusing on the poor state of the world, the magnitude is given by:

$$\frac{T_h^{C'} - \tilde{T}^{C'}}{e_h - 1} = \frac{\Gamma}{\beta(1-p_h)(e_h-e_l)} > 0$$

Economies in which the likelihood of a depreciation (p_h) is higher and the exchange rate is more volatile (i.e. larger spread around the mean) are characterized by higher degree of exchange rate pass-through via trade credit. This is an intuitive result because, in such economies, firms that borrow in foreign currency take on more risk and are more financially distressed, so they pass-through more exchange rate shocks along the supply chain. We summarize these results below.

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 accounts receivable.

Discussion and interpretation of results. 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, 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.

What types of firms are likely to fall within the above category? From the point of view of the model, it is firms that face a high borrowing cost, ψ. These firms are perceived as riskier borrowers by international lenders, and they face higher interest rates on their FX debt. Firms with large FX mismatches in their balance sheets also fall within this category. For example, exporters in emerging markets, who are also typically importers, have a natural hedge, since they have assets and liabilities denominated in FX, so they do not fall within this category. But, firms that are solely importing inputs and need to borrow in FX to pay for them are likely to be much more exposed to FX risk. In the next section, we test the model's predictions by exploiting differences in firm-level balance sheet exposures to XR risk.

4 Empirical Analysis

In this section, we test the two key predictions using the firm-level data from Capital IQ that we describe in Section 2.

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

To test this prediction, we run the following regression:

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

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 receivable).

In the model, debt, profits and sales all reflect the degree to which a firm is financially constrained, which is a function of the cost parameter, ψ. 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.[14]

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, country-sector-time fixed effects also absorb any common shocks for firms in each industry-country group. We present specifications with different levels of fixed effects, including one with firm fixed effects, to examine changes within a firm over time.

For reference, recall that, 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

[14] 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.

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 concerns, in Table 6 we repeat the exercise from above, 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").[15] 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.

[15] 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 (i.e. enough export revenue to be a meaningful hedge to FX debt), and non-exporters otherwise.

Table 5: Trade Credit Lending and Bank Debt

	(1)	(2)	(3)	(4)	(5)	(6)
Short-Term Debt$_{it}$	0.0926***	0.0760***	0.0727***	0.0735***	0.0669***	0.0346***
	(0.00453)	(0.00368)	(0.00350)	(0.00359)	(0.00312)	(0.00246)
Profit$_{it}$	0.315***	0.310***	0.303***	0.305***	0.267***	0.0875***
	(0.0165)	(0.0139)	(0.0138)	(0.0141)	(0.0166)	(0.00879)
Sales$_{it}$	0.114***	0.147***	0.157***	0.159***	0.155***	0.142***
	(0.00575)	(0.00481)	(0.00458)	(0.00465)	(0.00520)	(0.00513)
Low IR$_i$					0.00571***	
					(0.000675)	
Accounts Payable$_{it}$	0.522***	0.480***	0.447***	0.447***	0.454***	0.264***
	(0.0128)	(0.0109)	(0.0102)	(0.0102)	(0.0105)	(0.00674)
Cash$_{it}$	-0.0720***	-0.0933***	-0.104***	-0.104***	-0.0901***	-0.125***
	(0.00319)	(0.00256)	(0.00252)	(0.00254)	(0.00324)	(0.00304)
Inventory$_{it}$	-0.0723***	-0.0577***	-0.0497***	-0.0504***	-0.0472***	-0.0430***
	(0.00682)	(0.00622)	(0.00484)	(0.00496)	(0.00496)	(0.00360)
Size$_{it}$	-0.0156***	-0.0122***	-0.0125***	-0.0126***	-0.0131***	-0.0113***
	(0.000255)	(0.000250)	(0.000238)	(0.000244)	(0.000261)	(0.000698)
Observations	158117	158117	158094	157155	133061	156307
R^2	0.300	0.271	0.263	0.265	0.265	0.155
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

Sample splans 2006q1-2021q1. 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=1 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. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

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

	(1) Exporters	(2) Non-Exporters	(3) Net TC Lenders	(4) Net TC Borrowers
Short-Term Debt$_{it}$	0.0530***	0.0801***	0.0924***	0.00972***
	(0.00426)	(0.00398)	(0.00415)	(0.00354)
Profit$_{it}$	0.220***	0.331***	0.236***	0.0927***
	(0.0218)	(0.0155)	(0.0134)	(0.0117)
Sales$_{it}$	0.189***	0.154***	0.173***	0.0637***
	(0.00759)	(0.00499)	(0.00456)	(0.00451)
Accounts Payable$_{it}$	0.431***	0.446***	0.711***	0.336***
	(0.0109)	(0.0118)	(0.00811)	(0.00997)
Cash$_{it}$	-0.0728***	-0.112***	-0.0836***	-0.0565***
	(0.00619)	(0.00306)	(0.00260)	(0.00364)
Inventory$_{it}$	-0.0379***	-0.0518***	-0.0388***	-0.0161***
	(0.00523)	(0.00630)	(0.00425)	(0.00439)
Size$_{it}$	-0.0112***	-0.0129***	-0.0124***	-0.00296***
	(0.000458)	(0.000290)	(0.000236)	(0.000271)
Observations	40639	114643	127063	28247
R^2	0.284	0.256	0.376	0.349
CountryIndustryTimeFE	Yes	Yes	Yes	Yes

Sample spans 2006q1-2021q1. 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=1 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. Firm is classified as exporter if foreign revenue/total revenue $>$ 20% on average, and non-exporter otherwise. Firm is classified as net trade credit seller if on average accounts receivable $>$ accounts payable, and net trade credit buyer 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 raise less debt and provide less trade credit. In the event of an exchange rate depreciation, these more exposed firms experience sharper reductions in their debt and 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.[16] 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 borrowing in FX, we estimate the following empirical model:

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

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 the

[16] 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.

terms of payment and demand more upfront payment. And last, we examine Accounts Receivable/Assets to see how firms adjust the volume of accounts receivable (or trade credit extended) 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. From the theory, we expect a negative γ_1 for accounts receivable for non-exporting firms (that should be more exposed to the shock), as firms that take FX risk tend to moderate their trade credit lending generally. For γ_2 we expect negative coefficients for non-exporters on their profits, reflecting the shock to their balance sheets. We expect the coefficient for accounts receivable to be negative, but the magnitude (i.e. the degree of pass through) is of particular interest. For exporters, we expect γ_2 to be largely insignificant due to their natural hedges, though one might see a negative coefficient if that hedge is imperfect.

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. The controls are all normalized by assets (except log assets).

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 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).

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 receivables 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. See Table B1 in the appendix for reporting of these coefficients. 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. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

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. Consider a scenario of a 10% depreciation of the local currency and a non-exporting firm with a $FXExposure$ that is 17% of assets (90th percentile - see Table 1).[17] This firm would see quarterly profits decline by about 0.4% of assets compared to an unexposed firm ($0.17 \times 0.1 \times$-0.228 = 0.388%). This is sizeable compared to the median quarterly profit of 0.8% of assets (a 50% drop) or average profit of 0.4% (profits that quarter are wiped out). 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 as above (10% depreciation with 17% $FXExposure$), 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 trade-off between the two types of short-term assets.

Overall, the 1% decline in trade credit for our non-exporter with 90th percentile $FXExposure$ is significantly smaller in proportion than its 50% or more decline in profits (as benchmarked in the previous paragraph). This suggests that while exposed firms do pass through the shock, they are absorbing most of the hit and do not proportionally adjust their trade credit, consistent with the insurance mechanism outlined in the model.

Consistent with their natural hedge, exposed exporters see a much smaller drop in their profits relative to non-exporters (compare the coefficient estimates in the first row of column (1) and (5) in Table 7). If anything, exporters might increase the share of sales made on

[17]Note this figure is similar for both exporters and non-exporters.

credit, although the coefficient is not precisely estimated. This could reflect the natural hedge of exporters, which receive revenues in foreign currency. The exporters that are most likely to benefit long-term from a depreciation likely also have higher $FXExposure$. 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 8: Non-exporters' Debt and Trade Credit Adjustments

	Debt/Assets			AR/Assets	
	(1) All	(2) Net TC Lenders	(3) Net TC Borrowers	(4) Net TC Lenders	(5) Net TC Borrowers
FX Exposure$_{it-1}$ × XR Depr$_t$	-0.0303	-0.158**	0.386	-0.104**	-0.121
	(0.0774)	(0.0725)	(0.275)	(0.0488)	(0.0875)
FX Exposure$_{it-1}$	0.00593	0.00879	-0.0270	-0.00447	-0.00646
	(0.00873)	(0.0100)	(0.0239)	(0.00545)	(0.00694)
Observations	70511	54678	13730	55887	13808
R^2	0.737	0.748	0.693	0.0862	0.0517
CountryIndustryTimeFE	Yes	Yes	Yes	Yes	Yes
FirmFE	Yes	Yes	Yes	Yes	Yes
FirmControls	Yes	Yes	Yes	Yes	Yes

Sample spans 2006q1-2021q1. Sample is only non-exporters. Exporters are defined as having foreign revenue/total revenue > 20%, otherwise firms are non-exporters. Firm is classified as net trade credit lender if on average accounts receivable > accounts payable, and net trade credit borrower otherwise. Dependent variable in columns 1-3 is the ratio of debt (bond + bank) to assets, winsorized at 1%; in columns 4-5 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. See Table B2 for reporting of these coefficients. R^2 is within R^2. Errors are clustered at the industry-date level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Our second testable prediction indicates that constrained firms would be less able to access finance. Table 8 places debt (bank+bond) as the dependent variable for non-exporting firms, where we expect $\gamma_2 < 0$. Column (1) reveals a negative coefficient as expected, though not significant. But as we narrow the sample firms to our net trade credit lenders (matching the firms of interest in our model), the coefficient becomes larger and statistically significant. Columns (4) and (5) show the split for accounts receivable into net trade credit lenders and borrowers. Here, both groups have a negative coefficient, but that of the trade credit lender group is statistically significant.

Overall, the empirical results in this section suggest that firms that are more exposed to exchange rate 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. However, they do not pass through the shock proportionally, protecting their trading partners to some degree.

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 (average $FXExposure = 13\%$ for firms in our sample at end-2019). Considering a 10% depreciation event, we multiply this by the $FXExposure$ of each firm in our sample for Peru and by our estimated coefficients in columns 4 (for non-exporters) and 8 (for exporters) of Table 7. This gives us the total impact of the exchange rate shock (due to currency mismatch) for these firms. This exercise suggests the aggregate accounts receivable of these firms would fall by 1% in this case. The relatively mild aggregate impact highlights that the insurance mechanism illustrated in our model is meaningful, as firms tend to pass on a very small portion of the shock. Nevertheless, more exposed firms do pass on the shock to a greater degree.

Our findings have several implications. First, it is important to note that our analysis overlooks the distributional impact on the firms that receive trade credit, many of whom are small firms out of our data sample. If the decline in trade credit is concentrated, this could result in serious disruptions in the affected sectors. Second, if FX exposure rises broadly in an economy, a given exchange rate shock would result in a larger drop in trade credit. Third, the limited shock transmission is likely linked to the continued (if constrained) access to bank credit for these firms. Should a banking crisis accompany the sharp exchange rate depreciation (the so-called "twin crises", see Kaminsky and Reinhart (1999)), then even the large firms (including exporters) would be credit constrained and severely hampered by their balance sheet shock (Kalemli-Özcan et al., 2016). For instance, if firms passed through the shock proportionally (i.e. matching the 30-40% decline in profits), the impact on trade credit would be roughly a 30-40% decline, a massive shock. Authorities should carefully monitor the FX exposure and distress of firms in the economy, as the shock could turn into a catalyst if too many firms are constrained and if the bank credit supporting the trade credit lenders dries up.

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? How do these risks play out during a banking crisis? Authorities would benefit from greater monitoring of the FX mismatches of non-financial corporates and their health, in addition to that of banks.

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A Proofs and Derivations

A.1 Model Without Trade Credit

Constrained versus unconstrained borrowing and scale. To see that constrained borrowing and scale and lower than their unconstrained counterparts, note that, if constraint (6) binds, it must be that $D_{b,1}$ is not feasible, otherwise it would have been chosen; hence $\bar{D} < D_{b,1}$. Constraint (1) then implies that production must decline if the seller wants to continue to extract all the surplus from the buyer; thus $L_2 < L_1$. It follows from constraint (3) that the same ordering is true for debt levels, $D_{s,2} < D_{s,1}$, since D_s is a decreasing function of L as long as debt is below the maximum admissible level, $\frac{1}{2\psi}$.

Ruling out equilibria where constraint (5) binds. Why does constraint (5) never bind in equilibrium? The intuitive answer is because the seller, who makes a take-it-or-leave-it-offer, extracts all surplus from the buyer and drives the buyer to her borrowing limit first. To see this, suppose constraint (5) binds and (6) does not. In that case, the buyer can borrow a little bit more, which would relax constraint (5) and raise production. But, these marginal increases must respect the buyer's participation constraint, (1). Substituting the binding constraints (2), (3) and (5) into constraint (1) allows us to rewrite constraint (1) as follows:

$$\left(\frac{p}{w} - (1+r)(1+r^*)e_h\right) D_s - \frac{p}{w}\psi D_s^2 - \frac{\Gamma}{\beta} \geq 0$$

The quadratic formula yields two solutions for D_s:

$$D_s = \frac{\frac{p}{w} - (1+r)(1+r^*)e_h \pm \sqrt{\left(\frac{p}{w} - (1+r)(1+r^*)e_h\right)^2 - 4\psi\frac{p\Gamma}{w\beta}}}{2\psi\frac{p}{w}}$$

Let $x \equiv \frac{p}{w} - (1+r)(1+r^*)e_h$ and $y = 4\psi\frac{p\Gamma}{w\beta}$. If $x > 0$, then both roots are positive, and constraint (1) is slack. The seller will continue to raise debt and production until the buyer reaches the borrowing limit given by constraint (6). Hence, the equilibrium corresponds to the constrained scenario described in the main text. If $x < 0$, a real root does exist. Hence constraint (5) can never bind.

A.2 Model With Trade Credit

Borrowing and scale with and without trade credit. As described in the main text, comparing the unconstrained solution with trade credit in expression (18) to the unconstrained solution without trade credit in expression (7), it is clear that the seller raises more debt when she extends trade credit. Production scale is increasing in the amount of debt raised by the seller, since the derivative with respect to seller debt of expression (19) (or similarly, expression (8)) is positive for any debt level below the maximum level of $1/(2\psi)$. It then follows that the production scale is higher when there is trade credit, since the value in expression (19) exceeds the value in expression (8) for any level of debt raised by the buyer. Finally, when the buyer's constraint is binding in the model without trade credit, debt and production are constrained below the unconstrained optimum, so it follows immediately that the model with trade credit yields higher levels of debt and production in this case.

Ruling out equilibria where constraint (14) binds. Why does constraint (14) never bind in equilibrium? To see this, assume that constraints (10), (11), and (12) are binding, and suppose that (14) is binding. Then, the seller can increase both D_s and T_l' to raise her profits. To ensure that constraint (10) is not violated, $T_h^{'}$ should be decreased. This process can be repeated until constraint (13) binds. Substituting constraints (14) and (13) 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 (13) binds, then this solution corresponds to the unconstrained case described in the main text. Thus, constraint (14) cannot bind.

Constrained versus unconstrained borrowing and scale in the presence of trade credit. As described in the main text, the constrained solution arises when the repayment constraints in the poor state of the world are binding. If constraints (13) and (15) bind, it must be that D_S^{TC} is not feasible, otherwise it would have been chosen; hence $D_S^{TC} > D_S^C$. Both, $\tilde{T}^{TC'}$ and $\tilde{T}^{C'}$ are recovered from constraint (10), and L^{TC} and L^C follow from constraint (12). From constraint (10), $\tilde{T}^{'}$ is increasing in L, and because $D_s < \frac{1}{2\psi}$ in all cases, constraint (12) implies that 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. Indeed, the seller raises more debt when unconstrained, as this is the optimum amount.

B Additional Empirical Results

The two tables below include estimated coefficients for all variables included in the specifications that test Prediction 2 of the model.

Table B1: 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**	0.160	0.0378	-0.0358
	(0.0401)	(0.233)	(0.0526)	(0.0440)	(0.0341)	(0.209)	(0.0482)	(0.0358)
FX Exposure$_{it-1}$	0.00527	-0.00314	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)
Profit$_{it-1}$	0.121***	-0.0397	0.0911***	0.0531***	0.123***	0.0447	0.140***	0.109***
	(0.0118)	(0.0507)	(0.0132)	(0.0126)	(0.0212)	(0.0888)	(0.0278)	(0.0267)
AP$_{it-1}$	-0.000840	0.125***	0.000741	0.162***	-0.0114	0.165**	-0.136***	0.245***
	(0.00522)	(0.0446)	(0.00966)	(0.0113)	(0.00917)	(0.0785)	(0.0163)	(0.0260)
ST Liab$_{it-1}$	-0.00364	0.112***	-0.000160	0.0384***	0.00275	0.188***	0.0750***	0.0706***
	(0.00398)	(0.0184)	(0.00449)	(0.00437)	(0.00633)	(0.0429)	(0.00810)	(0.00704)
Bank Debt$_{it-1}$	-0.00966***	0.0313	-0.0189***	-0.0252***	-0.00861	0.204***	-0.0859***	0.0188**
	(0.00301)	(0.0198)	(0.00564)	(0.00481)	(0.00658)	(0.0431)	(0.0115)	(0.00877)
Bond Debt$_{it-1}$	-0.00240	0.00780	0.0276***	-0.0215***	-0.00809	0.0756	-0.0499***	0.0169
	(0.00417)	(0.0296)	(0.00797)	(0.00713)	(0.00928)	(0.0691)	(0.0147)	(0.0120)
Equity$_{it-1}$	0.0162	0.0962*	-0.0735***	-0.0118	0.0300	0.417***	-0.135***	0.0454*
	(0.0121)	(0.0525)	(0.0130)	(0.0135)	(0.0186)	(0.0884)	(0.0238)	(0.0266)
Liabilities$_{it-1}$	0.00770	0.0130	-0.118***	-0.0206	0.0204	0.168*	-0.222***	-0.0269
	(0.0127)	(0.0583)	(0.0145)	(0.0137)	(0.0164)	(0.0955)	(0.0243)	(0.0215)
Size$_{it-1}$	0.00144*	-0.00348	-0.0205***	-0.0165***	-0.00102	0.0194*	-0.00910***	-0.00515*
	(0.000744)	(0.00646)	(0.00128)	(0.00130)	(0.00184)	(0.00991)	(0.00256)	(0.00280)
Sales$_{it-1}$	0.0197***	-0.641***	0.0154***	0.0856***	0.0338***	-0.557***	0.0154*	0.112***
	(0.00256)	(0.0278)	(0.00513)	(0.00474)	(0.00527)	(0.0450)	(0.00827)	(0.00991)
Profit$_{it-1}$ × XR Depr$_t$	0.0157	0.848	0.0834	0.0615	0.708	0.489	-0.163	-0.362
	(0.158)	(0.655)	(0.180)	(0.172)	(0.498)	(1.625)	(0.442)	(0.455)
AP$_{it-1}$ × XR Depr$_t$	-0.00574	-0.540*	0.0536	-0.0560	0.0946	-2.205***	-0.0474	-0.199
	(0.0425)	(0.279)	(0.0839)	(0.0720)	(0.100)	(0.754)	(0.182)	(0.229)
ST Liab$_{it-1}$ × XR Depr$_t$	0.0687	0.00865	0.0486	0.0135	-0.351***	0.0948	-0.128*	0.0537
	(0.0458)	(0.183)	(0.0566)	(0.0370)	(0.105)	(0.377)	(0.0654)	(0.0851)
Bank Debt$_{it-1}$ × XR Depr$_t$	-0.0216	-0.0786	0.0248	0.000892	0.0961	-0.0229	-0.0387	-0.0575
	(0.0296)	(0.177)	(0.0437)	(0.0352)	(0.0977)	(0.490)	(0.169)	(0.105)
Bond Debt$_{it-1}$ × XR Depr$_t$	0.0345	-0.137	-0.114**	-0.00250	-0.122	-0.255	-0.0713	0.102
	(0.0346)	(0.248)	(0.0556)	(0.0525)	(0.135)	(0.819)	(0.219)	(0.160)
Equity$_{it-1}$ × XR Depr$_t$	-0.0883	-0.420	-0.197*	0.0124	0.192	-0.385	-0.413	0.316
	(0.0890)	(0.569)	(0.101)	(0.0913)	(0.212)	(1.279)	(0.317)	(0.333)
Liabilities$_{it-1}$ × XR Depr$_t$	-0.173*	-0.362	-0.239**	0.0566	0.168	-0.454	-0.231	0.271
	(0.101)	(0.601)	(0.118)	(0.101)	(0.192)	(1.327)	(0.300)	(0.298)
Size$_{it-1}$ × XR Depr$_t$	-0.00438**	-0.00380	0.00105	-0.000884	-0.00795	0.0193	-0.0134	0.00382
	(0.00212)	(0.0140)	(0.00532)	(0.00341)	(0.00508)	(0.0370)	(0.00851)	(0.00699)
Sales$_{it-1}$ × XR Depr$_t$	0.00296	0.440***	-0.0820*	0.0563	0.0860**	1.098**	0.114	0.0173
	(0.0260)	(0.144)	(0.0432)	(0.0377)	(0.0423)	(0.449)	(0.0888)	(0.0840)
Observations	72407	69837	61114	71772	19299	18973	17577	19355
R^2	0.0372	0.0304	0.0320	0.0710	0.0579	0.0345	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 receivables 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 (AP), short-term (ST) 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. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table B2: Non-exporters' Debt and Trade Credit Adjustments

	Debt/Assets			AR/Assets	
	(1)	(2)	(3)	(4)	(5)
	All	Net TC Lenders	Net TC Borrowers	Net TC Lenders	Net TC Borrowers
FX Exposure$_{it-1}$ × XR Depr$_t$	-0.0303	-0.158**	0.386	-0.104**	-0.121
	(0.0774)	(0.0725)	(0.275)	(0.0488)	(0.0875)
FX Exposure$_{it-1}$	0.00593	0.00879	-0.0270	-0.00447	-0.00646
	(0.00873)	(0.0100)	(0.0239)	(0.00545)	(0.00694)
Profit$_{it-1}$	-0.0592***	-0.0582***	-0.0752*	0.0584***	0.0109
	(0.0186)	(0.0214)	(0.0390)	(0.0158)	(0.0168)
AP$_{it-1}$	-0.0156	-0.0175	0.0114	0.229***	0.0701***
	(0.0120)	(0.0151)	(0.0217)	(0.0148)	(0.0133)
ST Liab$_{it-1}$	0.0101	0.0189**	-0.00571	0.0475***	0.00746
	(0.00701)	(0.00867)	(0.0130)	(0.00563)	(0.00518)
Bank Debt$_{it-1}$	0.886***	0.888***	0.886***	-0.0261***	-0.0111
	(0.0119)	(0.0141)	(0.0227)	(0.00574)	(0.00724)
Bond Debt$_{it-1}$	0.904***	0.891***	0.939***	-0.0267***	-0.0181**
	(0.0150)	(0.0166)	(0.0361)	(0.00881)	(0.00796)
Equity$_{it-1}$	-0.0903***	-0.110***	-0.0610	-0.0180	-0.00236
	(0.0229)	(0.0282)	(0.0417)	(0.0178)	(0.0119)
Liabilities$_{it-1}$	-0.0392	-0.0627**	-0.00851	-0.0282	-0.0155
	(0.0248)	(0.0300)	(0.0471)	(0.0182)	(0.0140)
Size$_{it-1}$	0.00279	0.00313	0.00730	-0.0192***	-0.00162
	(0.00232)	(0.00240)	(0.00828)	(0.00145)	(0.00176)
Sales$_{it-1}$	-0.00745	-0.00958	0.000503	0.0969***	0.0663***
	(0.00760)	(0.00969)	(0.0132)	(0.00597)	(0.00659)
Profit$_{it-1}$ × XR Depr$_t$	0.0471	0.0164	-0.240	0.0998	0.251
	(0.225)	(0.268)	(0.337)	(0.223)	(0.246)
AP$_{it-1}$ × XR Depr$_t$	0.0406	0.167	-0.269**	0.0323	-0.0538
	(0.0953)	(0.127)	(0.136)	(0.104)	(0.111)
ST Liab$_{it-1}$× XR Depr$_t$	-0.0989	-0.229**	0.169**	0.0335	-0.0104
	(0.0812)	(0.112)	(0.0677)	(0.0586)	(0.0439)
Bank Debt$_{it-1}$ × XR Depr$_t$	0.317***	0.367***	0.0869	-0.0236	0.0685
	(0.103)	(0.131)	(0.178)	(0.0442)	(0.0683)
Bond Debt$_{it-1}$× XR Depr$_t$	0.318***	0.356***	0.174	-0.0428	-0.0541
	(0.0973)	(0.127)	(0.195)	(0.0659)	(0.0806)
Equity$_{it-1}$ × XR Depr$_t$	0.279	0.151	0.653**	-0.0217	-0.108
	(0.174)	(0.209)	(0.265)	(0.111)	(0.149)
Liabilities$_{it-1}$ × XR Depr$_t$	0.342*	0.233	0.630*	0.0410	-0.122
	(0.197)	(0.231)	(0.338)	(0.125)	(0.177)
Size$_{it-1}$ × XR Depr$_t$	0.0115**	0.00795*	0.0190	0.00116	-0.00294
	(0.00506)	(0.00477)	(0.0148)	(0.00402)	(0.00502)
Sales$_{it-1}$ × XR Depr$_t$	0.00749	0.0509	-0.0714	0.0267	0.0257
	(0.0373)	(0.0527)	(0.0811)	(0.0492)	(0.0606)
Observations	70511	54678	13730	55887	13808
R^2	0.737	0.748	0.693	0.0862	0.0517
CountryIndustryTimeFE	Yes	Yes	Yes	Yes	Yes
FirmFE	Yes	Yes	Yes	Yes	Yes
FirmControls	Yes	Yes	Yes	Yes	Yes

Sample spans 2006q1-2021q1. Sample is only non-exporters. Exporters are defined as having foreign revenue/total revenue > 20%, otherwise firms are non-exporters. Firms are classified as a net trade credit lender if on average accounts receivable > accounts payable, and net trade credit borrower otherwise. Dependent variable in columns 1-3 is the ratio of debt to assets, winsorized at 1%; in columns 4-5 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 (AP), short-term (ST) liabilities, bank debt, bond debt, equity, total liabilities, and sales. Log assets and its interaction with the depreciation rate are also included. R^2 is within R^2. Errors are clustered at the industry-date level. * p < 0.10, ** p < 0.05, ***