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JEL Classification: F31, G15, G21

Keywords: cross-border banking, Exchange Rates, credit risk, corporate loans

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December 17, 2019

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When firms borrow in foreign currency, exchange rate changes can affect their ability to repay the debt. Loan-level data from U.S. banks' regulatory filings show that a 10 percent depreciation of the local currency quarter-to-quarter increases the probability that a firm becomes past due on its loans by 37 basis points for firms with foreign currency debt relative to those with local currency debt. Because firms do not perfectly hedge, exchange rate risk of the borrowers translates into credit risk for banks. Firms are more likely to borrow in foreign currency if they have foreign income and if a UIP deviation makes foreign currency loans cheaper. The paper establishes additional facts on large U.S. banks' international corporate loan portfolios, offering a more comprehensive perspective than syndicated loan data.

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1 Introduction

Borrowing in foreign currency is a prevalent phenomenon, especially in emerging market economies, and has increased over the past decade as figure 1 highlights. While foreign currency loans can be cheaper than local currency loans, they can expose firms to exchange rate risk by creating a currency mismatch on their balance sheets. Financial markets offer instruments to hedge against this risk, but hedging is costly and firms often remain unhedged.[1] As a result, firms may be negatively affected when the local currency depreciates.

The literature has emphasized the potential for this so-called balance sheet channel to counter or even overturn the classic expenditure-switching effect through which devaluations positively affect the performance of domestic firms (Mundell (1968)) but empirical evidence remains relatively scarce, mainly because of a lack of data.[2] Understanding the strength of the balance sheet channel is crucial to policy makers, however, because they set policies that often directly or indirectly move the exchange rate.[3] Exploiting unique loan-level data from U.S. regulatory filings covering a large set of firms in 79 countries, this paper provides new evidence on the effect of exchange rate movements in the presence of foreign currency debt. Specifically, it analyzes how exchange rate changes affect firms' ability to service their debt depending on the currency in which they borrow.

We start by developing a parsimonious model of currency choice and default with four testable predictions: i) A local currency depreciation raises the default probability of a firm borrowing in foreign currency relative to a firm borrowing in local currency. ii) This effect is smaller if the firm borrowing in foreign currency has a natural hedge. Also, firms are more likely to borrow in foreign currency iii) if a larger share of their sales is in foreign currency and iv) if there is a UIP deviation that reduces borrowing costs in foreign currency.

To test these predictions, we employ regulatory filings of large U.S. banks that participate in the Federal Reserve's Comprehensive Capital Analysis and Review (CCAR). The so-called Y-14 reports contain detailed quarterly information on banks' corporate loans and leases to non-U.S. borrowers with a loan amount of at least $1 million. We observe the location and the rating of the borrower, the currency in which the loan is denominated, and whether and for how long a loan has been past due. Importantly, 83 percent of the loans in the dataset are not syndicated, meaning that the majority of loans in our dataset cannot be found in syndicated loan databases, which

[1] On the trade-offs involved in hedging, see, for example, Nance et al. (1993) and Géczy et al. (1997).

[2] Through the balance sheet channel, devaluations can be contractionary (Bebczuk et al. (2010) and Kohn et al. (2015)), cause or worsen currency crises (Aghion et al. (2001), Aghion et al. (2004), Ranciere et al. (2010)), create systemic risk (Dell'Ariccia et al. (2016) and Yesin (2013)), and magnify monetary policy spillovers (Akinci and Queralto (2018)). The potential for the balance sheet channel to dominate is high because, as recent work by Gopinath et al. (2016) and Bruno et al. (2018) shows, dominant currency pricing weakens the trade channel.

[3] Both monetary policy (Eichenbaum and Evans (1995) and Cushman and Zha (1997)) and fiscal policy (Kim and Roubini (2008) and Corsetti and Müller (2006)) move the exchange rate.

are often the data source of choice for cross-country loan-level studies.[4] The sample includes around 26,000 borrowers around the world and runs from 2014q4 to 2018q4, a period that covers both a substantial USD appreciation and a notable period of USD depreciation.

We start by testing the effect of exchange rate changes on the past due status of firms (testable prediction (i)). To isolate the balance sheet channel from the classic expenditure switching channel, we employ a difference-in-difference type approach, comparing outcomes for firms in the same country, industry, quarter, and with the same bank-internal risk rating that borrow in different currencies. The strategy therefore controls for exchange rate effects through other channels (for example, through changes in demand) that are common across firms within these narrowly defined buckets. In addition, we control for the size of loans and their maturities.

In line with the theory, a 10 percent depreciation of the local currency quarter-to-quarter increases the probability that a firm that borrowed in foreign currency becomes past due on its loans by 37 basis points relative to a firm that borrowed in local currency. This effect mainly stems from local currency depreciations and is stronger for firms in industries with a smaller share of foreign sales in line with testable prediction (ii). Since the baseline probability that a loan becomes past due is around 0.2 percent, the effect is economically meaningful.

It is also considerable given that our estimate constitutes a lower bound for the average treatment effect of borrowing in foreign currency under random assignment. As the theoretical model highlights, a firm's currency choice is not random but depends on the currency composition of its income. And while we compare firms in the same industry, country, and quarter and with the same bank-internal rating, loan size and maturity structure, these firms could still differ in their foreign income. We cannot control for this selection because of a lack of data, but selection implies that the estimated effects are biased towards zero because firms tend to borrow in the currency that offers a natural hedge: A firm with a revealed preference for local currency debt would be more exposed to exchange rate risk if it borrowed in foreign currency than a firm that actually decides to borrow in foreign currency.

While the previously stated results are based on quarterly changes in the exchange rate, we also investigate whether exchange rate changes since loan origination matter for the past due status of firms' loans. Indeed, a 20-percent decrease of the local currency from the date of origination until quarter $t-1$ increases the probability that a firm becomes past due on its loans in quarter t by 22 basis points for a firm that borrows in foreign currency relative to a firm that borrows in local currency.

Some firms that become past due on their loans will repay the loan the next period. For these firms, an exchange rate movement may merely create a liquidity problem, but we estimate

[4]For example, Delis et al. (2018) study whether the exchange rate risk banks bear when they lend to borrowers in the currency of the borrower is passed on to borrowers through higher loan spreads using syndicated loan data from Dealscan.

that around 16 percent of the loans that become past due end up in default. We conclude that firms that borrow in foreign currency remain notably exposed to exchange rate risk, and, that as a result, the effects of exchange rate movements on firm default through the balance sheet channel are economically significant.

The unique regulatory data also allow us to shed light on the factors that determine firms' currency choices. Foreign currency loans are larger and have shorter maturities than local currency loans. In line with the notion that firms choose their loan currency to match the currency composition of their income stream, firms in industries with a higher share of exports in total sales are more likely to borrow in foreign currency.[5] Similarly, firms are more likely to borrow in foreign currency the cheaper the foreign currency loan is relative to the local currency loan in line with testable prediction (iv).[6] On average, foreign currency loans have a 100 to 140 basis point lower interest rate. If we adjust interest rates for expected future changes in the exchange rate to obtain the UIP deviations, the difference shrinks to 40-65 basis points.

This paper contributes to the literature on foreign currency debt in several distinct ways. First, the paper documents the relevance of the balance sheet channel in normal times and across many countries, drawing on loan-level data with broad country coverage, which allows for a tight identification. Second, the paper is, to the best of our knowledge, the first paper that considers the past due status of loans as a measure of firm performance and, therefore, shows how exchange rate risk of the borrower translates into credit risk for banks. Third, the paper presents a model of endogenous loan currency choice and default in which firms vary in their foreign income to guide the empirical analysis. Fourth, the paper provides estimates of UIP deviations in U.S. bank loans and shows that firms' loan currency choices depend on the share of income generated abroad and the size of UIP deviations. Finally, the paper generates stylized facts on the international lending activities of the largest U.S. banks based on comprehensive loan-level data from regulatory filings, expanding our knowledge of this activity beyond previously employed data that only covered syndicated loans.

Related literature Early studies provide macro-level evidence on the balance sheet channel. For example, Edward (1986) finds short-term contractionary effects of devaluations, while Céspedes (2005) shows that devaluations have stronger negative effects on output for countries that are more indebted. In addition, Bebczuk et al. (2010) document that dollar debt can make devaluations contractionary.[7]

A growing number of studies employ micro-level data to analyze the effect of foreign cur-

[5]This is in line with empirical evidence that firms are more likely to have foreign currency debt when they have foreign income or foreign assets (for example, Brown et al. (2011), Bleakley and Cowan (2008), Kedia and Mozumdar (2003), and Keloharju and Niskanen (2001)).

[6]Varela and Salomao (2016) also find that UIP deviations increase the fraction of firms that borrow in foreign currency using Hungarian firm-level data. Similarly, Basso et al. (2011) find that interest rate differentials matter for foreign currency borrowing (and lending).

[7]In addition, see Kamin and Klau (1997).

rency debt on firm investment and employment, often in the aftermath of crises. Aguiar (2005) shows that firms in Mexico with heavy short-term foreign debt exposure had substantially lower investments after a large devaluation.[8] Along these lines, Kim et al. (2015) report that firms' economic performance declined and default rates increased more for firms with foreign currency debt during the 1997-1998 Korean crisis. In contrast, Bleakley and Cowan (2008) do not find such differential effects, using accounting data for five Latin American countries.[9] Analyzing Mexican firms' response to a large devaluation, Hardy (2018) finds that small firms invest less while large firms invest more. Kalemli-Ozcan et al. (2016) document adverse effects of devaluations on firm investment in the presence of foreign-denominated debt but only if there is a contemporaneous banking crisis.[10]

Several papers study the determinants of firms' currency choices (Brown et al. (2011), Bleakley and Cowan (2008), Kedia and Mozumdar (2003), and Keloharju and Niskanen (2001))).[11] Galindo et al. (2003) provides a survey on the determinants of debt currency denomination. In comprehensive work that is both theoretical and empirical, Varela and Salomao (2016) build a dynamic model of currency choice where heterogeneous firms face a tradeoff between exchange rate exposure and growth since cheaper foreign currency lending allows firms to grow faster.[12]

The link between exchange rate changes and credit risk has been emphasized by macroeconomic papers studying the causes of financial crises, but less so in the banking literature. Kim et al. (2016) study whether banks charge higher interest rates when the borrower is exposed to exchange rate risk. Božović et al. (2009) provide a model where exchange rate risk spills over into default risk, resulting in reduced credit supply and growth. Bruno and Shin (2015) focus on the implications of local currency depreciation for the credit risk of global banks, showing empirically that banks reduce their cross-border lending when the U.S. dollar appreciates.[13]

The remainder of the paper is structured as follows. Section 2 proposes a theoretical model of currency choice and default. Section 3 introduces the data sources and presents key facts about foreign currency loans in comparison to local currency loans. Section 4 presents the regression results. Section 5 concludes.

[8]Similarly, Carranza et al. (2003), Echeverry et al. (2003), Pratap et al. (2003), Cowan et al. (2005), and Cowan et al. (2006) find that firms with higher foreign debt contract investment more after devaluations.

[9]Several other papers do not find evidence for the balance channel, for example, Bernard et al. (2003), Bonomo et al. (2003), and Alvarez and Hansen (2017).

[10]Using bond data to identify firms' foreign currency exposures, Caballero (2018) finds that local currency depreciations lower firms' capital expenditures.

[11]For more recent studies, see Kamil (2012), Brown et al. (2014), Basso et al. (2011), and Keller (2018).

[12]In line with results in Varela and Salomao (2016), Kalemli-Ozcan et al. (2019) find that firms in countries with greater shares of FX debt in total debt reduce their leverage more than firms in countries with low FX debt when the local currency depreciates.

[13]For papers on banks' choices of lending currencies, see Ize and Yeyati (2003), Luca and Petrova (2008), and Brown and De Haas (2012a).

2 Theory

This section develops a parsimonious model of firm borrowing with endogenous currency choice. It derives four predictions regarding the effect of exchange rates on firm default and firms' optimal choices. First, a depreciation of the local currency weakly increases (decreases) the default probability of a firm that borrows in foreign (local) currency. Second, foreign currency income provides a natural hedge against this risk. Third, firms borrow in the currency in which they generate most of their income. Finally, if there is a deviation from uncovered interest parity (UIP), then firms borrow in the currency with the lower expected interest rate.

2.1 Basic Setup

Firm problem A firm borrows one unit of capital from a bank. It invests the capital in a project that delivers safe return $R > 1$. A fraction α of that return is generated in local currency and a fraction $1 - \alpha$ in foreign currency. The firm operates under limited liability, that is, the shareholders are residual claimants after bank loans are repaid but are not liable for any losses. The firm can choose the currency of its loan. Let $r > 1$ and $r^* > 1$ be the interest rates paid by a firm for a local and foreign currency loan, respectively.[14] Without loss of generality, normalize the exchange rate to 1 when the loan is issued. If a firm borrows in local currency, this implies the following profits in local currency:

$$\Pi^{LC} = \max\{0, (\alpha R - r) + s(1 - \alpha)R\}, \tag{1}$$

where the max operator reflects the fact that the firm operates under limited liability and cannot have negative profits. With a local currency loan and some foreign income ($\alpha < 1$), profits in local currency increase in the exchange rate s. Rearranging the equation, we can derive a minimum exchange rate that is required for a firm to be able to repay its loan:[15]

$$s \geq \frac{r - \alpha R}{(1 - \alpha)R} = \underline{s}. \tag{2}$$

Alternatively, a firm can borrow in foreign currency. Then, the firm's profits, expressed in local currency units, are given by:

$$\Pi^{FC} = \max\{0, \alpha R + s((1 - \alpha)R - r^*)\}. \tag{3}$$

[14] To simplify notation, r and r^* include the principal.

[15] Note that in the baseline model, the only reason for a firm to default is an unfavorable realization of the exchange rate. In appendix D, we show how the model can be generalized to include an additional shock to profits.

If foreign currency income is sufficiently small $\left(1-\alpha < \frac{r^*}{R}\right)$, profits in foreign currency decrease in the exchange rate s. In this case, a firm defaults on its loan for any value of the exchange rate s that is above $\bar{s}$:

$$s > \frac{\alpha R}{r^* - (1-\alpha)R} = \bar{s}. \tag{4}$$

Default risk and exchange rates For our empirical analysis, we want to understand how exchange rate changes affect default and how effects differ across firms that borrow in different currencies. The basic relationship between exchange rates and defaults is captured in the following proposition:

Proposition 1 (Loan default and exchange rates) *When the local currency depreciates (s increases), the probability that a firm defaults on its loan*

i) Decreases when the loan is in local currency and the firm has limited local currency income ($\alpha < \frac{r}{R}$).

ii) Increases when the loan is in foreign currency and the firm has limited foreign currency income ($1-\alpha < \frac{r^*}{R}$).

iii) Remains unchanged if

- *the loan is in local currency and the firm has sufficient local currency income ($\alpha \geq \frac{r}{R}$),*
- *or the loan is in foreign currency and the firm has sufficient foreign currency income ($1-\alpha \geq \frac{r^*}{R}$).*

Proof. *Follows directly from equations* (1) *and* (3). ■

The proposition states that the exchange rate affects credit risk if there is sufficient currency mismatch at the firm level, that is, if there are levels of the exchange rate at which a firm is unable to pay back its loans. This is the case if a firm borrows in local currency but does not have enough local income $\left(\alpha < \frac{r}{R}\right)$ or if a firm borrows in foreign currency without sufficient foreign income $\left(1-\alpha < \frac{r^*}{R}\right)$.

We are particularly interested in the relative default risk of two firms that borrow in local and foreign currency, respectively, and may generate different shares of their income in local currency (different α). Suppose firm A borrows in foreign currency with local currency income share α^{FC}. Firm B borrows in local currency and has local currency income share α^{LC}. We can then prove the following corollary.

Corollary 1 (Relative default) *Suppose there are two firms that borrow in local and foreign currency, respectively, generating fractions α^{LC} and α^{FC} of their total income at home. When the local currency depreciates:*

i) The default probability of the firm that borrows in foreign currency relative to the firm that borrows in domestic currency increases:

(a) If the firm borrowing in foreign currency faces default risk ($1-\alpha^{FC} < \frac{r^*}{R}$).

(b) If the firm borrowing in local currency faces default risk ($\alpha^{LC} < \frac{r}{R}$).

ii) The relative default probability remains unchanged if $1-\alpha^{FC} \geq \frac{r^*}{R}$ and $\alpha^{LC} \geq \frac{r}{R}$.

Proof. *Follows directly from Proposition 1.* ■

There are two cases. In the first case, a local depreciation increases the relative default risk of the firm that borrows in foreign currency. This happens if at least one of the firms faces exchange-rate related default risk ($1-\alpha^{FC} < \frac{r^*}{R}$ or $\alpha^{LC} < \frac{r}{R}$). In the second case, a local depreciation has no effect on default rates. Then, firms have sufficient income in the currency of their loan and do not face any exchange-rate related default risk.

Corollary 1 implies that independent of the shares of foreign income generated, α^{FC} and α^{LC}, the probability of default of a firm borrowing in foreign currency weakly increases relative to that of a firm borrowing in local currency when there is a local depreciation. If a firm borrowing in foreign currency has a larger share of income in foreign currency than a firm borrowing in local currency (that is, if they borrow in line with their natural hedge, which is the case as shown in section 2.2), then this relative effect becomes smaller and is either positive or zero but never negative.

Next we show how foreign currency income can serve as a natural hedge for a firm that borrows in foreign currency. Recall that a firm borrowing in foreign currency defaults whenever the exchange rate is above $\bar{s}$ while a firm borrowing in local currency defaults whenever the exchange rate falls below $\underline{s}$. Probabilities of default are therefore given by:

$$PD^{FC} = \int_{\bar{s}}^{\infty} f(s)ds, \qquad PD^{LC} = \int_{0}^{\underline{s}} f(s)ds \tag{5}$$

Now, taking taking the derivatives with respect to α delivers:

$$\frac{\partial PD^{FC}}{\partial \alpha} = -f(\bar{s})\frac{R(r^*-R)}{(r^*-(1-\alpha)R)^2} \geq 0, \qquad \frac{\partial PD^{LC}}{\partial \alpha} = f(\underline{s})\frac{R(r-R)}{((1-\alpha)R)^2} \leq 0. \tag{6}$$

Our findings on the natural hedge are summarized in the following proposition:

Proposition 2 (Natural Hedge) *A firm's probability of default*

i) Rises in the domestic sales share α^{FC} if the firm borrowed in foreign currency.

ii) Falls in the domestic sales share α^{LC} if the firm borrowed in domestic currency.

Proof. Follows directly from equation (6). ■

The proposition is quite intuitive. If more income is in the currency of the loan, this income provides a natural hedge and any swing in the exchange rate creates less default risk for the firm.

2.2 Optimal Currency Choice

We now turn to the optimal currency choice of the firm. A firm's expected profits when borrowing in the local currency are:

$$\mathrm{E}[\Pi^{LC}] = \int_{\underline{s}}^{\infty} \left[(\alpha R + s(1-\alpha)R) - r\right] f(s)ds. \tag{7}$$

Expected profits from borrowing in foreign currency are:

$$\mathrm{E}[\Pi^{FC}] = \int_{0}^{\bar{s}} \left[\alpha R + s((1-\alpha)R - r^*)\right] f(s)ds. \tag{8}$$

When is a foreign currency loan preferred over a local currency loan? To answer this question, we calculate the difference between expected profits from these two options:

$$\begin{aligned} \Delta\Pi &= \mathrm{E}[\Pi^{FC}] - \mathrm{E}[\Pi^{LC}] \\ &= \int_{0}^{\bar{s}} \left[\alpha R + s((1-\alpha)R - r^*)\right] f(s)ds - \int_{\underline{s}}^{\infty} \left[(\alpha R + s(1-\alpha)R - r)\right] f(s)ds. \end{aligned} \tag{9}$$

The choice crucially depends on the interest rates charged to the firms, r and r^*, which are endogenous objects that we derive next.

Bank problem The banking sector is perfectly competitive. Banks can borrow at the risk-free rates $i > 1$ and $i^* > 1$ in local and foreign currency, respectively. Banking markets for foreign and local currency are segmented, and banks cannot take on currency risk themselves; that is, for lending in foreign currency, they have to finance the exact loan amount at the foreign risk-free rate. If a firm defaults, a bank can recover a fraction $\gamma \in [0, 1]$ of the revenues. In addition, assume that the local risk-free rate differs form the foreign risk-free rate by a factor $\phi > 0$, so that $i = \phi s i^*$. Perfect competition implies that the bank's expected profits will be equal to the risk-free rate:

$$i = \int_{\underline{s}}^{\infty} r f(s)ds + \int_{0}^{\underline{s}} \gamma \left[\alpha R + s(1-\alpha)R\right] f(s)ds, \tag{10}$$

where the first integral reflects full repayment by the firm and the second integral captures the residual claim of the bank when the firm defaults. For a foreign currency loan, the bank needs

to recover the foreign risk-free rate. We can write the bank's expected profits from a foreign currency loan in local currency units as:

$$si^* = \int_0^{\bar{s}} sr^* f(s)ds + \int_{\bar{s}}^{\infty} \gamma \left[\alpha R + s(1-\alpha)R\right] f(s)ds. \tag{11}$$

Rewriting equation (10) and combining it with equation (11), noting that $i = \phi si^*$, we obtain:

$$\begin{aligned} \int_{\underline{s}}^{\infty} rf(s)ds &= \int_0^{\bar{s}} \phi sr^* f(s)ds + \int_{\bar{s}}^{\infty} \phi\gamma \left[\alpha R + s(1-\alpha)R\right] f(s)ds \\ &\quad - \int_0^{\underline{s}} \gamma \left[\alpha R + s(1-\alpha)R\right] f(s)ds. \end{aligned} \tag{12}$$

Finally, rewriting equation (9) and plugging in equation (12) delivers:

$$\begin{aligned} \Delta\Pi &= (\phi - 1) \int_0^{\bar{s}} sr^* f(s)ds + (1-\gamma) \int_0^{\underline{s}} \left[\alpha R + s((1-\alpha)R)\right] f(s)ds \\ &\quad + (\phi\gamma - 1) \int_{\bar{s}}^{\infty} \left[\alpha R + s((1-\alpha)R)\right] f(s)ds. \end{aligned} \tag{13}$$

For the key insights from the model, consider three special cases.

Case 1: $\gamma = 1$**,** $\phi = 1$ When there is no UIP deviation ($\phi = 1$) and banks can fully recover revenues in case of default, firms are indifferent between FC and LC loans, that is $\Delta\Pi = 0$. In particular, the currency choice is independent of the local currency income share α.

Case 2: $\gamma < 1$**,** $\phi = 1$ Next, consider the case without a UIP deviation but with costly default. Plugging in the corresponding parameter values delivers:

$$\Delta\Pi = (1-\gamma) \left(\int_0^{\underline{s}} \left[\alpha R + s(1-\alpha)R\right] f(s)ds - \int_{\bar{s}}^{\infty} \left[(\alpha R + s(1-\alpha)R) f(s)\right] ds \right). \tag{14}$$

Taking the derivative with respect to α, we obtain:[16]

$$\frac{\partial \Delta\Pi}{\partial \alpha} = (1-\gamma)R \left(\int_0^{\underline{s}} (1-s) f(s)ds - \int_{\bar{s}}^{\infty} \left[(1-s) f(s)\right] ds \right) \geq 0. \tag{15}$$

When firm liquidation is costly for banks ($\gamma < 1$), a firm is less likely to choose a foreign currency loan when more of its income is in local currency (higher α). This is intuitive: When default is costly, there is an incentive to pick the currency that, all else equal, minimizes default risk. The fact that firms optimally choose the currency of the loan so that they are naturally hedged

[16]Note that there are also derivatives with respect to the boundaries, following Leibniz' rule, but they are equal to zero as profits at the boundaries are zero.

against exchange rate moves implies $\alpha^{LC} \geq \alpha^{FC}$: A firm that selects a local currency loan has a weakly higher local currency income share than a firm that selects a foreign currency loan.

Case 3: $\gamma = 1$ Consider the case where banks can fully recover revenues in default but there is a UIP deviation:

$$\Delta\Pi \quad = \quad (\phi - 1) \left(\int_{\bar{s}}^{\infty} \left[\alpha R + s(1-\alpha)R \right] f(s) ds + \int_{0}^{\bar{s}} s r^* f(s) ds \right). \tag{16}$$

If $\phi > 1$, the foreign risk-free rate is lower than the local risk-free rate, and firms, all else equal, prefer foreign currency loans. We summarize our findings in the following proposition.

Proposition 3 (Currency choice) *A firm*

i) Is indifferent between foreign currency and local currency loans if there is no UIP deviation and no liquidation cost ($\phi = 1$, $\gamma = 1$).

ii) Chooses the currency of the loan in line with its natural hedge (implying $\alpha^{LC} \geq \alpha^{FC}$) if there is no UIP deviation but there is a liquidation cost ($\phi = 1$, $\gamma < 1$).

iii) Chooses the currency with the lower risk-free rate if there is a UIP deviation but no liquidation cost ($\phi \neq 1$, $\gamma = 1$).

Proof. *Follows from equations* (13), (15) *and* (16). ■

The key predictions relevant for our empirical analysis are ii) and iii). The former implies that firms tend to select the currency of the loan so as to minimize the default risk and, hence, tend to match the loan currency to the currency in which the income is denominated.[17] The latter states that firms select the currency in which it is cheaper to borrow, accounting for expected exchange rate changes.

2.3 Additional Aspects

We briefly discuss some additional aspects that are not explicitly modeled.

Financial hedges If firms are not fully hedged through their revenue streams, they can buy protection against local currency depreciation or appreciation and engage in foreign exchange

[17] This result has found empirical support: Brown et al. (2009) report that foreign currency income is the dominant reason for foreign currency borrowing in Eastern Europe. Similarly, Bleakley and Cowan (2008), Kedia and Mozumdar (2003), and Keloharju and Niskanen (2001) find that firms obtain foreign currency debt to hedge against foreign currency income.

swaps.[18] However, not all firms may hedge because it is costly. Firms may face both a variable cost associated with individual hedges and a fixed overhead cost from participating in the foreign exchange market. Hedging with financial instruments should reduce the effect of local depreciations on default similar to the effect of natural hedges studied in the model.[19]

Pass-through of debt servicing costs If firms have a currency mismatch and debt servicing costs rise because the local currency depreciates, firms might pass on the higher cost to their customers through higher prices. However, firms may not be able to increase prices, either because of the market structure and competitive pressures or because prices are sticky in the short run. As the local currency depreciates, the cost of debt for these firms, which often face monthly interest payments, rises but prices cannot be adjusted promptly to compensate the firms for the higher cost. A large literature documents short-term price stickiness and less than perfect pass-through of higher costs to consumers.[20] To the extent that firms have some ability to adjust prices, for example, because competitors have similar foreign-currency exposures, the effect of local currency depreciations on defaults should be mitigated.

2.4 Key Takeaways from the Model

To summarize, the model developed in this section has four testable predictions.

Testable prediction 1: A local depreciation raises the default probability of a firm that borrows in foreign currency relative to a firm that borrows in local currency.

Testable prediction 2: A local depreciation raises (lowers) the default probability by less if there is a smaller currency mismatch, that is the firm borrowing in foreign (local) currency has more sales in foreign (local) currency.

Testable prediction 3: Firms are more likely to borrow in foreign currency if a larger share of their sales is in foreign currency.

Testable prediction 4: Firms are more likely to borrow in foreign currency if there is a UIP deviation that reduces borrowing costs in the foreign currency.

[18] Géczy et al. (1997) show that firms with foreign exchange rate exposures are more likely to use currency derivatives.

[19] It would be straightforward to extend the model in this direction by allowing a firm to vary its domestic currency share α at a cost. Buying a financial hedge is then isomorphic to shifting income from one currency stream to the other at the cost of reducing expected income.

[20] See, for example, Klenow and Kryvtsov (2008), Klenow and Malin (2010), Nakamura and Steinsson (2013), and Gopinath and Rigobon (2008).

The focus of this paper is on testable prediction 1, as we are interested in understanding how exchange rate changes affect the probability of default of firms that borrow in foreign currency. That said, we provide evidence in support of all four predictions in this paper. Of note, testable prediction 1 holds even when allowing for endogenous selection of currency. As discussed above, a natural hedge from selection into currency can dampen the effect of local depreciations on relative default but does not overturn it.

3 Data Sources and Facts

This section provides information on data sources as well as some key facts about U.S. bank lending to foreign borrowers, including the incidence of a loan becoming past due.

3.1 Data Sources

Corporate loan data source The loan-level data used in this paper come from Y-14 reports that U.S. banks that are stress-tested by the Federal Reserve have to file on a quarterly basis.[21] Banks report corporate loans and leases that are held for investment and held for sale with a committed exposure above $1 million. They report at the consolidated level, that is, we observe not only cross-border loans extended to foreign firms by the parent bank but also those extended by the banks' foreign subsidiaries and branches (although we cannot distinguish them). Reporting of the loan-level information started in 2011q3. However, information of the currency denomination of the loan, crucial for our analysis, is only available from 2014q4 onwards. Therefore, the baseline sample covers a shorter time period, running from 2014q4 to 2018q4. The sample includes 29 banks, some of which enter the sample as they become part of the annual stress-testing exercise.

To obtain a consistent dataset, we subject the data to several cleaning procedures and collapse the loan-level dataset to the borrower level.[22] A borrower is identified as a combination of customer identifier, location, and bank.[23] The least restrictive sample has 147,103 observations and covers 26,345 borrowers residing in 79 countries.[24]

[21] Banks report corporate loans on schedule H.1. The data are confidential but available to researchers within the Federal Reserve System.

[22] The decision to delay payments on individual loans is taken at the borrower-level, making it the appropriate level for our analysis. In almost all cases in our data, borrowers are late with their payments on all of their loans at the same time.

[23] In general, when collapsing the data, we calculate utilized exposure-weighted averages for all variables. Details on data cleaning can be found in the data appendix.

[24] We drop countries whose currencies are pegged to the USD as well as the United States. In addition, we drop observations for Ghana and Venezuela which had extremely volatile exchange rates over the sample period.

Additional data sources The borrower-level dataset is complemented with data from a variety of sources. Information on bilateral exchange rates are from the IMF's International Financial Statistics. Country-industry level variables (specifically, international sales over total sales) are constructed from Worldscope balance sheet data. Further details on variables and their sources can be found in the data appendix.

3.2 Characteristics of International Loans

The Y-14 data contain unique information on the international corporate loan portfolios of the largest U.S. banks. In the following, we document key facts about these loan portfolios. The statistics provide novel insights as existing research is either based on more aggregated data (for example, on the BIS International Banking Statistics) or on syndicated loan data. Syndicated loans, as shown below, represent a relatively small fraction of total international C&I loans on U.S. banks' balance sheets.[25]

Foreign currency loans are prevalent, tend to be larger, and have similar ratings to local currency loans. 50 percent of firm-quarter observations are accounted for by borrowers that exclusively borrow in USD while 40 percent of the firms borrow in local currency. 4 percent have loans in a foreign currency other than the USD, and 6 percent borrow in more than one currency. Table 1 shows the average and median sizes, maturities, probabilities of default, and interest rates of loans in different currencies. The table shows that firms that borrow in foreign currency take out larger loans than firms that borrow only in the local currency. Interestingly, as figure 2 highlights, the distribution of loans across rating buckets does not differ much by currency.

Local currency loans carry a higher interest rate. As table 1 indicates, local currency loans pay higher interest rates than foreign currency loans. To further explore this difference, we look at the sample of newly originated loans and regress the interest rate of a loan on a dummy variable that is one when the loan is denominated in USD, controlling for a battery of fixed effects as well as the size of the loan and its maturity. Results are shown in table 2. All regressions include country-time and ratings fixed effects.[26] Columns (1) through (4) show results for fixed-rate loans while columns (5) through (8) show results for variable-rate loans. As columns (1) and (5) show, the interest rate of a foreign-currency loan is on average between 100 and 140 basis points lower than the interest rate of a comparable local currency loan. This interest rate difference partly reflects expectations about future moves in the bilateral exchange rate. To

[25] One reason for the low share of syndicated loans on bank balance sheets is that banks sell a large fraction of the syndicated loans they originate to institutional investors. See, for example, Irani et al. (2018).

[26] In addition, table 17 provides robustness for these results, including firm-time and loan type fixed effects.

control for this effect, we adjust the interest rate by the expected change in the USD exchange rate vis-a-vis the local currency.[27] Difference in these adjusted interest rates between a dollar loan and a foreign currency loan indicates deviations from uncovered interest rate parity (UIP).[28] Indeed, columns (3) and (7) show that even when accounting for exchange rate expectations, foreign currency loans are between 45 to 60 basis points cheaper than domestic currency loans.

Volatile currencies have large UIP deviations. One reason why UIP may not hold is the cost of hedging against exchange rate fluctuations. That is, a U.S. bank charges a higher interest rate on a foreign currency loan because it either takes on exchange rate risk or needs to pay for a hedge. We would therefore expect the UIP deviation to be larger for countries with more volatile exchange rates. Results are presented in columns (2), (4), (6), and (8) of table 1. Findings are in line with our expectations. For loans to firms in countries with above median exchange rate volatilities, the average interest rate difference between a U.S. dollar loan and a foreign currency loan doubles, both for the observed interest rates (columns (2) and (6)) and for interest rates adjusted for exchange rate expectations (columns (4) and (8)). For loans to firms in countries with below median exchange rate volatilities, we do not find significant differences in interest rates between dollar and local currency loans.

The majority of loans are not syndicated or participated. Existing papers that investigate cross-country aspects of corporate loans rely on aggregate data or syndicated loan data. Information on syndicated loans is available from commercial sources and has been collected for many years. While the loan-level data obtained from banks' Y-14 reports are available for a shorter time period, they have the advantage of covering a much larger set of loans as table 3 shows. 83 percent of loans on the banks' balance sheets are not syndicated, with the average size of these loans being less than half of that of syndicated loans. Interestingly, the share of loans issued in foreign currencies is quite similar across loan types (63 percent for syndicated loans versus 58 percent for non-syndicated loans).[29]

The dataset covers loans in a variety of countries and industries. The 79 countries in the sample cover all world regions, as shown in table 4. The largest share of loans is to high-income OECD countries (42 percent), followed by countries in Latin America and the Caribbean

[27] Specifically, we use the expected change in the USD exchange rate over the next 24 months from the Survey of Professional Forecasters.

[28] Uncovered interest rate parity states that $1 + i^* = (1 + i)\frac{s}{f}$, where f is the expected future exchange rate expressed in units of the foreign currency per domestic currency. We approximate this condition by adjusting the observed interest rate by the 24 month exchange rate expectations. If the expected change in the exchange rate over the lifetime of the loan were different from this survey result, it would affect the estimated coefficient on the foreign currency dummy.

[29] Around 3 percent of borrowers have a mix of syndicated and non-syndicated loans. In this table, borrowers with less than 50 percent of their utilized exposure in syndicated loans are classified as not syndicated.

(24 percent). Borrowing in foreign currency is particularly prevalent in Europe and Central Asia, Latin America and the Caribbean, and Sub-Saharan Africa. Loans in all regions become past due over the sample period, but this event is more frequent for loans to borrowers in OECD countries and Latin America and the Caribbean.

Table 5 displays loan characteristics by industry. Manufacturing firms represent 34 percent of observations. The finance and insurance industry accounts for 17 percent of observations. Loans to the finance and insurance sector are larger, carry lower risk and interest, and are more often in foreign currency than loans to other sectors. The event that a borrower becomes past due on its loan payments is more frequent for the finance and insurance sector and other services than for the manufacturing, transportation, and wholesale/retail sectors.

3.3 Past-due Loans

Payment delays are a rare event. In the Y-14 data, banks report if a borrower is late on interest or principal payments.[30] Based on this information, we construct a variable that takes the value of 1 if a borrower becomes newly past due on her loan payments in a given quarter and zero otherwise. The event that a borrower misses a loan or principal payment after paying in the previous quarter is rare, occuring a total of 331 times in our dataset (0.23 percent of observations).

While borrowers in emerging economies represent 49 percent of the total loan value, they account for 53 percent of newly past due borrowers.[31] Figure 3 shows the share of borrowers that become newly past due by their lagged risk rating. Among the highest rated borrowers (rating of AAA), none become past due on their loans. The share of borrowers in lower rating buckets that become past due lies between 0.1 and 0.3 percent. Figure 4 shows the shares of USD and local currency loans that become past due in each quarter, which vary significantly both over time and across denominations. The chart also plots the broad dollar, a trade-weighted dollar index, from 2014q4 to 2018q4, illustrating how the dollar appreciated notably over this period.

Tables 1 and 3 show the share of observations that become past due by currency and participation type, respectively. Of note, even though local currency loans had slightly higher probabilities of default, which reflect the banks' ex-ante assessments of their riskiness, these loans became past due less often than foreign currency loans, i.e. they were ex-post less risky over the sample period. The fact that foreign currency loans turned out to be riskier than anticipated by banks may reflect the large appreciation of the dollar over that period, which was likely not fully anticipated. Comparing loans that become past due with performing loans, the former are smaller in size and have a shorter maturity, with an average size of 16 million and an average

[30] Specifically, banks have to report a borrower as past due and the exact number of days the borrower is past due if the borrower is at least 30 days late on his payments.

[31] Total loan values correspond to total utilized exposures.

maturity of 4.8 years.

Liquidity versus solvency Missing a loan or principal payment for 30 days or more on a large loan (i.e. becoming newly past due) indicates severe financial stress for the borrower. A key question is whether this incidence reflects a temporary liquidity problem or is the first sign of a solvency problem, that is, a default. Figure 5 shows what happens to borrowers after they become past due. Of the 0.2 percent of borrowers that become past due, 58 percent pay in the next period. 14 percent continue to have loans that are past due, whereas 27 percent of borrowers exit the sample. The exit rate is slightly higher for borrowers that have past due loans than those that have not missed payments (24 percent). The increase in the drop-out rate likely occurs because banks write off the loans some time after they become past due, which makes them disappear from the loan book.

To obtain an estimate of the share of borrowers that default on their loans after becoming past due, we make the following assumptions. (i) A borrower is in default if she is still past due on her loans after two additional quarters. (ii) Differences in exit rates between borrowers that are past due and those that are not past due are explained by loan write-offs due to default. Based on these assumptions and the numbers shown in figure 5, we calculate that around 16 percent of loans that become newly past due ultimately end up in default. Our past due variable therefore captures severe liquidity problems but also reflects solvency problems for a subset of borrowers.

4 Empirical Analysis

Proceeding in four steps, this section presents empirical evidence on the effect of exchange rate changes on firms' ability to service debt and on the determinants of firms' currency choices. First, we detail our baseline specification and show graphical evidence for the key finding. Second, we discuss the main regression results. Third, we present additional results with an emphasis on the factors that drive currency choice. Finally, we provide an extensive set of robustness checks.

4.1 Main Empirical Specification

Our main specification tests if a firm that borrows in foreign currency is more likely to default on its loan when the local currency depreciates than a firm that borrows in local currency (testable prediction 1). We employ a difference-in-difference type approach, running the following probit regression:

$$\text{past due new}_{it} = \beta_1 \Delta ln(XR_{ct}) + \beta_2 \Delta ln(XR_{ct}) \times \text{FC}_{it} + \beta_3 \text{FC}_{it} + \Gamma X_{it} + \alpha_{c(kr)t} + \epsilon_{it}, \quad (17)$$

where past due new$_{it}$ takes the value of 1 if a firm becomes past due on its loans from quarter $t-1$ to quarter t.[32] FC$_{it}$ is the share of loans of firm i that are denominated in a foreign currency. $\Delta ln(XR_{ct})$ is the quarterly change in the average bilateral exchange rate between the USD and the local currency of country c where borrower i is located (defined as local currency per USD). The key coefficient of interest β_2 associated with the interaction term between the change in the dollar exchange rate and the foreign currency share of loans is predicted to be positive. X_{it} represents firm-level control variables (maturity, total loan volume, rating).

We are also interested in the longer-term effects of exchange rate movements. For this purpose, we run additional regressions that include both the contemporaneous quarterly change in the exchange rate as well as the cumulative exchange rate change from the date of loan origination to the preceding quarter and interactions of these two variables with the foreign currency share FC$_{it}$.

In all regressions, standard errors are clustered at the country-quarter level unless noted otherwise. Moreover, regressions include an extensive set of fixed effects. The most demanding specification includes country-quarter-industry-rating fixed effects. This means that we compare the effect of exchange rate changes on the probability of becoming past due between firms with foreign currency and those with local currency loans within the same country, industry, rating category, and quarter. As a result, other channels through which the exchange rate may affect firm performance are controlled for to the extent that they affect firms in the same country, industry and with the same rating in the same way, for example, through effects on demand.

Two firms in the same country, industry, rating bucket, and quarter might still have different exchange rate exposures, for example, because they generate different shares of their incomes in foreign currency. While we cannot directly control for this selection because we do not observe firms' exposures, Corollary 1 implies that sorting generates a downward bias for our coefficient of interest β_2. Intuitively, a depreciation of the local currency should have a stronger negative effect on the repayment probability of a foreign currency loan for a firm that has a revealed preference for local currency debt (with a smaller foreign income stream) than for a firm that actually chooses to borrow in foreign currency (with a larger foreign income stream). Therefore, our estimate of β_2 represents a lower bound for the average effect of exchange rate changes on a firm's probability of becoming past due on a loan under random currency assignment.

In addition, measurement error may bias our estimate of β_2 downward because whether a firm borrows in local or foreign currency from a U.S. bank is only a proxy for the firm's overall currency composition of debt. Generally, it would be desirable to complement our dataset with firm balance sheet data. Unfortunately, much information related to firm balance sheets is missing for foreign firms in the Y-14 data. In addition, we cannot obtain balance sheet data for

[32] While the model outcome is an outright default, in the data, as discussed in section 3.3, we observe if a firm is past due on its loan payment.

a large enough sample of firms from external sources. This is because the dataset includes loans to many firms that are not publicly traded and, more importantly, the event that a borrower becomes newly past due on her loans is concentrated in smaller loans, meaning smaller firms, for which balance sheet data are not available.

4.2 Graphical Evidence

Figure 6 presents graphical evidence for our main result. Consider the two top panels that show the kernel density estimates of quarterly bilateral exchange rate changes for firms that become past due on their loans and, separately, for firms that do not become past due. The left panel has the kernel densities for firms with local currency loans, while the right panel presents those for firms with foreign currency loans. While there is no difference in the distribution of exchange rate changes between firms with local currency loans that become past due and firms with local currency loans that do not become past due (left panel), the right panel shows significant differences when the loans are denominated in foreign currency. Specifically, the distribution of firm-quarter observations that become past due is significantly shifted to the right, that is, towards larger dollar appreciations. This indicates that the more the dollar appreciates against the local currency within a quarter, the higher is the probability that a foreign currency borrower becomes newly past due. The regression results in the next section establish this result formally.

The bottom panels of figure 6 are constructed in parallel to the top panels but show the distribution of exchange rate changes since the loan was originated. Similar to the right top panel, firms with foreign currency loans that become past due experience a stronger appreciation of the dollar (since loan origination). Interestingly, differences are also apparent for firms that borrow in local currency. The distribution of exchange rate changes since origination for firms that do not become past due on their loans is skewed to the right. That is, firms that borrow in local currency and do not become past due on their loans experience a stronger appreciation of the dollar than firms that borrow in local currency and become past due on their loans. This finding might be reflective of the Mundell-Fleming expenditure switching channel through which firms may benefit from local currency depreciation, which increases the demand for their goods. This positive effect of local currency depreciation likely takes longer to unfold and may therefore only be evident when exchange rate changes over a longer time period are considered. Regression results shown in the next section support this interpretation of the results.

4.3 Regression Results

The effect of exchange rate changes on the past-due status of loans Table 6 displays regression results that test prediction 1. Columns (2) to (7) present the results for the specification stated in equation (17) with different combinations of fixed effects and control variables.

Before turning to these, column (1) presents a benchmark regression without the interaction term between exchange rate changes and the foreign currency dummy. It finds that the average effect of a dollar appreciation on the past due status of loans is positive in a regression that only includes time fixed effects.

Column (2) shows that exchange rate changes affect firms with foreign currency loans and those with local currency loans differently. When the interaction term between the foreign currency dummy and the exchange rate change is included in the regression, the coefficient associated with the exchange rate change (β_1) turns negative and insignificant. At the same time, the coefficient of the interaction term (β_2) is positive and highly significant, in line with prediction 1 and confirming the graphical evidence in the top panels of figure 6. The interaction term remains positive and highly significant as various types of fixed effects are included (columns (3) and (4)). Columns (5) and (6) add interaction terms between observable loan characteristics (total loan volume, average maturity, obligor rating) and the exchange rate change. As one might expect, exchange rate changes have stronger effects on the past due status of loans of lower-rated firms. Column (7) shows results for the most restrictive set of fixed effects, namely country-time-industry-rating-fixed effects. Even in this specification, the interaction term between exchange rate changes and the foreign currency dummy remains highly significant.

In table 7, we account for exchange rate changes since origination. To disentangle the effects of contemporaneous and past exchange rate changes, we split exchange rate changes since origination into (i) the exchange rate change in the last quarter (included as a regressor in table 6) and (ii) exchange rate changes in prior quarters after origination. The results indicate that both contemporaneous as well as past exchange rate changes play a role for the probability that a firm becomes past due on its loans. In column (3), the coefficients associated with the quarterly exchange rate change and the lagged cumulative exchange rate change are both negative and significant at standard significance levels, which suggests that dollar appreciation since loan origination decreases the probability that a firm becomes past due on its loans when it borrows in local currency. This is consistent with an expenditure switching channel through which local currency depreciation benefits firms as the foreign demand for domestic goods increases. The estimated coefficients associated with the interaction term between the (contemporaneous) quarterly exchange rate change and the foreign currency dummy remain positive and quantitatively very similar to those in table 7. The interaction term between the lagged cumulative exchange rate change and the foreign currency dummy is also positive: Dollar appreciation in prior quarters (after loan origination) increases the probability that a firm with foreign currency loans becomes past due on its loans relative to a firm with local currency loans. The negative effects of foreign currency appreciation on a firm's ability to pay for its foreign currency debt are thus quite persistent and affect outcomes over the life of the loan.

Economic significance Column (2) of table 8 shows the marginal effects for various exchange rate coefficients from column (3) of table 7. They imply that a depreciation of the local currency by 10 percent within one quarter increases the probability that the firm becomes past due on its loans by 13 basis points when it borrows in foreign currency. This compares to a 24 basis-point reduction in the probability of becoming past due for firms with local currency loans. Combining these results, the probability that a firm with only foreign currency loans becomes past due on its loans after a 10 percent depreciation of the local currency increases 37 basis points relative to a firm with only local currency loans.

Looking next at the effect of cumulative exchange rate changes, a 20 percent increase in the exchange rate between origination and the last quarter increases the probability that firms with foreign currency loans become past due on their loans by 2 basis points, while the same exchange rate change leads to a 20 basis-point reduction in the probability that a firm that borrows in local currency becomes past due. Thus, for a firm that borrowed in foreign currency, the probability of becoming past due increases 22 basis points relative to a firm that borrowed in local currency.

Compared to a firm's baseline probability of becoming past due on loans of 0.2 percent (the frequency of new past due status in our data), these differential effects are economically significant.

Alternative estimation methods Columns (3) to (7) of table 8 show the regression results and marginal effects when alternative estimation methods are employed to estimate the same specification as in column (3) of table 7). Significance of the coefficients and magnitudes of the marginal effects are very similar across specifications. In appendix table 18, we present the results when the specifications in table 7 are estimated using OLS. Appendix table 19 shows the marginal effects of key coefficients for all columns of table 7.

4.3.1 Additional Results

Dollar appreciation versus depreciation Are firms affected differently depending on the direction of the exchange rate change? This question is answered in table 9. The regressions shown in the table include a triple interaction between the exchange rate change, the foreign currency dummy, and a dummy variable that takes the value of 1 if the local exchange rate depreciated against the dollar and zero otherwise. Columns (1) and (2) show results for quarterly exchange rate changes. Columns (3) and (4) use exchange rate changes since loan origination instead. The coefficients associated with the triple interactions are always positive and significant. That is, the differential effect of exchange rate changes on firms with foreign currency loans relative to firms with local currency loans is stronger when the local currency depreciates.

This finding is consistent with our model if we assume that on average firms that borrow in

foreign currency have larger currency mismatches than firms that borrow in local currency.[33] In the model, a local currency depreciation raises the default risk for mismatched firms that borrow in foreign currency, whereas a local currency appreciation raises the default risk of mismatched firms that borrow in local currency. To the extent that currency mismatch is more prominent for foreign-currency borrowers, this should give rise to the asymmetry we find in the data.

Foreign sales as a natural hedge Prediction 2 states that the effect of a depreciation of the local currency on the default probability of firms with foreign currency loans relative to that of firms with local currency loans is smaller when firms have a natural hedge, that is, when they face a smaller currency mismatch because of income streams in the currency of the loan. Table 10 tests this prediction, showing results from a specification that includes a triple interaction between the exchange rate change, the foreign currency dummy, and the share of foreign sales in total sales specific to a quarter, industry and country.[34]

Columns (1) and (2) present results for quarterly exchange rate changes, whereas columns (3) and (4) show results for exchange rate changes since loan origination. In all columns, the coefficients associated with the triple interactions are negative and highly significant. Thus, the differential effect of exchange rate changes on firms that borrow in foreign currency relative to firms that borrow in local currency is smaller the larger the share of foreign sales in total sales is. In other words, foreign sales reduce the effects of exchange rate changes on loan payments, operating as a natural hedge for firms. Using the OLS estimates from appendix table 21, we calculate that, on average, there is no difference in the effect of quarterly exchange rate changes between firms that borrow in local currency and firms that borrow in foreign currency when they operate in an industry where around 60 percent of sales go to foreign countries. The effect of a 10-percent depreciation of the local currency on the probability that a firm becomes past due is 38 basis points higher for firms with foreign currency loans relative to firms with local currency loans when firms are in industries with a foreign sales share in the 25th percentile of the distribution (12 percent foreign sales). This compares to a 3-basis-point difference for firms in the 75th percentile of the foreign sales share distribution (56 percent foreign sales).

Selection into borrowing in foreign currency The theoretical model predicts that firms with foreign currency income are more likely to choose to borrow in foreign currency (prediction 3). At the same time, more firms should borrow in foreign currency if the foreign risk-free rate is below the domestic risk-free rate (prediction 4). Table 11 provides empirical evidence for the validity of these predictions. In column (1), a dummy variable that takes the value of 1 if

[33]Note that this is a natural assumption as most firms (including exporters) have most of their sales at home. See, for example, Bernard et al. (2003).

[34]Information on the foreign sales share is from Worldscope and is calculated by averaging the shares for all available firms within a country, industry and quarter.

the loan is denominated in foreign currency is regressed on the country-industry-time varying share of foreign sales, the country-time varying difference in average interest rates between a local currency and a USD loan, as well as several loan characteristics (log loan size, and log maturity). Associated marginal effects from the probit regression are shown in column (2). In column (3), the simple difference in average interest rates is replaced by the average UIP deviation, where interest rates have been adjusted for expected exchange rate changes following the approach described in section 3.2.[35] Columns (4) and (5) repeat the regressions with different combinations of fixed effects. The coefficients on the foreign sales share are highly significant and positive throughout suggesting that firms in industries with a higher share of foreign sales are more likely to borrow in foreign currency than firms in industries that sell more domestically. Similarly, a larger difference between the interest rate paid for the local currency loan and that paid for the USD loan increases the probability that a firm borrows in foreign currency. Moreover, foreign currency loans are larger and have shorter maturities than local currency loans.[36]

Quantitatively, interest rate differentials are a more important determinant of currency choice than the share of foreign sales. When the interest rate differential is increased by 0.029, which corresponds to going from the 25th to the 75th percentile of the distribution, the probability that a firm chooses the foreign currency loan increases, on average, by 150 percent. In comparison, an increase in the foreign sales share by 45 percentage points (increase from the 25th percentile to the 75th percentile) increases the probability that a firm chooses the foreign currency loan by 5 percent on average.

4.4 Robustness

This section presents several robustness exercises. In particular, results are robust to accounting for differences between variable- and fixed-rate loans and for the interest rates firms pay. We also show that results are not driven by changes in the oil price, which is highly correlated with changes in the dollar exchange rate over the sample period.

Split by loan type The dataset used in this paper contains loans with floating interest rates and fixed interest rates as well as a mix of these two types. Foreign currency floating-rate loans are often tied to a foreign reference rate. For 78 percent of floating rate USD loans, the applicable

[35]The interest rate differential is calculated as the difference between the average interest rate of a local currency loan and that of a foreign currency loan by country and quarter. As an alternative, we first regressed interest rates on log size, log maturity, and rating and used the residuals of this regression to calculate the average interest rate differential. Results are basically identical.

[36]The literature has uncovered several firm characteristics that play a role in foreign currency borrowing. As shown by Gelos (2003) and Aguiar (2005), size plays a role with larger firms being more likely to borrow in a foreign currency. Allayannis et al. (2003) and Mora et al. (2013) find that less opaque firms with easily verifiable collateral, higher net worth, and greater tangible assets have more dollar debt. The evidence on the role of profits and leverage for the currency denomination of loans is mixed. See also Brown and De Haas (2012b).

reference rate is the USD Libor.[37] When the foreign reference rate increases, the debt burden of firms with foreign-currency floating-rate loans rises. At the same time, the increase in the foreign reference rate may be accompanied by a depreciation of the local currency vis-a-vis the foreign country. To address concerns that the exchange rate effects we identify could be driven by changes in interest rates, we run regressions for fixed-rate and floating-rate loans separately. Results are presented in table 12. In columns (1) and (2), $Dln(XR)$ reflects the quarterly change in the bilateral exchange rate. In column (3) and (4), it stands for the exchange rate change since loan origination. As columns (1) and (3) show, the coefficient of interest β_2 is positive and highly significant for fixed rate loans with coefficients that are similar to those obtained for the sample of variable-rate loans. We conclude that the differential effects that we find for firms with foreign currency and local currency loans are not driven by differential changes in the underlying reference rates.

As an alternative to the sample splits shown in table 12, we include country-quarter-interest-rate-type fixed effects in the regressions. Results are shown in table 13. While the standard errors of β_2 increase for the regressions that employ quarterly changes in the exchange rate (columns (1) through (3)), the estimates of β_2 remain highly significant and quantitatively similar with the additional set of fixed effects when the exchange rate change since origination is used (shown in columns (4) through (6)).

Controlling for the lagged interest rate So far, we have included as controls a firm's total loan volume, maturity of its loans, and its rating. In a next step, we also include the interest rate a firm pays on its loans. Differences in interest rates between firms may contain additional information about firms that might be useful to control for. To account for differences in the role of the interest rate for floating rate and fixed-rate loans, we allow the effect of the lagged interest rate to differ across these two types of loans. To this end, the interaction term between the log change in the exchange rate and the log lagged interest rate is interacted with two dummies that indicate floating or fixed rate loans, respectively. Results are shown in table 14. Results are qualitatively and quantitatively little changed when differences in interest rates are accounted for.

Controlling for changes in the oil price As highlighted by figure 5, the dollar appreciated substantially over the sample period. At the same time, the oil price and commodity prices, more broadly, fell. To exclude that our results are driven by effects of falling commodity prices, we include changes in the oil price in our regressions in table 15. The coefficient on the interaction term between the change in the log change in the oil price and the foreign currency dummy is not statistically significant and other coefficients remain essentially unchanged. In a second exercise,

[37] Based on information on loan originations.

we exclude firms in commodity sectors from the sample and rerun the regressions. As table 16 demonstrates, regression results remain very similar to the baseline results.

5 Conclusions

Employing unique data on U.S. banks' loans to foreign firms, this paper explores the effect of exchange rate changes on the ability of firms to repay their debt when they borrow in foreign currency. The estimation results indicate that an appreciation of the dollar against the local currency of the borrower makes firms with foreign currency debt less likely to repay their loans. Even though firms tend to borrow in foreign currency when they have foreign currency income, many firms remain exposed to exchange rate risk.

Exchange rate exposures appear sizeable, especially because the sample covers the years 2014 to 2018, a period of generally benign economic and financial conditions. Movements in the exchange rate might have stronger effects on firm performance when the domestic economy is faltering, the supply of credit is more constrained, and exchange rate changes are more drastic, for example, in a currency crisis.

As the paper shows, firms' exchange rate exposure translates into credit risk for banks, which see a larger share of foreign currency loans become past due when the dollar appreciates. For large U.S. banks, this component of credit risk is relatively limited because foreign currency lending constitutes a small share of these banks' overall activities and because, at least in normal times, the absolute share of past-due loans is small.

This could be different for banks from other countries. Large U.S. banks are monitored and regulated by the Federal Reserve. In fact, the Y-14 data this paper employs are submitted for stress testing purposes. Lending practices of other banks that provide foreign currency loans may not be as closely watched and credit risk associated with borrowers' exchange rate exposures could be much more material, as past historical episodes highlight, especially when banks lend to lower quality borrowers.

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Table 1: Loan characteristics, by currency

	(1) USD		(2) oth foreign		(3) local		(4) mix	
	mean	p50	mean	p50	mean	p50	mean	p50
Util. Exposure (USD million)	31.0	8.73	35.4	9.80	17.9	4.29	51.2	26.6
Maturity (years)	5.82	4.76	5.74	4.99	5.22	4.68	6.21	5.00
Prob. of default (pct)	1.79	0.66	1.42	0.64	2.00	0.71	1.58	0.66
Interest rate (pct)	2.97	2.42	2.56	1.84	4.05	3.29	3.29	2.65
Loans newly past due (pct)	0.27	0	0.23	0	0.18	0	0.13	0
Observations	74286		6024		58639		8154	

Note: The table shows summary statistics of the baseline sample with 147,103 observations grouped by the currency denomination of the loans. Column 1 includes observations where the borrower has loans denominated exclusively in USD. Column 2 has observations where the borrower has loans in a foreign currency other than the USD. Column 3 is based on borrowers with local currency loans. Column 4 includes observations where the borrowers have loans in multiple currencies. The table displays the means and the medians of the following variables: utilized exposure, maturity, bank-internal probability of default, interest rate, and a dummy variable which is one when the borrower becomes past due on its loans in period t.

Table 2: Differences in interest rates between USD and local currency loans, Baseline

	Fixed Rate				Floating Rate			
	(1) Int	(2) Int	(3) UIP	(4) UIP	(5) Int	(6) Int	(7) UIP	(8) UIP
FC	-1.397***	-2.524***	-0.565**	-1.174***	-1.019***	-3.407***	-0.467**	-2.400***
	(0.0955)	(0.189)	(0.227)	(0.429)	(0.131)	(0.178)	(0.196)	(0.512)
FC X Low Volat.		2.443***		1.200**		3.153***		2.408***
		(0.233)		(0.504)		(0.184)		(0.529)
Ln(loan size)	-0.0944***	-0.0883***	-0.0827***	-0.0780***	-0.0969***	-0.0860***	-0.0667***	-0.0550***
	(0.0259)	(0.0255)	(0.0262)	(0.0254)	(0.0140)	(0.0141)	(0.0197)	(0.0189)
Ln(maturity)	0.0965**	0.121***	0.0923**	0.110***	0.243***	0.196***	0.209***	0.190***
	(0.0384)	(0.0355)	(0.0413)	(0.0394)	(0.0314)	(0.0288)	(0.0321)	(0.0300)
Ct-time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Rating FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	11461	11058	6556	6554	11632	11005	7449	7447
R^2	0.427	0.449	0.585	0.589	0.454	0.526	0.588	0.606

Note: The table explores differences in interest rates borrowers pay between local currency and foreign currency loans. The sample includes only newly originated loans. In columns 1, 2, 5, and 6, the interest rate paid on a loan during the quarter of loan origination is regressed on a dummy variable FC, which takes the value of 1 if the loan is denominated in a currency other than the currency of the country where the borrower is located. In columns, 3, 4, 7, and 8, the interest rate was adjusted for the expected change in the exchange rate over the next 24 months from the Survey of Professional forecasters. As a result, the coefficient on the variable FC in these columns measures the average UIP deviation in the data. $Low\ Volat.$ is a dummy variable that takes the value of 1 for borrowers in countries with below median exchange rate volatility and zero otherwise. Columns 1 through 4 include loans with fixed interest rates, while columns 5 through 8 include floating rate loans. Standard errors are clustered by bank-quarter. *, ** and *** denote significance at the 10%, 5% and 1% level.

Table 3: Loan characteristics, syndicated vs. non-syndicated

	(1) non-syndicated		(2) syndicated	
	mean	p50	mean	p50
Util. Exposure (USD million)	22.6	5.23	49.3	27.2
Maturity (years)	5.55	4.36	5.83	5.01
Prob. of default (pct)	1.81	0.68	2.00	0.64
Interest rate (pct)	3.52	2.75	2.82	2.59
Loans in for. currency (pct)	0.58	1	0.63	1
Loans newly past due (pct)	0.25	0	0.12	0
Observations	122327		24776	

Note: The table shows summary statistics of the baseline sample with 147,103 observations grouped into syndicated and non-syndicated loans. Column 1 includes observations where less than 50 percent of the borrower's loans are syndicated or participated. Column 2 has observations where at least 50 percent of the borrower's loans are syndicated or participated. The table displays the means and the medians of the following variables: utilized exposure, maturity, bank-internal probability of default, interest rate, a dummy variable which is one when the borrower becomes past due on its loans in period t, and the share of a borrower's loans that are not denominated in the currency of the country where the borrower is located.

Table 4: Loan characteristics, by region

	(1) EAP		(2) ECA		(3) OECD		(4) Non-OECD		(5) LAC		(6) MENA		(7) SA		(8) SSA	
	mean	p50	mean	p50	mean	p50	mean	p50	mean	p50	mean	p50	mean	p50	mean	p50
Util. Exposure (USD million)	22.7	6	35.4	9.75	32.2	9.24	24.6	4.52	21.5	5.23	18.7	9	20.6	6.11	30.9	15.7
Maturity (years)	5.52	4.01	5.69	4.85	5.72	5.00	5.83	4.61	5.05	4.27	7.92	5.73	6.10	5.08	6.41	5.00
Prob. of default (pct)	1.39	0.67	2.06	0.81	1.68	0.64	2.06	0.71	2.12	0.71	2.65	1.08	2.10	1.04	2.31	0.66
Interest rate (pct)	3.46	2.99	5.10	3.10	2.64	2.50	2.42	2.12	4.24	3.17	3.90	3.92	4.93	3.92	4.43	3.50
Loans newly past due (pct)	0.017	0	0.049	0	0.26	0	0.034	0	0.41	0	0.22	0	0.043	0	0.15	0
Loans in for. currency (pct)	0.70	1	0.83	1	0.47	0	0.66	1	0.70	1	0.59	1	0.41	0	0.76	1
Observations	17905		6158		62330		11667		35743		1367		9291		2642	

Note: The table shows summary statistics of the baseline sample with 147,103 observations grouped by region. EAP: East Asia & Pacific, ECA: Europe & Central Asia, OCED: High-income OCED countries, non-OECD: High-income non-OECD countries, LAC: Latin America and the Caribbean, MENA: Middle East and North Africa, SA: South Asia, SSA: Sub-Saharan Africa. The table displays the means and the medians of the following variables: utilized exposure, maturity, bank-internal probability of default, interest rate, a dummy variable which is one when the borrower becomes past due on its loans in period t, and the share of a borrower's loans that are not denominated in the currency of the country where the borrower is located.

Table 5: Loan characteristics, by sector

	(1) Fin & In		(2) Manuf		(3) Other		(4) Serv		(5) Transp		(6) Whole/Retail	
	mean	p50	mean	p50	mean	p50	mean	p50	mean	p50	mean	p50
Util. Exposure (USD million)	49.8	16.6	16.4	5.28	45.4	17.1	19.4	4.66	32.6	15	12.4	3.72
Maturity (years)	6.84	4.84	5.15	4.60	5.86	5.00	4.71	4.25	8.13	5.59	5.07	4.46
Prob. of default (pct)	1.21	0.64	2.04	0.71	1.94	0.66	1.39	0.64	2.41	0.67	2.26	1.10
Interest rate (pct)	2.47	1.92	3.78	2.98	3.48	2.98	2.69	2.01	3.51	3.12	4.09	3.25
Loans newly past due (pct)	0.41	0	0.081	0	0.22	0	0.49	0	0.18	0	0.13	0
Loans in for. currency (pct)	0.73	1	0.56	1	0.58	1	0.58	1	0.63	1	0.49	0
Observations	25488		50696		22884		19107		5557		23371	

Note: The table shows summary statistics of the baseline sample with 147,103 observations grouped by industry. Column 1: Finance & Insurance (naics 52) column 2: Manufacturing (naics 31-33), column 3: All other, column 4: Service Industries (naics 54-56, 61, 62, 71, 72, 81), column 5: Transportation and Warehousing (naics 42, 44, 45), column 6: Wholesale & Retail Trade (naics 48, 49). The table displays the means and the medians of the following variables: utilized exposure, maturity, bank-internal probability of default, interest rate, a dummy variable which is one when the borrower becomes past due on its loans in period t, and the share of a borrower's loans that are not denominated in the currency of the country where the borrower is located.

Table 6: Baseline results for quarterly exchange rate changes

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
D ln(XR)	1.899***	-0.431	-1.785				
	(0.412)	(1.086)	(1.089)				
D ln(XR) X FC		2.691**	3.479***	4.588***	4.730***	7.309***	8.023***
		(1.161)	(1.161)	(1.745)	(1.680)	(2.329)	(3.112)
Lagged rating	0.0492**	0.0477**	0.0454**	0.0492**	0.00972	0.0289	
	(0.0226)	(0.0226)	(0.0221)	(0.0249)	(0.0279)	(0.0409)	
Ln(loan size)	-0.0430***	-0.0524***	-0.0717***	-0.0785***	-0.0710***	-0.105***	-0.0622
	(0.0140)	(0.0143)	(0.0161)	(0.0184)	(0.0220)	(0.0351)	(0.0434)
Ln(maturity)	-0.0467**	-0.0471**	-0.0698**	-0.0724**	-0.0853**	-0.0982**	-0.129**
	(0.0225)	(0.0225)	(0.0272)	(0.0308)	(0.0335)	(0.0470)	(0.0545)
FC		0.0848	0.119*	0.102	0.0972	-0.0350	-0.102
		(0.0593)	(0.0698)	(0.0845)	(0.0825)	(0.113)	(0.152)
D ln(XR) X ln(loan size)					-0.205	-0.0467	-0.294
					(0.332)	(0.556)	(0.710)
D ln(XR) X ln(maturity)					0.454	0.933	1.696
					(0.603)	(0.757)	(1.097)
D ln(XR) X L rating					1.291***	1.657***	
					(0.434)	(0.641)	
Time FE	Yes	Yes	Yes	No	No	No	No
Ct FE	No	No	Yes	No	No	No	No
Ct-time FE	No	No	No	Yes	Yes	No	No
Ct-Time-Ind FE	No	No	No	No	No	Yes	No
Ct-Time-Ind-Rat	No	No	No	No	No	No	Yes
Observations	147103	147103	119767	51811	51811	9987	5220
Pseudo R^2	0.039	0.045	0.096	0.078	0.080	0.143	0.171

Note: This table shows the effect of exchange rate changes on the past due status of borrowers. The dependent variable takes a value of 1 if a borrower becomes past due on her loans in period t. *D ln(XR)* is the change in the log exchange rate between the USD and the currency of the country where the borrower resides from quarter $t-1$ to t. The exchange rate is defined as LC/USD. FC is the foreign currency share of a firms' loans. Standard errors are clustered by country-quarter. *, ** and *** denote significance at the 10%, 5% and 1% level.

Table 7: Baseline results for quarterly and lagged cumulative exchange rate changes

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
D ln(XR)	1.666***	-1.484	-2.842**				
	(0.496)	(1.292)	(1.174)				
D ln(XR) X FC		3.573***	4.420***	5.381***	5.586***	9.359***	11.19**
		(1.353)	(1.240)	(1.973)	(1.959)	(3.059)	(4.478)
L Cum. D ln(XR)	0.159	-0.611**	-1.188***	-1.074***	-4.955**	-5.826	-4.131
	(0.136)	(0.261)	(0.313)	(0.364)	(2.404)	(3.865)	(6.267)
L Cum. D ln(XR) X FC		0.832***	1.300***	1.465***	1.281***	1.551***	1.720**
		(0.280)	(0.320)	(0.366)	(0.389)	(0.587)	(0.801)
Lagged rating	0.0308	0.0301	0.0285	0.0338	-0.0325	-0.0373	
	(0.0276)	(0.0277)	(0.0270)	(0.0312)	(0.0356)	(0.0584)	
Ln(loan size)	-0.0570***	-0.0684***	-0.0961***	-0.106***	-0.152***	-0.184***	-0.115**
	(0.0164)	(0.0171)	(0.0196)	(0.0225)	(0.0301)	(0.0466)	(0.0577)
Ln(maturity)	-0.0247	-0.0120	-0.0710*	-0.103**	-0.0920*	-0.114	-0.124
	(0.0344)	(0.0342)	(0.0431)	(0.0503)	(0.0540)	(0.0918)	(0.116)
FC		0.0145	-0.0202	-0.0361	-0.0149	-0.159	-0.233
		(0.0701)	(0.0792)	(0.0960)	(0.0970)	(0.149)	(0.226)
D ln(XR) X ln(loan size)					-0.237	0.198	0.386
					(0.412)	(0.668)	(0.900)
D ln(XR) X ln(maturity)					0.956	1.973	2.227
					(0.984)	(1.713)	(1.965)
D ln(XR) X L rating					1.532***	0.909	
					(0.580)	(0.928)	
L Cum. D ln(XR) X ln(loan size)					0.372***	0.387***	0.214
					(0.120)	(0.148)	(0.215)
L Cum. D ln(XR) X ln(maturity)					-0.380	-0.419	-0.811
					(0.300)	(0.521)	(0.677)
L Cum. D ln(XR) X L rating					0.230	0.405	1.213
					(0.159)	(0.313)	(0.819)
Time FE	Yes	Yes	Yes	No	No	No	No
Ct FE	No	No	Yes	No	No	No	No
Ct-time FE	No	No	No	Yes	Yes	No	No
Ct-Time-Ind FE	No	No	No	No	No	Yes	No
Ct-Time-Ind-Rat	No	No	No	No	No	No	Yes
Observations	99981	99981	72009	32711	32711	5611	2994
Pseudo R^2	0.038	0.048	0.090	0.090	0.097	0.164	0.194

Note: This table shows how changes in the exchange rate from the date of origination of the loan to the prior quarter affect the past due status of loans in addition to effects of contemporaneous changes in the exchange rate. The dependent variable takes the value of 1 if a borrower becomes past due on her loans in period t. *D ln(XR)* is the change in the log exchange rate between the USD and the currency of the country where the borrower resides from quarter $t-1$ to t. The exchange rate is defined as LC/USD. *L Cum. D ln (XR)* is the change in the log exchange rate from the date when the loan was originated to quarter $t-1$. FC is the foreign currency share of a firms' loans. Standard errors are clustered by country-quarter. *, ** and *** denote significance at the 10%, 5% and 1% level.

Table 8: Marginal effects

	(1) Probit	(2) Probit ME	(3) OLS	(4) Logit	(5) Logit ME	(6) CLogLog	(7) ClogLog ME
D ln(XR)	-2.842**	-0.0235**	-0.0183**	-7.585**	-0.0218**	-7.540**	-0.0218**
	(1.174)	(0.00983)	(0.00905)	(3.511)	(0.0102)	(3.505)	(0.0102)
D ln(XR) X FC	4.420***	0.0366***	0.0445***	11.89***	0.0342***	11.81***	0.0341***
	(1.240)	(0.0104)	(0.0130)	(3.697)	(0.0107)	(3.687)	(0.0108)
L Cum. D ln(XR)	-1.188***	-0.00984***	-0.00635***	-3.582***	-0.0103***	-3.575***	-0.0103***
	(0.313)	(0.00265)	(0.00175)	(0.975)	(0.00287)	(0.973)	(0.00288)
L Cum. D ln(XR) X FC	1.300***	0.0108***	0.00703***	3.911***	0.0113***	3.905***	0.0113***
	(0.320)	(0.00273)	(0.00208)	(0.988)	(0.00294)	(0.986)	(0.00294)
Ct FE	Yes	No	No	Yes	No	Yes	No
Time FE	Yes	No	No	Yes	No	Yes	No
Observations	72009	72009	72009	72009	72009	72009	72009
R^2	-	-	0.004	-	-		-
Pseudo R^2	0.090	-	-	0.091	-		-

Note: This table shows the results from estimating the baseline regression equation using different estimation techniques along with the resulting marginal effects. The dependent variable takes the value of 1 if a borrower becomes past due on her loans in period t. *D ln(XR)* is the change in the log exchange rate between the USD and the currency of the country where the borrower resides from quarter $t-1$ to t. The exchange rate is defined as LC/USD. *L Cum. D ln (XR)* is the change in the log exchange rate from the date when the loan was originated to quarter $t-1$. FC is the foreign currency share of a firms' loans. Column 1 is equivalent to column 3 of table 7. Column 2 has the corresponding marginal effects. Column 3 was estimated using OLS. Column 4 shows results from logit regressions, with marginal effects displayed in column 5. Column 6 results from estimating a CLogLog specification. Associated marginal effects are presented in column 7. Additional controls are included but are not displayed. Standard errors are clustered by country-quarter. *, ** and *** denote significance at the 10%, 5% and 1% level.

Table 9: Depreciation vs. appreciation

	Quart. Change		Cum. Change	
	(1)	(2)	(3)	(4)
D ln(XR)	9.167		4.847*	4.652
	(6.932)		(2.939)	(3.499)
D ln(XR) X FC	-8.810**	-11.37*	-8.491***	-8.699***
	(4.273)	(5.831)	(2.962)	(3.362)
D ln(XR) X depr.	-11.59***		-9.856***	-11.14***
	(3.926)		(2.481)	(2.934)
D ln(XR) X FC X depr.	12.20***	15.84**	11.09***	11.74***
	(4.719)	(6.323)	(3.034)	(3.450)
FC X depr.	0.485***	0.565***	0.186	0.119
	(0.155)	(0.212)	(0.167)	(0.191)
Deprec.	-0.333***		-0.182	-0.176
	(0.125)		(0.127)	(0.151)
Ct FE	Yes	No	Yes	No
Time FE	Yes	No	Yes	No
Ct-time FE	No	Yes	No	Yes
Observations	119767	51811	96537	45257
Pseudo R^2	0.102	0.084	0.102	0.096

Note: This table analyzes potential asymmetric effects of currency appreciations and depreciations. The dependent variable takes the value of 1 if a borrower becomes past due on her loans in period t. In columns 1 and 2, *D ln(XR)* stands for the change in the log exchange rate between the USD and the currency of the country where the borrower resides from quarter $t-1$ to quarter t. In columns 3 and 4, it stands for the change in the log exchange rate from the date when the loan was originated to quarter t. The exchange rate is defined as LC/USD. FC is the foreign currency share of a firms' loans. *depr.* represents a dummy variable that takes the value of 1 if $Dln(XR) > 0$, meaning that the local currency depreciated. Standard errors are clustered by country-quarter. *, ** and *** denote significance at the 10%, 5% and 1% level.

Table 10: Sales as a natural hedge

	Quart. Change		Cum. Change	
	(1)	(2)	(3)	(4)
D ln(XR)	-15.19**		-7.155***	-7.907***
	(7.093)		(1.947)	(2.529)
D ln(XR) X FC	5.136***	7.336***	2.519***	3.100***
	(1.592)	(2.498)	(0.573)	(0.772)
D ln(XR) X for. sales	6.033***	7.795**	1.165	1.554
	(2.313)	(3.370)	(1.079)	(1.358)
D ln(XR) X FC X for. sales	-7.131**	-9.068*	-2.965**	-3.512**
	(3.632)	(4.764)	(1.330)	(1.649)
FC X for. sales	-0.500***	-0.474**	-0.210	-0.181
	(0.187)	(0.230)	(0.219)	(0.260)
For. sales share	-0.0273	-0.0992	0.000333	-0.0475
	(0.134)	(0.163)	(0.159)	(0.195)
Ct FE	Yes	No	Yes	No
Time FE	Yes	No	Yes	No
Ct-time FE	No	Yes	No	Yes
Observations	100353	40582	79357	34879
R^2				
Pseudo R^2	0.099	0.083	0.100	0.093

Note: This table analyzes whether the effect of exchange rate changes differs across industries with varying shares of international sales in total sales. The dependent variable takes the value of 1 if a borrower becomes past due on her loans in period t. In columns 1 and 2, *D ln(XR)* stands for the change in the log exchange rate between the USD and the currency of the country where the borrower resides from quarter $t-1$ to quarter $t-1$. In columns 3 and 4 instead, it stands for the change in the log exchange rate from the date when the loan was originated to quarter t. The exchange rate is defined as LC/USD. FC is the foreign currency share of a firms' loans. *for. sales* represents the average share of sales that go abroad for an industry-country-quarter combination derived from Worldscope. Additional controls are included but are not displayed. Standard errors are clustered by country-quarter. *, ** and *** denote significance at the 10%, 5% and 1% level.

Table 11: Determinants of the denomination of a loan

	(1)	(2)	(3)	(4)	(5)
	Reg. coeff.	Margin. eff.	Reg coeff.	Reg coeff.	Reg coeff.
Foreign Sales Share	0.147**	0.0478**	0.335***	0.163***	0.405***
	(0.0682)	(0.0221)	(0.0790)	(0.0631)	(0.0826)
Ln(loan size)	0.101***	0.0326***	0.113***	0.107***	0.0903***
	(0.0101)	(0.00323)	(0.0121)	(0.0101)	(0.0102)
Ln(maturity)	-0.165***	-0.0533***	-0.118***	-0.176***	-0.159***
	(0.0182)	(0.00575)	(0.0210)	(0.0174)	(0.0173)
Int. rate. diff.	4.713***	1.528***			
	(1.252)	(0.406)			
UIP diff.			2.649***		
			(0.940)		
Constant	0.637		0.293	1.413*	0.570
	(0.526)		(0.591)	(0.800)	(0.801)
Time FE	Yes	No	Yes	No	No
Country FE	Yes	No	Yes	No	No
Rating FE	Yes	Yes	Yes	Yes	Yes
Country-time FE	No	No	No	Yes	Yes
Industry-time FE	No	No	No	No	Yes
Observations	15888	15888	11285	15948	15719
Pseudo R^2	0.152		0.143	0.191	0.227

Note: This table explores the factors that determine whether a loan is denominated in foreign or domestic currency. The dependent variable takes the value of 1 if the loan is denominated in a currency other than that of the country where the borrower resides. *Foreign Sales Share* represents the average share of sales that go abroad specific to an industry-country-quarter combination derived from Worldscope. *Int. rate. diff* stands for the difference in the average interest rate of a local currency loan and a USD loan specific to a country and quarter. *UIP diff.* represents the average UIP deviation for loans to a country in a given quarter, calculated as the difference in average interest rates where interest rates have been adjusted for exchange rate expectations. With the exception of column 2, all columns show regression results, while column 2 displays marginal effects associated with the coefficients shown in column 1. Standard errors are clustered by country-quarter. *, ** and *** denote significance at the 10%, 5% and 1% level.

Table 12: Distinguishing between fixed rate and variable rate loans

	Quart. Change		Cum. Change	
	(1)	(2)	(3)	(4)
	Fixed Rate	Variable Rate	Fixed Rate	Variable Rate
D ln(XR)			-15.82**	-2.022
			(6.259)	(2.648)
D ln(XR) X FC	3.668**	2.632	2.272***	1.480**
	(1.669)	(2.456)	(0.737)	(0.632)
FC	-0.274*	0.162	-0.427***	0.0550
	(0.143)	(0.111)	(0.154)	(0.123)
D ln(XR) X ln(loan size)	-0.518	-0.418	0.563**	0.160
	(0.830)	(0.507)	(0.240)	(0.131)
D ln(XR) X ln(maturity)	0.559	0.426	0.405	-0.455
	(1.434)	(0.727)	(0.621)	(0.362)
D ln(XR) X L rating	1.049	1.857**	0.523*	0.415
	(0.731)	(0.823)	(0.273)	(0.264)
Ln(loan size)	-0.0909**	-0.0834***	-0.199***	-0.138***
	(0.0389)	(0.0298)	(0.0529)	(0.0334)
Ln(maturity)	-0.130**	-0.0579	-0.128*	-0.0595
	(0.0651)	(0.0483)	(0.0742)	(0.0559)
Lagged rating	0.0117	0.00385	-0.0510	-0.0139
	(0.0575)	(0.0362)	(0.0588)	(0.0425)
Ct-time FE	Yes	Yes	Yes	Yes
Observations	10616	19099	8395	16559
Pseudo R^2	0.111	0.126	0.140	0.137

Note: This table explores differences in exchange rate effects for borrowers with floating-rate versus fixed-rate loans. Columns 1 and 3 show results for borrowers with fixed-rate loans, columns 2 and 4 are for borrowers with floating-rate loans. The dependent variable takes the value of 1 if a borrower becomes past due on her loans in period t. In columns 1 and 2, *D ln(XR)* stands for the change in the log exchange rate between the USD and the currency of the country where the borrower resides from quarter $t-1$ to quarter t. In columns 3 and 4, it stands for the change in the log exchange rate from the date when the loan was originated to quarter t. The exchange rate is defined as LC/USD. FC is the foreign currency share of a firms' loans. Standard errors are clustered by country-quarter. *, ** and *** denote significance at the 10%, 5% and 1% level.

Table 13: Controlling for country-quarter-interest-rate-type fixed effects

	Quart. Change			Cum. Change		
	(1)	(2)	(3)	(4)	(5)	(6)
D ln(XR)				-5.446**	-7.845*	-2.002
				(2.463)	(4.275)	(4.481)
D ln(XR) X FC	2.327	6.095**	4.106	1.989***	3.132***	4.681***
	(1.584)	(2.950)	(4.152)	(0.460)	(0.799)	(1.100)
FC	0.00374	-0.0560	-0.121	-0.139	-0.219	-0.473**
	(0.0889)	(0.139)	(0.205)	(0.0906)	(0.142)	(0.207)
D ln(XR) X ln(loan size)	-0.507	-0.175	-0.475	0.231**	0.359**	0.181
	(0.395)	(0.593)	(0.749)	(0.107)	(0.173)	(0.209)
D ln(XR) X ln(maturity)	0.480	0.905	1.703	-0.241	-0.264	-0.606
	(0.747)	(0.971)	(1.281)	(0.312)	(0.517)	(0.602)
D ln(XR) X L rating	1.617***	1.648*		0.431**	0.420	
	(0.585)	(0.873)		(0.203)	(0.410)	
Ln(loan size)	-0.0855***	-0.116***	-0.0684	-0.140***	-0.174***	-0.108*
	(0.0257)	(0.0399)	(0.0486)	(0.0281)	(0.0461)	(0.0552)
Ln(maturity)	-0.105***	-0.114*	-0.127*	-0.0371	-0.0396	0.0275
	(0.0396)	(0.0591)	(0.0677)	(0.0489)	(0.0829)	(0.106)
Lagged rating	0.00622	0.0404		-0.00607	-0.00977	
	(0.0331)	(0.0519)		(0.0368)	(0.0641)	
Ct-time-int. type FE	Yes	Yes	Yes	Yes	Yes	Yes
Ct-Time-Ind FE	No	Yes	No	No	Yes	No
Ct-Time-Ind-Rat	No	No	Yes	No	No	Yes
Observations	26431	6326	3506	22941	5503	3082
Pseudo R^2	0.124	0.178	0.190	0.134	0.189	0.205

Note: This table explores the robustness of the results to the inclusion of various combinations of fixed effects. The dependent variable takes the value of 1 if a borrower becomes past due on her loans in period t. In columns 1 through 3, *D ln(XR)* stands for the change in the log exchange rate between the USD and the currency of the country where the borrower resides from quarter $t-1$ to quarter t. In columns 4 through 6, it stands for the change in the log exchange rate from the date when the loan was originated to quarter t. The exchange rate is defined as LC/USD. FC is the foreign currency share of a firms' loans. Columns 1 and 4 include country-quarter-interest-rate-type fixed effects. Columns 2 and 5 have country-quarter-industry fixed effects. Columns 3 and 6 control for country-quarter-industry-rating fixed effects. Standard errors are clustered by country-quarter. *, ** and *** denote significance at the 10%, 5% and 1% level.

Table 14: Controlling for the interest rate borrowers' pay

	Quart. Change			Cum. Change		
	(1)	(2)	(3)	(4)	(5)	(6)
D ln(XR)				-6.769***	-9.826***	-5.231
				(2.075)	(3.302)	(3.787)
D ln(XR) X FC	3.388**	6.670***	6.744**	1.940***	2.392***	2.747***
	(1.571)	(2.383)	(3.266)	(0.416)	(0.586)	(0.767)
L ln(Int) X Floating	-0.00595	0.0102	0.0344	-0.00317	0.0260	0.0413
	(0.0295)	(0.0356)	(0.0407)	(0.0290)	(0.0363)	(0.0429)
L ln(Int) X Fix	0.0645**	0.0863**	0.127**	0.0593**	0.0999**	0.131**
	(0.0308)	(0.0390)	(0.0525)	(0.0302)	(0.0410)	(0.0538)
D ln(XR) X L ln(Int) X Floating	-0.707	-0.410	-0.645	-0.956*	-0.782	-1.188
	(0.569)	(0.659)	(0.795)	(0.580)	(0.706)	(0.958)
D ln(XR) X L ln(Int) X Fix	0.369	0.341	0.240	0.157	0.101	-0.290
	(0.577)	(0.684)	(0.951)	(0.543)	(0.758)	(1.124)
Ct-time FE	Yes	No	No	Yes	No	No
Ct-Time-Ind FE	No	Yes	No	No	Yes	No
Ct-Time-Ind-Rat	No	No	Yes	No	No	Yes
Observations	50107	9849	5167	43956	8382	4494
Pseudo R^2	0.103	0.155	0.184	0.114	0.164	0.192

Note: This table explores the robustness of the results. Regressions include an interaction term between the lagged interest rate the borrower pays and the change in the exchange rate. The coefficients on the interaction terms are estimated separately for borrowers with floating-rate versus fixed-rate loans. The dependent variable takes the value of 1 if a borrower becomes past due on her loans in period t. In columns 1 through 3, *D ln(XR)* stands for the change in the log exchange rate between the USD and the currency of the country where the borrower resides from quarter $t-1$ to quarter t. In columns 4 through 6, it stands for the change in the log exchange rate from the date when the loan was originated to quarter t. The exchange rate is defined as LC/USD. FC is the foreign currency share of a firms' loans. *L ln(int)* stands for the lagged log interest rate the borrower pays for her loans. *Floating* is a dummy variable that takes the value of 1 if the borrower has only floating-rate loans. *Fix* is a dummy variable that takes the value of 1 if the borrower has only fixed-rate loans. Standard errors are clustered by country-quarter. *, ** and *** denote significance at the 10%, 5% and 1% level.

Table 15: Controlling for the oil price

	Quart. Change			Cum. Change		
	(1)	(2)	(3)	(4)	(5)	(6)
D ln(XR)				-5.715***	-8.681***	-3.166
				(1.928)	(3.091)	(3.591)
D ln(XR) X FC	5.181***	8.436***	10.30***	2.083***	2.370***	2.725***
	(1.908)	(2.726)	(3.952)	(0.413)	(0.540)	(0.702)
FC	0.0996	-0.0292	-0.0920	-0.0607	-0.168	-0.255
	(0.0833)	(0.116)	(0.159)	(0.0787)	(0.116)	(0.161)
D ln(XR) X ln(loan size)	-0.206	-0.0426	-0.275	0.236***	0.316***	0.164
	(0.332)	(0.558)	(0.713)	(0.0872)	(0.120)	(0.162)
D ln(XR) X ln(maturity)	0.458	0.937	1.711	-0.185	-0.0162	-0.191
	(0.603)	(0.758)	(1.098)	(0.248)	(0.444)	(0.495)
D ln(XR) X L rating	1.294***	1.653***		0.360***	0.443*	
	(0.434)	(0.641)		(0.118)	(0.228)	
Ln(loan size)	-0.0710***	-0.105***	-0.0628	-0.125***	-0.162***	-0.0944*
	(0.0220)	(0.0352)	(0.0435)	(0.0256)	(0.0391)	(0.0482)
Ln(maturity)	-0.0854**	-0.0983**	-0.130**	-0.0461	-0.0529	-0.0540
	(0.0335)	(0.0471)	(0.0546)	(0.0411)	(0.0645)	(0.0848)
Lagged rating	0.00968	0.0292		-0.00795	-0.0150	
	(0.0279)	(0.0410)		(0.0314)	(0.0483)	
D ln(oil price) X FC	0.175	0.430	0.785	-0.360	-0.559	-0.465
	(0.387)	(0.514)	(0.723)	(0.351)	(0.438)	(0.577)
Ct-time FE	Yes	No	No	Yes	No	No
Ct-Time-Ind FE	No	Yes	No	No	Yes	No
Ct-Time-Ind-Rat	No	No	Yes	No	No	Yes
Observations	51811	9987	5220	45257	8490	4542
Pseudo R^2	0.080	0.143	0.172	0.092	0.154	0.179

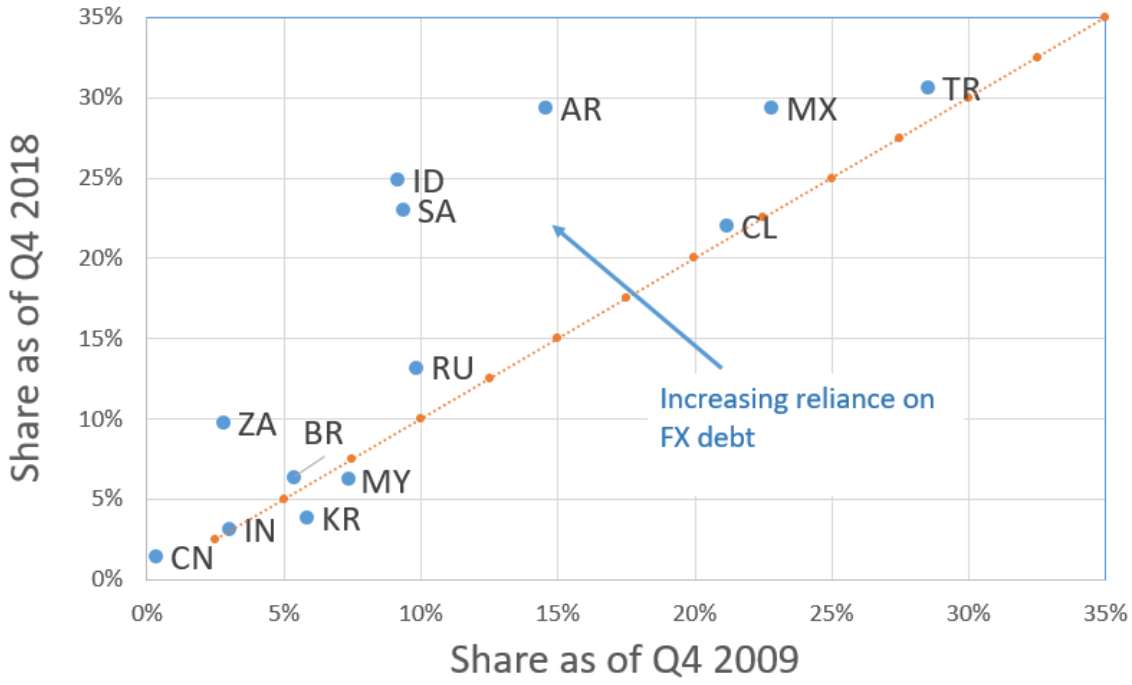
Note: This table tests whether results are robust to the inclusion of an interaction term between the foreign currency share *FC* and the log change in the oil price. The dependent variable takes the value of 1 if a borrower becomes past due on her loans in period t. In columns 1 through 3, *D ln(XR)* stands for the change in the log exchange rate between the USD and the currency of the country where the borrower resides from quarter $t-1$ to quarter t. In columns 4 through 6, it stands for the change in the log exchange rate from the date when the loan was originated to quarter t. The exchange rate is defined as LC/USD. FC is the foreign currency share of a firms' loans. Standard errors are clustered by country-quarter. *, ** and *** denote significance at the 10%, 5% and 1% level.

Table 16: Excluding the oil sector and commodities

	Quart. Change			Cum. Change		
	(1)	(2)	(3)	(4)	(5)	(6)
D ln(XR)				-5.709***	-8.136**	-3.562
				(1.970)	(3.171)	(3.652)
D ln(XR) X FC	4.644***	6.913***	7.609**	2.112***	2.449***	2.789***
	(1.686)	(2.314)	(3.093)	(0.420)	(0.555)	(0.719)
FC	0.101	-0.0245	-0.0850	-0.0332	-0.140	-0.220
	(0.0835)	(0.113)	(0.153)	(0.0754)	(0.108)	(0.145)
D ln(XR) X ln(loan size)	-0.173	-0.0159	-0.293	0.229**	0.287**	0.196
	(0.345)	(0.555)	(0.712)	(0.0901)	(0.127)	(0.159)
D ln(XR) X ln(maturity)	0.456	0.976	1.662	-0.178	-0.00739	-0.202
	(0.600)	(0.761)	(1.098)	(0.254)	(0.452)	(0.503)
D ln(XR) X L rating	1.302***	1.682***		0.362***	0.406*	
	(0.445)	(0.647)		(0.126)	(0.231)	
Ln(loan size)	-0.0655***	-0.103***	-0.0557	-0.116***	-0.152***	-0.0902*
	(0.0223)	(0.0351)	(0.0436)	(0.0258)	(0.0393)	(0.0484)
Ln(maturity)	-0.0841**	-0.0964**	-0.124**	-0.0441	-0.0530	-0.0537
	(0.0336)	(0.0474)	(0.0549)	(0.0417)	(0.0658)	(0.0862)
Lagged rating	0.0126	0.0294		-0.00349	-0.00983	
	(0.0286)	(0.0418)		(0.0321)	(0.0493)	
Ct-time FE	Yes	No	No	Yes	No	No
Ct-Time-Ind FE	No	Yes	No	No	Yes	No
Ct-Time-Ind-Rat	No	No	Yes	No	No	Yes
Observations	49977	9896	5177	43563	8402	4499
Pseudo R^2	0.080	0.142	0.169	0.090	0.150	0.178

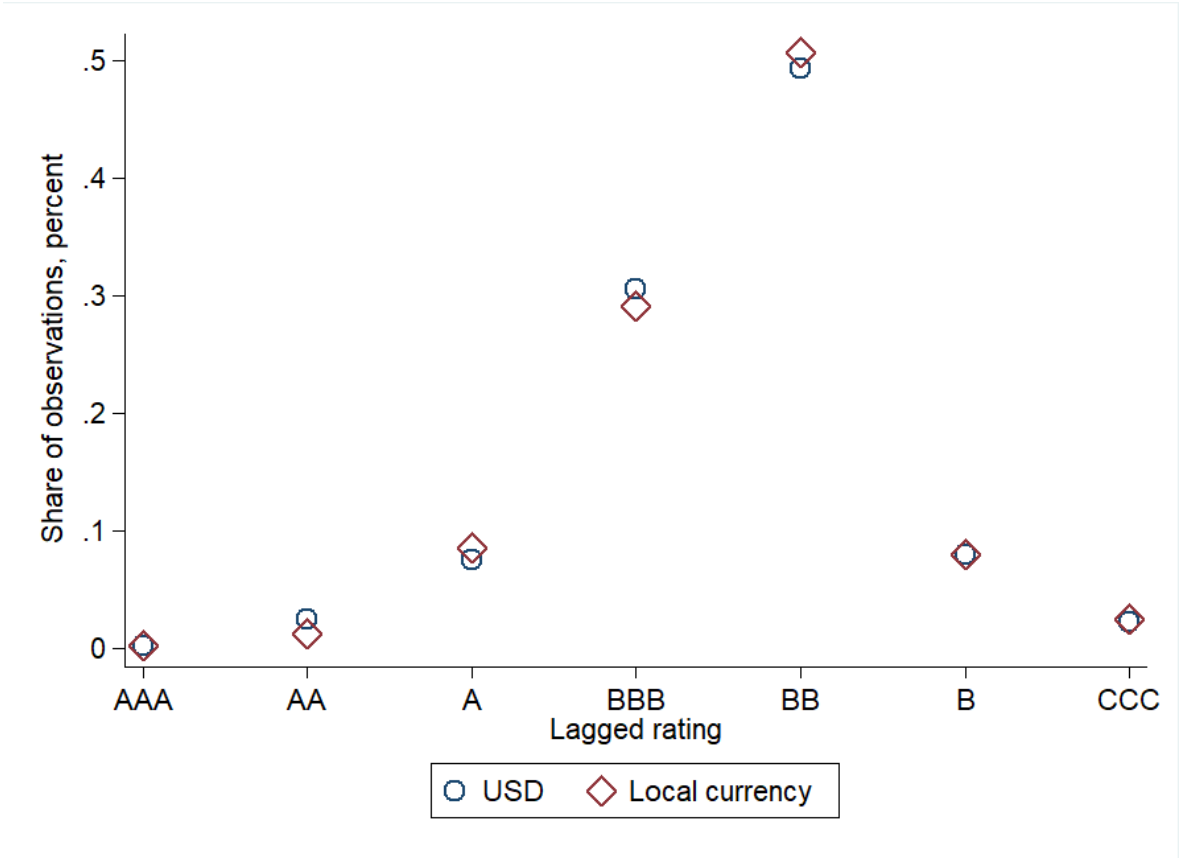
Note: This table shows results when borrowers in the oil sector and other commodity sectors are excluded from the sample. The dependent variable takes the value of 1 if a borrower becomes past due on her loans in period t. In columns 1 through 3, *D ln(XR)* stands for the change in the log exchange rate between the USD and the currency of the country where the borrower resides from quarter $t-1$ to quarter t. In columns 4 through 6, it stands for the change in the log exchange rate from the date when the loan was originated to quarter t. The exchange rate is defined as LC/USD. FC is the foreign currency share of a firms' loans. Standard errors are clustered by country-quarter. *, ** and *** denote significance at the 10%, 5% and 1% level.

Figure 1: Foreign currency debt as a share of total credit to the non-financial sector for select countries



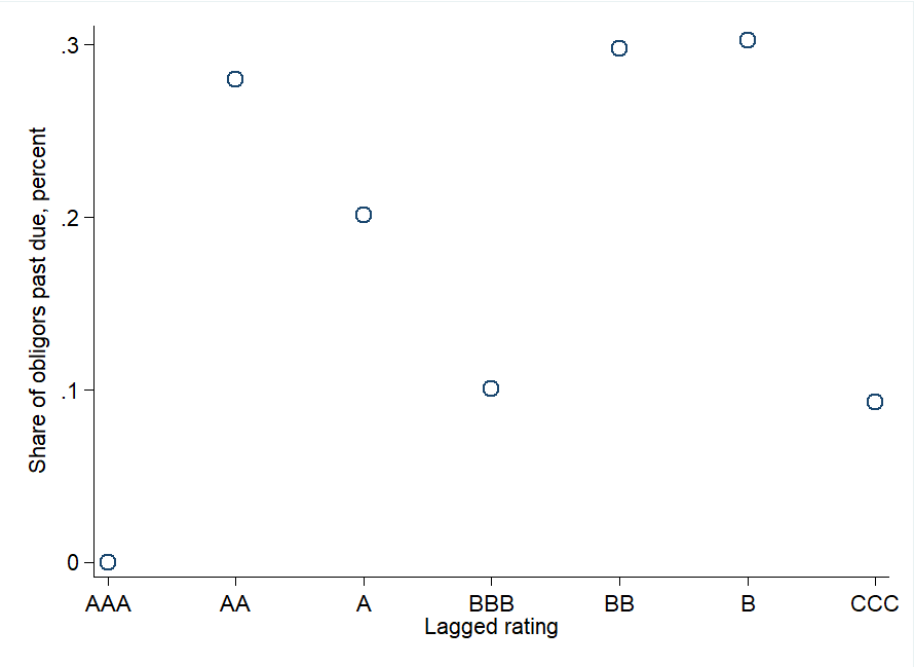
Note: This figure shows various countries' foreign currency bonds and loans as a share of total credit to the non-financial sector for two points in time. The y-axis has the shares as of 2018:4. The x-axis has the shares as of 2009:Q4. Shares were calculated using the BIS Global Liquidity Indicators and the BIS Total Credit Series.

Figure 2: Distribution of ratings by currency



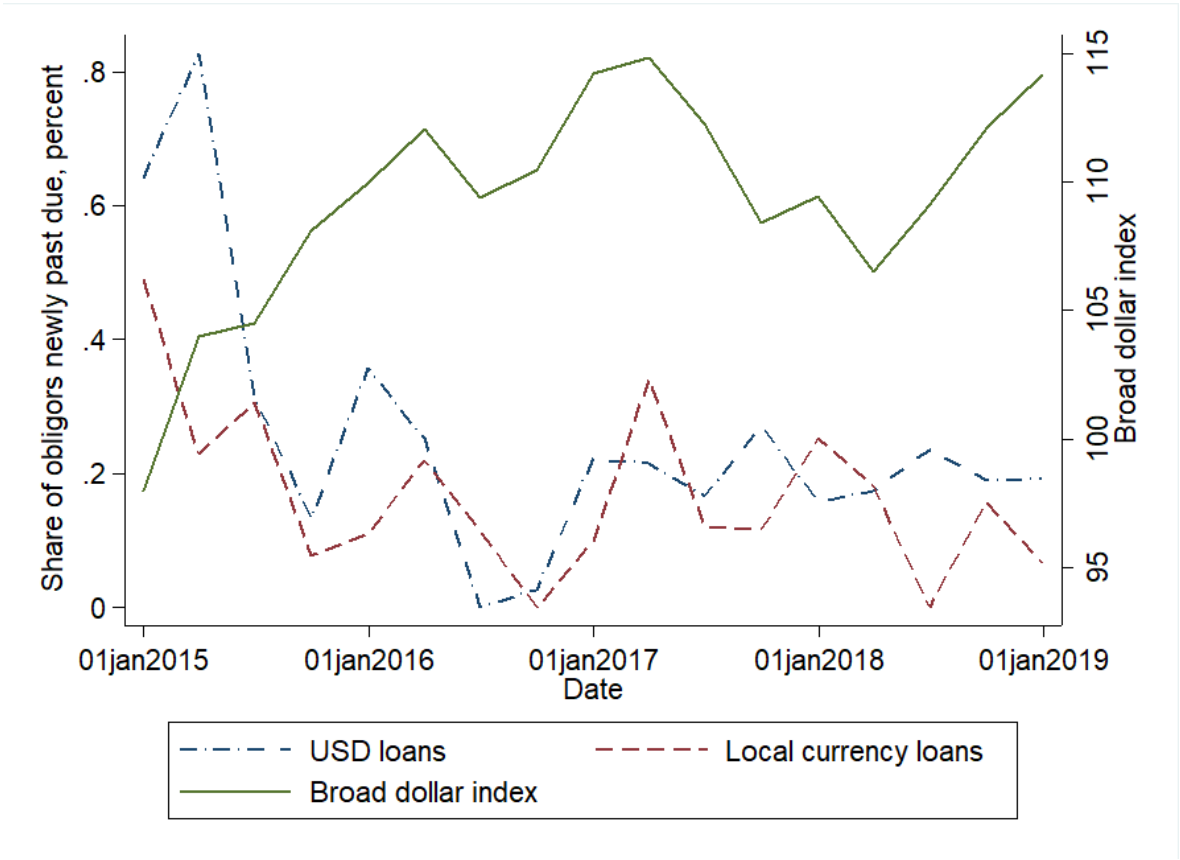
Note: This figure shows the share of observations in each ratings bucket. Borrowers have been split into those that borrow in local currency (diamonds) and those that borrow in USD (circles).

Figure 3: Share of obligors that become past due by lagged rating



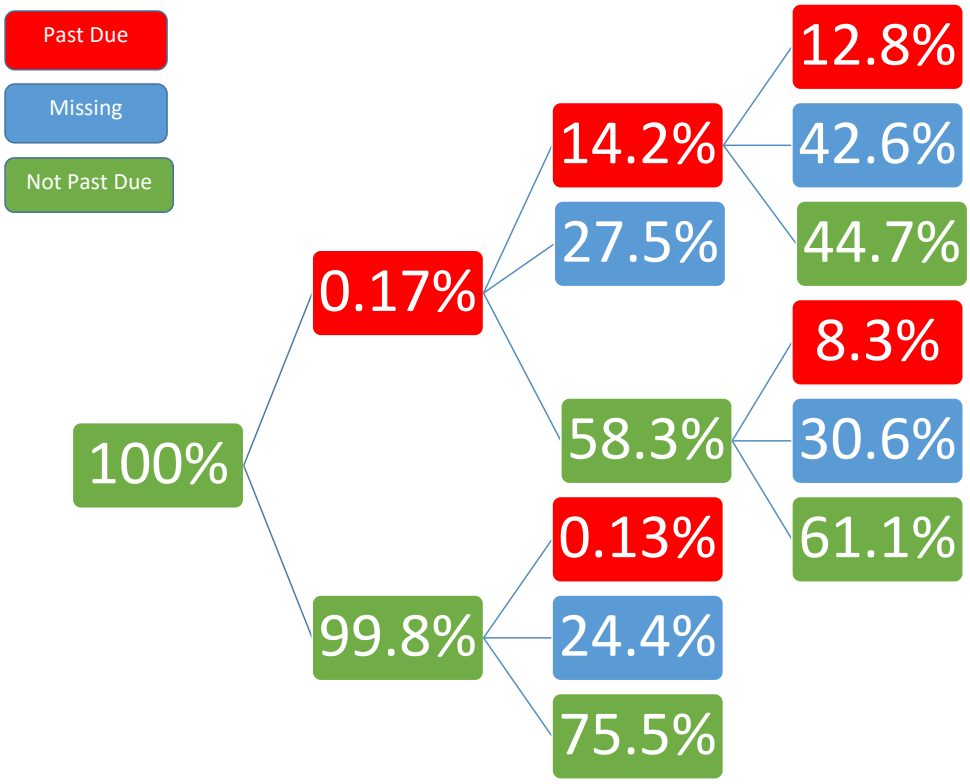
Note: This figure shows the share of borrowers that become past due within each ratings bucket, where borrowers' ratings have been lagged by a quarter.

Figure 4: Past due status by currency



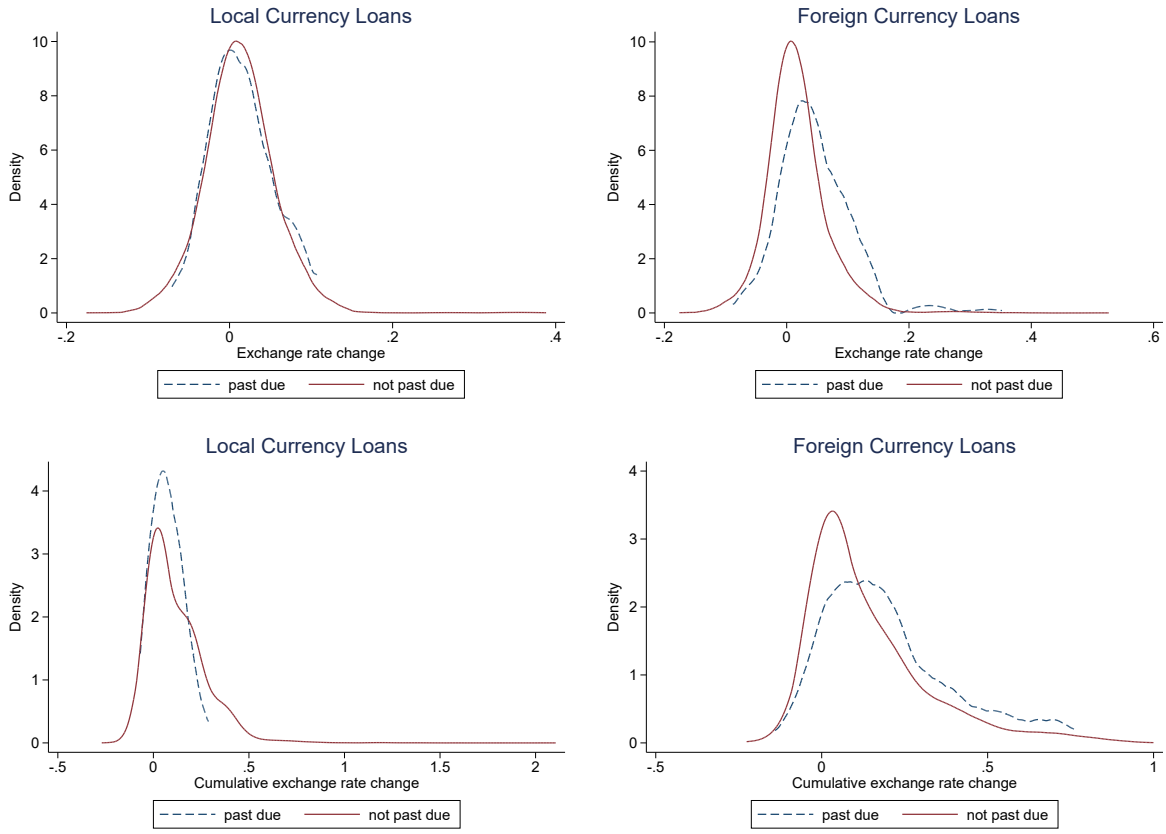
Note: This figure shows the share of borrowers that become past due on their loans over time on the left y-axis, where borrowers have been split into those that borrow in local currency (dashed line) and those that borrow in dollars (dash-dotted line). The solid line corresponds to the broad dollar index, a trade-weighted dollar index computed by the Federal Reserve Board, which is plotted on the right y-axis.

Figure 5: Tracking loans' past due status over time



Note: This figure illustrates the past-due status of loans over time. All loans start out as performing, but after one quarter $(t+1)$, 0.17 percent of the loans are past due, while 99.8 percent remain performing. Of the 0.17 percent loans that become past due, 58.3 percent become performing again in $t+2$, whereas 14.2 percent remain past due. 27.5 percent disappear from the sample. 12.8 percent of the 14.2 percent of loans that were past due in quarter $t+1$ and $t+2$ are still past due in $t+3$.

Figure 6: Exchange rate changes and past due status



Note: This figure presents key findings of this paper in graphical form. The four panels show the kernel density estimates of quarterly exchange rate changes for firms that become past due on loans (dashed line) and firms that do not become past due (solid line). The left panels show kernel density estimates for firms that borrow in local currency. The right panels plot kernel densities for firms that borrow in foreign currency. The top panel has quarterly exchange rate changes on the x-axis. The bottom panel shows the distribution of exchange rate changes since the origination of the loan. Exchange rates are defined as LC/USD so that a positive change indicates an appreciation of the USD against the currency of the country where the borrower resides.

A Data Appendix

A.1 Y-14 data

There are several cleaning procedures which we apply to the raw Y-14 data to obtain the borrower-level dataset. Among other steps, we drop observations with missing customer id or loan id, loans with a D (default) rating that are not declared past due, and loans where the currency changed over time. A firm is identified as a combination of a unique customer id, bank id and country. We drop loans with zero utilized exposure.

A.2 Other data sources

- USD Index: Trade-weighted "broad" USD index, calculated by Federal Reserve Board staff.
- Average share of foreign sales by country, industry and quarter: Thomson Reuters Worldscope.
- Exchange rates: Quarterly data from the International Financial Statistics (IFS) provided by the IMF.
- Exchange rate volatility: Quarterly exchange rate volatility calculated as the standard deviation of daily exchange rates within a quarter.
- Oil price: Downloaded from Haver.
- Inflation: Consumer Price Inflation from the International Financial Statistics (IFS) provided by the IMF.
- Exchange rate expectations: 24-month ahead forecast from the Survey of Professional Forecasters.

B Additional Tables

Table 17: Differences in interest rates between USD and local currency loans, robustness

	Fixed Rate				Floating Rate			
	(1) Int	(2) Int	(3) UIP	(4) UIP	(5) Int	(6) Int	(7) UIP	(8) UIP
FC	-1.155**	-2.451***	-0.856	-3.104***	-1.170***	-4.803***	-0.597	-5.031***
	(0.453)	(0.539)	(0.806)	(1.050)	(0.290)	(1.134)	(0.377)	(0.560)
FC X Low Volat.		2.773***		4.361***		4.332***		5.346***
		(0.597)		(1.093)		(1.135)		(0.691)
Ln(loan size)	-0.0505	-0.0548	0.0166	0.00597	-0.127***	-0.0916***	-0.132***	-0.0624**
	(0.0333)	(0.0363)	(0.0538)	(0.0556)	(0.0279)	(0.0189)	(0.0356)	(0.0254)
Ln(maturity)	-0.0856	-0.0757	-0.302***	-0.240**	0.220***	0.142***	0.263***	0.124**
	(0.0805)	(0.0781)	(0.105)	(0.101)	(0.0633)	(0.0432)	(0.0927)	(0.0615)
Firm-time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Loan type FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2781	2635	1304	1304	3104	2964	2018	2016
R^2	0.929	0.930	0.919	0.929	0.903	0.925	0.908	0.928

Note: The table explore differences in interest rates borrowers pay between local currency and foreign currency loans similar to table 2 but includes a different set of fixed effects, namely firm-quarter and loan type fixed effects. The sample includes only newly originated loans. In columns 1, 2, 5, and 6, the interest rate paid on a loan during the quarter of loan origination is regressed on a dummy variable FC, which takes the value of 1 if the loan is denominated in a currency other than the currency of the country where the borrower is located. In columns, 3, 4, 7, and 8, the interest rate was adjusted for the expected change in the exchange rate over the next 24 months from the Survey of Professional forecasters. As a result, the coefficient on the variable FC in these columns measures the average UIP deviation in the data. $Low\ Volat.$ is a dummy variable that takes the value of 1 for borrowers in countries with below median exchange rate volatility and zero otherwise. Columns 1 through 4 include loans with fixed interest rates, while columns 5 through 8, include floating rate loans. Standard errors are clustered by bank-quarter. *, ** and *** denote significance at the 10%, 5% and 1% level.

Table 18: Baseline regressions, OLS

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
D ln(XR)	0.0183***	-0.00269	-0.00960				
	(0.00509)	(0.00682)	(0.00721)				
D ln(XR) X FC		0.0294***	0.0322***	0.0366***	0.0398***	0.0338***	0.0294***
		(0.0104)	(0.0102)	(0.0112)	(0.0115)	(0.00864)	(0.00965)
Lagged rating	0.000348**	0.000337**	0.000280*	0.000309**	0.000106	0.0000868	
	(0.000150)	(0.000148)	(0.000146)	(0.000147)	(0.000140)	(0.000160)	
Ln(loan size)	-0.000265***	-0.000333***	-0.000484***	-0.000485***	-0.000394***	-0.000488***	-0.000287**
	(0.0000896)	(0.0000953)	(0.000111)	(0.000112)	(0.000104)	(0.000132)	(0.000139)
Ln(maturity)	-0.000334**	-0.000341**	-0.000436***	-0.000392**	-0.000361**	-0.000323**	-0.000288*
	(0.000165)	(0.000166)	(0.000169)	(0.000169)	(0.000145)	(0.000153)	(0.000151)
FC		0.000630*	0.000918**	0.000834**	0.000766*	0.0000727	-0.000142
		(0.000353)	(0.000432)	(0.000416)	(0.000409)	(0.000392)	(0.000421)
D ln(XR) X ln(loan size)					-0.00612**	-0.00541	-0.00459
					(0.00271)	(0.00379)	(0.00376)
D ln(XR) X ln(maturity)					-0.000857	0.00126	0.00506
					(0.00479)	(0.00497)	(0.00680)
D ln(XR) X L rating					0.0121***	0.0128***	
					(0.00385)	(0.00454)	
Time FE	Yes	Yes	Yes	No	No	No	No
Ct FE	No	No	Yes	No	No	No	No
Ct-time FE	No	No	No	Yes	Yes	No	No
Ct-time-Ind FE	No	No	No	No	No	Yes	No
Ct-Time-Ind-Rat FE	No	No	No	No	No	No	Yes
Observations	147103	147103	147103	147084	147084	142347	130399
Pseudo R^2							

Note: This table shows the effect of exchange rate changes on the past due status of borrowers similar to table 6. However, this table shows results from OLS estimations in contrast to the probit results displayed in the aforementioned table. The dependent variable takes a value of 1 if a borrower becomes past due on her loans in period t. *D ln(XR)* is the change in the log exchange rate between the USD and the currency of the country where the borrower resides from quarter $t-1$ to t. The exchange rate is defined as LC/USD. FC is the foreign currency share of a firms' loans. Standard errors are clustered by country-quarter. *, ** and *** denote significance at the 10%, 5% and 1% level.

Table 19: Marginal effects associated with key coefficents from table 7

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
D ln(XR)	0.0107***	-0.00945	-0.0235**				
	(0.00322)	(0.00833)	(0.00983)				
D ln(XR) X FC		0.0228**	0.0366***	0.0899***	0.0926***	0.626***	1.103**
		(0.00892)	(0.0104)	(0.0329)	(0.0324)	(0.202)	(0.436)
L Cum. D ln(XR)	0.00102	-0.00389**	-0.00984***				
	(0.000870)	(0.00174)	(0.00265)				
L Cum. D ln(XR) X FC		0.00530***	0.0108***	0.0245***	0.0212***	0.104***	0.169**
		(0.00187)	(0.00273)	(0.00610)	(0.00644)	(0.0391)	(0.0785)
Observations	99981	99981	72009	32711	32711	5611	2994
Pseudo R^2							

Note: This table shows the marginal effects associated with key coefficients displayed in table 7.

Table 20: Depreciation versus appreciation, OLS

	Quart. Change		Cum. Change	
	(1)	(2)	(3)	(4)
D ln(XR)	0.129**		0.0189	0.0110
	(0.0598)		(0.0168)	(0.0180)
D ln(XR) X FC	-0.0279*	-0.0386*	-0.0316**	-0.0344**
	(0.0167)	(0.0206)	(0.0149)	(0.0152)
D ln(XR) X depr.	-0.0525***		-0.0329***	-0.0365***
	(0.0170)		(0.00969)	(0.0113)
D ln(XR) X FC X depr.	0.0701***	0.0853***	0.0423***	0.0449***
	(0.0223)	(0.0258)	(0.0152)	(0.0156)
FC X depr.	0.00200**	0.00239**	0.000873	0.00100
	(0.000855)	(0.000960)	(0.000924)	(0.000940)
Deprec.	-0.00160**		-0.000658	-0.00122
	(0.000716)		(0.000722)	(0.000796)
Time FE	Yes	No	Yes	No
Ct FE	Yes	No	Yes	No
Ct-time FE	No	Yes	No	Yes
Observations	146971	146952	127134	127121
Pseudo R^2				

Note: This table is parallel to table 9. Here, regressions were estimated using OLS in contrast to the probit results shown in the aforementioned table. The dependent variable takes the value of 1 if a borrower becomes past due on her loans in period t. In columns 1 and 2, *D ln(XR)* stands for the change in the log exchange rate between the USD and the currency of the country where the borrower resides from quarter $t-1$ to quarter t. In columns 3 and 4, it stands for the change in the log exchange rate from the date when the loan was originated to quarter t. The exchange rate is defined as LC/USD. FC is the foreign currency share of a firms' loans. *depr.* represents a dummy variable that takes the value of 1 if $Dln(XR) > 0$, meaning that the local currency depreciated. Standard errors are clustered by country-quarter. *, ** and *** denote significance at the 10%, 5% and 1% level.

Table 21: Sales as a natural hedge, OLS

	Quart. Change		Cum. Change	
	(1)	(2)	(3)	(4)
D ln(XR)	-0.0483		-0.0340*	-0.0348*
	(0.0610)		(0.0177)	(0.0196)
D ln(XR) X FC	0.0476***	0.0568***	0.0129***	0.0131***
	(0.0149)	(0.0161)	(0.00318)	(0.00334)
D ln(XR) X for. sales	0.0464**	0.0415	-0.000141	0.000508
	(0.0232)	(0.0276)	(0.00489)	(0.00463)
D ln(XR) X FC X for. sales	-0.0796**	-0.0859**	-0.0150**	-0.0146**
	(0.0334)	(0.0354)	(0.00720)	(0.00702)
FC X for. sales	-0.00293***	-0.00277***	-0.00200	-0.00205
	(0.00103)	(0.00104)	(0.00147)	(0.00149)
For. sales share	-0.000147	-0.000297	0.000645	0.000393
	(0.000817)	(0.000823)	(0.00117)	(0.00117)
Time FE	Yes	No	Yes	No
Ct FE	Yes	No	Yes	No
Ct-time FE	No	Yes	No	Yes
Observations	120980	120961	103857	103826
R^2	0.004	0.012	0.004	0.014
Pseudo R^2				

Note: This table is parallel to table 10. Here regressions were estimated using OLS in contrast to the probit results shown in the aforementioned table. The dependent variable takes the value of 1 if a borrower becomes past due on her loans in period t. In columns 1 and 2, *D ln(XR)* stands for the change in the log exchange rate between the USD and the currency of the country where the borrower resides from quarter $t-1$ to quarter $t-1$. In columns 3 and 4 instead, it stands for the change in the log exchange rate from the date when the loan was originated to quarter t. The exchange rate is defined as LC/USD. FC is the foreign currency share of a firms' loans. *for. sales* represents the average share of sales that go abroad specific to an industry-country-quarter combination derived from Worldscope. Additional controls are included but are not displayed. Standard errors are clustered by country-quarter. *, ** and *** denote significance at the 10%, 5% and 1% level.

C Introducing a profitability shock ϵ

In this section, we show how the model works if we introduce an additional reason for firm default. Specifically, assume that the firm has another income stream in local currency, ϵ, that is drawn randomly from a distribution $F(\epsilon)$ with a mean of zero. If a firm borrows in local currency, this implies the following profits in local currency:

$$\Pi^{LC} = \max\{0, (\alpha R - r) + s(1-\alpha)R + \epsilon\}. \tag{18}$$

A firm defaults if the exchange rate is below that minimum rate, that is if:

$$s < \frac{r - \alpha R - \epsilon}{(1-\alpha)R} = \underline{s}. \tag{19}$$

Assuming that the exchange rate s and the additional profit term ϵ are drawn independently, we can calculate the expected default probability when borrowing in local currency as:

$$PD^{LC} = F\left(r - \alpha R - s(1-\alpha)R\right) \tag{20}$$

When a firm borrows in foreign currency, profits, expressed in local currency units, are given by:

$$\Pi^{FC} = \max\{0, \alpha R + s((1-\alpha)R - r^*) + \epsilon\}. \tag{21}$$

If foreign currency income is sufficiently small $\left(1-\alpha < \frac{r^*}{R}\right)$, profits in local currency decrease with the exchange rate s. In this case, the firm defaults on its loan for any value of the exchange rate s that is above $\bar{s}$:

$$s > \frac{\alpha R + \epsilon}{r^* - (1-\alpha)R} = \bar{s}. \tag{22}$$

Again, assuming independence between s and ϵ, we get the probability of default when borrowing in foreign currency as:

$$PD^{FC} = F\left(s(r^* - (1-\alpha)R) - \alpha R\right) \tag{23}$$

Default Risk and Exchange Rates The basic relationship between exchange rates and defaults is captured in the following proposition:

Proposition 4 (Loan default and exchange rates) *When the local currency depreciates (s increases), the probability that a firm defaults on its loan*

i) ***Decreases*** *when*

- *the loan is in* ***local currency*** *and the firm has some foreign currency income* ($1-\alpha > 0$).
- *or the loan is in* ***foreign currency*** *and the firm has significant foreign currency income* ($1-\alpha > \frac{r^*}{R}$)

ii) ***Increases*** *when the loan is in* ***foreign currency*** *and the firm has limited foreign currency income* ($1-\alpha < \frac{r^*}{R}$).

iii) ***Remains unchanged*** *if*

- *the loan is in* ***local currency*** *and the firm has no foreign currency income* ($\alpha = 1$),
- *or the loan is in* ***foreign currency*** *and the firm's foreign income exactly covers its interest costs* ($1-\alpha = \frac{r^*}{R}$).

Proof. *Taking the derivative of equation* (20) *with respect to* s *delivers*

$$\frac{\partial PD^{LC}}{\partial s} = -f(r - \alpha R - s(1-\alpha))(1-\alpha)R,$$

which is negative if $\alpha < 1$. *Taking the derivative of equation* (23) *with respect to* s *delivers*

$$\frac{\partial PD^{FC}}{\partial s} = f(s(r^* - (1-\alpha)R) - \alpha R)(r^* - (1-\alpha)R),$$

which is negative if $1-\alpha > \frac{r^*}{R}$ *and positive if* $1-\alpha < \frac{r^*}{R}$. ■

The proposition is quite intuitive. A local depreciation lowers the default probability if a firm has more foreign currency income than foreign currency interest costs ($1-\alpha > 0$ with a local currency loan or $1-\alpha > \frac{r^*}{R}$ with a foreign currency loan). Conversely, a local depreciation raises the default probability if a firm has less foreign currency income than foreign currency interest costs ($1-\alpha < \frac{r^*}{R}$ with a foreign currency loan). If the foreign income exactly pays for the interest costs, then the exchange rate does not affect default risk.

We are particularly interested in the relative default risk of two firms that borrow in local and foreign currency, respectively, and may generate different shares of their income in local currency (different α). We can prove the following Corollary to Proposition 4.

Corollary 2 (Relative default risk) *Suppose there are two firms that borrow in local and foreign currency, respectively, and suppose that the firm borrowing in foreign currency has less foreign income than foreign interest rate costs* ($1-\alpha^{FC} < \frac{r^*}{R}$). *Then, a local depreciation increases the probability that the firm borrowing in foreign currency defaults relative to the firm borrowing in local currency.*

Proof. Taking the difference between equations (23) and (20) and then taking the derivative with respect to s delivers:

$$\frac{\partial \Delta PD}{\partial s} = f(s(r^* - (1-\alpha)R) - \alpha R)(r^* - (1-\alpha)R) + f(r - \alpha R - s(1-\alpha))(1-\alpha)R.$$

$r^* - (1-\alpha)R > 0$ is a sufficient condition for this derivative to be positive.

Proof of Proposition 5 Taking the derivative of equation (23) with respect to α delivers:

$$\frac{\partial PD^{FC}}{\partial \alpha} = f\left[s(r^* - (1-\alpha)R) - \alpha R\right](s-1)R,$$

which is positive when the local currency depreciates ($s > 1$). Taking the derivative of equation (20) with respect to α delivers:

$$\frac{\partial PD^{LC}}{\partial \alpha} = f\left[r - \alpha R - s(1-\alpha)R\right](s-1)R,$$

which is positive when the local currency depreciates ($s > 1$). ■

Proposition 5 (Default and Foreign Currency Income) *When the local currency depreciates, the probability that a firm defaults on its loan is the higher, the lower is its share of foreign currency income in total income.*

The proposition states that when the local currency depreciates, keeping the composition of borrowing fixed, a higher share of foreign currency income helps the firm repay the loan. Thus, foreign currency income provides a natural hedge against default risk related to local currency depreciation.

Assuming that the exchange rate is independently drawn from distribution $G(s)$, we can calculate a firm's expected profits when borrowing in the local currency as:

$$\mathrm{E}[\Pi^{LC}] = \int_{-\infty}^{\infty} \left(\int_{\underline{s}}^{\infty} \left[(\alpha R + s(1-\alpha)R - r)g(s)\right] ds \right) f(\epsilon) d\epsilon. \tag{24}$$

Expected profits from borrowing in foreign currency are:

$$\mathrm{E}[\Pi^{FC}] = \int_{-\infty}^{\infty} \left(\int_{0}^{\bar{s}} \left[(\alpha R + s((1-\alpha)R - r^*)g(s)\right] ds \right) f(\epsilon) d\epsilon. \tag{25}$$

Bank Problem Again, perfect competition implies that the bank's expected returns will be equal to the risk-free rate:

$$i = \int_{-\infty}^{\infty} \left(\int_{\underline{s}}^{\infty} rg(s)ds + \int_{0}^{\underline{s}} \gamma \left[\alpha R + s(1-\alpha)R \right] g(s)ds \right) f(\epsilon)d\epsilon, \tag{26}$$

where the first interior integral reflects full repayment by the firm and the second interior integral captures the residual claim of the bank when the firm defaults.

For a foreign currency loan, the bank needs to recover the foreign risk-free rate. We can write the bank's expected profits from a foreign currency loan in local currency units as:

$$si^* = \int_{-\infty}^{\infty} \left(\int_{0}^{\bar{s}} sr^* g(s)ds + \int_{\bar{s}}^{\infty} \gamma \left[\alpha R + s(1-\alpha)R \right] g(s)ds \right) f(\epsilon)d\epsilon. \tag{27}$$

Rewriting equation (26) and combining it with equation (27), noting that $i = \phi si^*$, we obtain:

$$\begin{aligned} & \int_{-\infty}^{\infty} \left(\int_{\underline{s}}^{\infty} rg(s)ds \right) f(\epsilon)d\epsilon \qquad (28) \\ = & \int_{-\infty}^{\infty} \left(\int_{0}^{\bar{s}} \phi sr^* g(s)ds + \int_{\bar{s}}^{\infty} \phi\gamma \left[\alpha R + s(1-\alpha)R \right] g(s)ds - \int_{0}^{\underline{s}} \gamma \left[\alpha R + s(1-\alpha)R \right] g(s)ds \right) f(\epsilon)d\epsilon. \end{aligned}$$

Optimal Currency Choice When is a foreign currency loan preferred over a local currency loan? To answer this question, we calculate the difference between expected profits from these two options:

$$\begin{aligned} \Delta\Pi &= \mathrm{E}[\Pi^{FC}] - \mathrm{E}[\Pi^{LC}] \qquad (29) \\ &= \int_{-\infty}^{\infty} \left(\int_{0}^{\bar{s}} \left[(\alpha R + s((1-\alpha)R - r^*) \right] g(s)ds - \int_{\underline{s}}^{\infty} \left[(\alpha R + s(1-\alpha)R - r) \right] g(s)ds \right) f(\epsilon)d\epsilon. \end{aligned}$$

Rewriting equation (29) and plugging in equation (28) delivers:

$$\begin{aligned} \Delta\Pi = \int_{-\infty}^{\infty} \Bigg(& (\phi - 1) \int_{0}^{\bar{s}} sr^* g(s)ds + (1-\gamma) \int_{0}^{\underline{s}} \left[(\alpha R + s((1-\alpha)R)g(s) \right] ds \qquad (30) \\ & + (\phi\gamma - 1) \int_{\bar{s}}^{\infty} \left[(\alpha R + s(1-\alpha)R)g(s) \right] ds \Bigg) f(\epsilon)d\epsilon. \end{aligned}$$

For the key insights from the model, consider three special cases.

Case 1: $\gamma = 1$, $\phi = 1$ When there is no UIP deviation ($\phi = 1$) and banks can fully recover revenues in case of default, firms are indifferent between FC and LC loans, that is $\Delta\Pi = 0$. In

particular, the currency choice is independent of the local currency income share α.

Case 2: $\gamma < 1$**,** $\phi = 1$ Next, consider the case without a UIP deviation but with costly default. Plugging in the corresponding parameter values delivers:

$$\Delta\Pi = \int_{-\infty}^{\infty} \left((1-\gamma) \left(\int_0^{\underline{s}} \left[(\alpha R + s((1-\alpha)R) g(s) \right] ds - \int_{\bar{s}}^{\infty} \left[(\alpha R + s(1-\alpha)R) g(s) \right] ds \right) \right) f(\epsilon) d\epsilon.$$

Taking the derivative with respect to α, we obtain:[38]

$$\frac{\partial \Delta\Pi}{\partial \alpha} = \int_{-\infty}^{\infty} \left((1-\gamma) R \left(\int_0^{\underline{s}} \left[(1-s) g(s) \right] ds - \int_{\bar{s}}^{\infty} \left[(1-s) g(s) \right] ds \right) \right) f(\epsilon) d\epsilon \geq 0. \tag{31}$$

When firm liquidation is costly for banks ($\gamma < 1$), a firm is less likely to choose a foreign currency loan when more of its income is in local currency (higher α). This is intuitive: When default is costly, there is an incentive to pick the currency that, all else equal, minimizes default risk. The fact that firms optimally choose the currency of the loan so that they are naturally hedged against exchange rate moves implies $\alpha^{LC} \geq \alpha^{FC}$: A firm that selects a local currency loan has a weakly higher local currency income share than a firm that selects a foreign currency loan.

Case 3: $\gamma = 1$ Consider the case where banks can fully recover revenues in default but there is a UIP deviation:

$$\Delta\Pi = \int_{-\infty}^{\infty} \left((\phi - 1) \left(\int_{\bar{s}}^{\infty} \left[(\alpha R + s(1-\alpha)R) g(s) \right] ds + \int_0^{\bar{s}} s r^* g(s) ds \right) \right) f(\epsilon) d\epsilon. \tag{32}$$

If $\phi > 1$, the foreign risk-free rate is lower than the local risk-free rate, and firms, all else equal, prefer foreign currency loans.

[38] Note that there is also a derivative with respect to the boundaries, following Leibniz' rule, but those cancel out as marginal profits are zero.