Foreign Currency Loans and Credit Risk: Evidence from U.S. Banks*

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Abstract

When firms borrow in foreign currency but collect revenues in local currency, exchange rate changes can affect their ability to repay their debt. Using loan-level data from U.S. banks' regulatory filings, this paper studies the effect of exchange rate changes on firms' loan payments. A 10 percent depreciation of the local currency makes a firm with foreign currency debt 69 basis points more likely to become past due on its loans than a firm with local currency debt. This result implies that firms do not perfectly hedge against exchange rate risk and that this risk translates into credit risk for banks. The findings lend support to both the *balance sheet channel* and the *financial channel of exchange rates*.

Keywords: cross-border banking, exchange rates, credit risk, corporate loans

JEL-Codes: F31, G15, G21

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1 Introduction

Borrowing in foreign currency is a prevalent phenomenon, especially in emerging market economies. While loans denominated in a foreign currency are typically cheaper than domestic currency loans, they expose firms to exchange rate risk. Financial markets offer instruments to hedge against this risk, but these instruments are costly, and firms often remain unhedged.[1] In this case, when the domestic currency depreciates, firms' debt burden increases with negative consequences for their economic performance (the so-called balance sheet channel).

Traditionally, currency devaluations have been thought of as enhancing firm performance by increasing the foreign demand for domestic goods. However, because of 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. (2010a)), and create systemic risk (Dell'Ariccia et al. (2016b) and Yesin (2013)). In addition, they may feed back onto bank balance sheets through higher credit risk, causing a reduction in cross-border lending (Bruno and Shin (2014) and Avdjiev et al. (2016)).[2]

Understanding the aggregate effects of exchange rate changes is highly relevant to policy makers because exchange rates often respond to policy decisions; they can be a channel for international spillovers of both monetary policy (Eichenbaum and Evans (1995) and Cushman and Zha (1997)) and fiscal policy (Kim and Roubini (2008) and Corsetti and Müller (2006)). For example, a divergence of the monetary policy stances of the United States and the euro area may cause the USD to appreciate. Also, a destination-based cash flow tax (DBCFT) with a border adjustment, which has been discussed in the United States, would likely lead to significant USD appreciation, raising concerns about adverse effects on borrowers, especially in emerging markets.[3]

Micro-level evidence on the relevance of the balance sheet channel is limited and mixed. Most studies in the literature rely on firm balance sheet data from a small set of countries to study this question. Aguiar (2005) uses Mexican balance sheet data, finding that firms with heavy short-term foreign debt exposure had substantially lower investments after a large devaluation. Along these lines, Kim et al. (2015) report that firms' economic performance declined 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. 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.

Using unique loan-level data derived from U.S. banks' regulatory filings, this paper provides

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

[2] See also Eichengreen et al. (2007) for a general discussion of currency mismatch.

[3] See Auerbach et al. (2017) for a discussion of the DBCFT.

direct evidence on the balance sheet channel. Specifically, we show that exchange rate changes affect firms' ability to service their debt when the firms' debt is denominated in a foreign currency. This study contributes to the existing literature in three distinct ways. First, it documents the relevance of the balance sheet channel in normal times based on a sample of firms in 105 countries. As mentioned, previous papers have mainly focused on a single country or a small set of countries during large devaluations. Second, the detailed loan-level data with broad country coverage allow for a robust estimation with a large number of fixed effects. Third, because the data are derived from bank loan portfolios, this paper provides the first direct evidence that exchange rate fluctuations (exchange rate risk) translate into credit losses (credit risk) for banks.

The loan-level data come from Y-14 filings that banks subject to stress testing by the Federal Reserve have to file on a quarterly basis. They are composed of corporate loans and leases with a loan amount of at least $1 million and contain various characteristics of the loans, including whether and how long they have been past due. We also observe the location of the borrower and the currency denomination of the loan as well as loan size, maturity, and the interest rate, among other characteristics. Importantly, 84 percent of the loans are not syndicated, meaning that the majority of loans in our dataset cannot be found in syndicated loan databases, which are often the data source of choice for cross-country loan-level studies. The sample period runs from 2014q4 to 2016q2, a period of substantial USD appreciation.

Before exploring the balance sheet channel, we establish several facts. First, as of 2016q2, 75 percent of loans to non-U.S. residents are denominated in a different currency than the borrower's home currency. Second, only a small share of loans is ever past due, roughly 0.6 percent of loans. Third, foreign currency loans are around 151 basis points cheaper. Fourth, foreign currency loans are more prevalent in countries with higher inflation, lower exchange rate volatility, and a higher credit-to-GDP ratio. Also, firms in industries with a higher share of foreign sales and a lower share of foreign assets are more likely to borrow a foreign currency. Finally, foreign currency loans are larger and of shorter maturity.

A key challenge in identifying the balance sheet channel is that exchange rates are correlated with macroeconomic variables that also drive firm performance. Testing for the balance sheet channel therefore requires isolating it from other confounding channels. We do this by comparing firms with foreign debt with firms with domestic debt in the same country, industry, quarter, and with the same bank-internal rating. Furthermore, we control for the size of loans and their maturities. Our identification assumption is that, in the absence of foreign currency debt, exchange rate changes would affect firms in the same industry, country, and quarter and with the same bank-internal rating, loan size and maturity structure in the same way. Obviously, a firm's choice of currency is not random, and it is challenging to control for all possible factors. But the key is that the selection of firms into currency happens in a way that makes it less likely for us to find effects of exchange rate changes on loan payments. Firms tend to choose foreign currency debt when they have foreign income or foreign assets (Brown et al. (2011), Bleakley

and Cowan (2008), Kedia and Mozumdar (2003), and Keloharju and Niskanen (2001)).[4] And in the absence of natural hedges, firms with larger foreign currency exposures are more likely to buy protection against currency moves (for example, Géczy et al. (1997)). Also, banks have an incentive to lend in foreign currency to firms that better tolerate exchange rate volatility.

Nevertheless, we find strong evidence that exchange rate movements affect firms' ability to service their debt, which indicates that firms remain significantly exposed to exchange rate volatility. A 10 percent depreciation of the local currency increases the probability that a firm becomes past due on its loans by 69 to 160 basis points more for firms with foreign currency debt compared with firms with domestic currency debt. This effect mainly stems from local currency depreciations and is stronger for firms in industries with a smaller share of foreign sales. Applying these results to the total foreign currency loans of U.S. banks in our sample indicates that a 10 percent appreciation of the USD causes an increase in late loan payments of $2.5 billion for these banks.

More related literature A considerable number of papers study the balance sheet channel using macro and micro data. Starting with macro-level evidence, Edward (1986) finds short-term contractionary effects of devaluations. Céspedes (2005) shows that devaluations have stronger negative effects on output for countries that are more indebted. Bebczuk et al. (2010) analyze the role of dollar denominated debt for the effect of real depreciations on GDP growth, documenting that dollar debt can make devaluations contractionary.[5] Studies using micro-level data have analyzed the effect of foreign currency debt on firm investment and employment with mixed evidence on the balance sheet channel, as mentioned before. Similar to Aguiar (2005), Carranza et al. (2003), Echeverry et al. (2003), Benavente et al. (2003), and Galiani et al. (2003) find that firms with higher foreign debt contract investment more after devaluations. Based on data from Hungary, Varela and Salomao (2016) find that foreign currency borrowing is associated with higher aggregate income, but at the expense of higher volatility.

The link between exchange rate changes and credit risk has been emphasized by macro-oriented papers studying the causes of financial crises, but less so in the banking literature. 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 and increased credit risk for global banks and these banks' cross-border lending.[6]

[4] See also Kamil (2012) and Brown et al. (2014a). See Galindo et al. (2003a) for a survey on the determinants of debt currency denomination.

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

[6] Two recent papers investigate whether banks charge higher interest on loans when firms have foreign currency exposures. See Francis and Hunter (n.d.) and Kim et al. (2016).

2 Background on Foreign Currency Debt

When a firm borrows in a foreign currency but its revenues are in local currency, this currency mismatch can affect its performance. Without hedging through foreign exchange swaps or natural hedges (that is, revenues in foreign currency), the firm faces a higher debt burden when the local currency depreciates. In response, firms might lower their investment, reduce staff and, ultimately, become unable to service their debt.[7] The following section provides more background information and summarizes evidence in the literature on foreign currency borrowing and the balance sheet channel.

Foreign currency debt is a relevant phenomenon. It is especially prevalent in emerging economies. Figure 1 illustrates this fact using data from the Bank for International Settlements (BIS) on cross-border banking. Total cross-border borrowing from banks in BIS reporting countries by 67 borrowing countries was just below $18 trillion at the end of the second quarter of 2016. Figure 1 shows the share of cross-border borrowing denominated in foreign currency from 2012 to 2017, dividing countries into emerging and advanced economies.[8] More than 70 percent of funds borrowed cross-border from foreign banks by emerging countries are denominated in one of the five major currencies. In contrast, less than 40 percent of funds borrowed by advanced economies are denominated in a foreign currency. The dataset employed in this paper, which is composed of U.S. banks' corporate loans to non-U.S. residents, reveals a similar pattern, with 75 percent of loans denominated in a foreign currency in the second quarter of 2016.

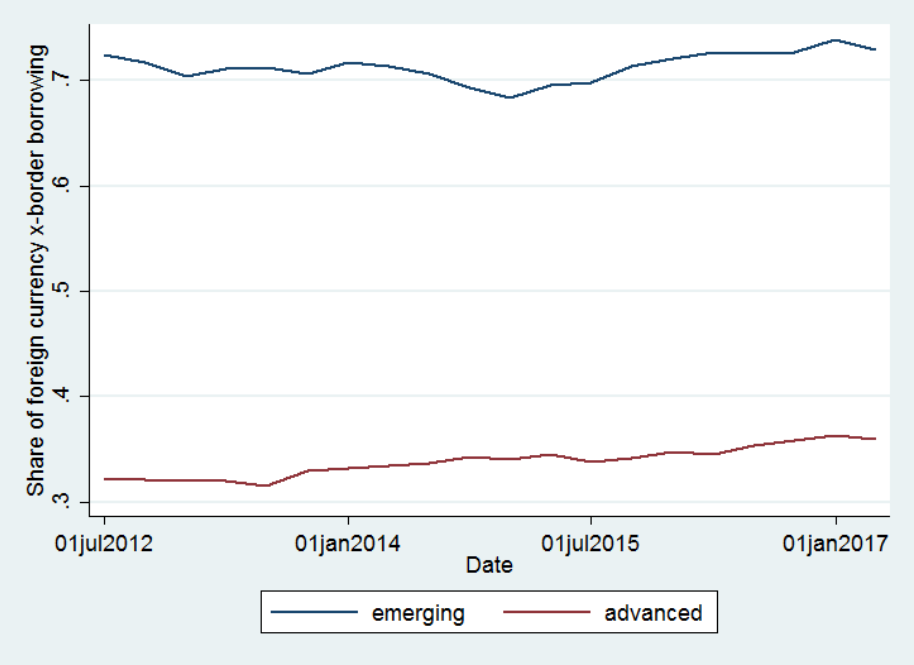
Why do firms borrow in a foreign currency instead of the local currency? Foreign currency loans may be cheaper than local currency loans. The U.S. bank-level data show that foreign currency loans are in fact associated with lower interest rates during the 2014-2016 time period, which the dataset derived from Y-14 data used in this paper covers. Table 1 shows a regression of the interest rate of a loan on a dummy that is one when the loan is denominated in a foreign currency controlling for a battery of fixed effects and additional variables. On average, the interest rate on foreign currency loans is 151 basis points lower than on local currency loans, as shown in column 5 of the table. The column displays the results when firm-time, loan-type, and interest-rate-type fixed effects are included in the regression.

A second reason for foreign currency borrowing is firms' desire to hedge against currency risk arising from income in foreign currency or assets denominated in foreign currency. For example, 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

[7]For theoretical papers that model the balance sheet channel, see Jeanne (2000), Aghion et al. (2001), Caballero and Krishnamurthy (2003), Ranciere et al. (2008), Kohn et al. (2015), and Dell'Ariccia et al. (2016a).

[8]The shares shown are lower bounds. The BIS Locational Statistics leave a portion of the cross-border borrowing unallocated for countries that do not have the EUR, CHF, GBR, JYE, USD as the domestic currency.

Figure 1: Share of cross-border borrowing from banks denominated in foreign currency



Note: The chart is based on the Locational Banking Statistics maintained by the Bank for International Settlements. It shows the cross-border borrowing from banks in BIS reporting countries in a currency other than the borrowing country's home currency as a share of total cross-border bank borrowing for two groups of countries: 30 emerging economies and 27 advanced economies. For the emerging economies foreign borrowing includes borrowing in GBP, JPY, USD, EUR, and CHF.

Table 1: Interest rates on local currency versus foreign currency loans

	(1)	(2)	(3)	(4)	(5)
FC	-0.0122***	-0.0154***	-0.0174***	-0.0151***	-0.0151***
	(0.000466)	(0.000886)	(0.00206)	(0.00245)	(0.00247)
Ln(loan size)		-0.00223***	-0.00125***	-0.000775**	-0.000773**
		(0.000212)	(0.000333)	(0.000332)	(0.000331)
Ln(maturity)		0.000946*	-0.000214	-0.000543	-0.000639
		(0.000532)	(0.000514)	(0.000755)	(0.000751)
Time FE	Yes	No	No	No	No
Ct-time FE	No	Yes	No	No	No
Firm-time FE	No	No	Yes	Yes	Yes
Loan type FE	No	No	No	Yes	Yes
Rate type FE	No	No	No	No	Yes
Observations	11566	11405	3811	3178	3178
R^2	0.057	0.320	0.885	0.898	0.899

Note: This table shows results of regressions of a loan's interest rate on a dummy variable that takes a value of 1 if the loan is denominated in a foreign currency. Other regressors are the loan's log loan size and log maturity. Column 1 includes time fixed effects, column 2 country-time fixed effects, column 3 firm-time fixed effects, and column 4 firm-time plus loan-type fixed effects. Finally, column 5 adds fixed effects for the type of interest rate grouped into variable-, floating- and mixed-rate loans. Standard errors are clustered by bank-quarter. *, ** and *** denote significance at the 10%, 5% and 1% level.

Mozumdar (2003), and Keloharju and Niskanen (2001) find that firms obtain foreign currency debt to hedge against foreign currency income.[9] Additional evidence suggests that banks also influence the denomination of loans. Brown et al. (2014b) show that "foreign currency lending is at least partially driven by bank eagerness to match the currency structure of assets with that of liabilities," indicating that supply factors can also play a role.

When does foreign currency debt give rise to a balance sheet channel? Several conditions have to be met. First, foreign currency borrowing must lead to a currency mismatch. This happens when firms are not hedged. As discussed above, firms with foreign currency loans often have natural hedges. And even if they are not naturally hedged, they can buy protection against local currency depreciation and engage in foreign exchange swaps.[10] However, not all firms may hedge because it is costly. While data on the foreign currency exposure of firms is generally scarce, the literature agrees that currency mismatch is an issue and has played a significant role in past crises. Currency mismatch is thought to have been a key amplifier during the Asian crisis in the late 90s (for example, Corsetti et al. (1999)). Moreover, currency mismatch in Eastern Europe has been documented and discussed as a source of systemic risk, for example by Ranciere

[9]For literature reviews, see Kamil (2012) and Galindo et al. (2003b).

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

et al. (2010b) and Yesin (2013).

A second condition for the balance sheet channel to operate relates to firms' responses to a higher debt burden. If firms have a currency mismatch and debt servicing costs rise because the local currency depreciates, firms could pass on the higher cost to their customers through higher prices. However, firms might not be able to increases prices either because of the market structure and competitive pressures or because prices are sticky in the short-run. As the local exchange rate 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. (See, for example, Klenow and Kryvtsov (2008), Klenow and Malin (2010), Nakamura and Steinsson (2013), and Gopinath and Rigobon (2008)).

3 The Dataset

3.1 The Data Source for Corporate Loans

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.[11] Banks report corporate loans 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 smaller time period, running from 2014q4 to 2016q2. During this time, the dollar appreciated significantly, as figure 2 illustrates. The sample includes 31 different banks. Some banks 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.[12] A borrower is identified as a combination of customer identifier, location, and bank name.[13] The least restrictive sample has 74,747 observations and covers 19,210 borrowers residing in 105 different countries.[14]

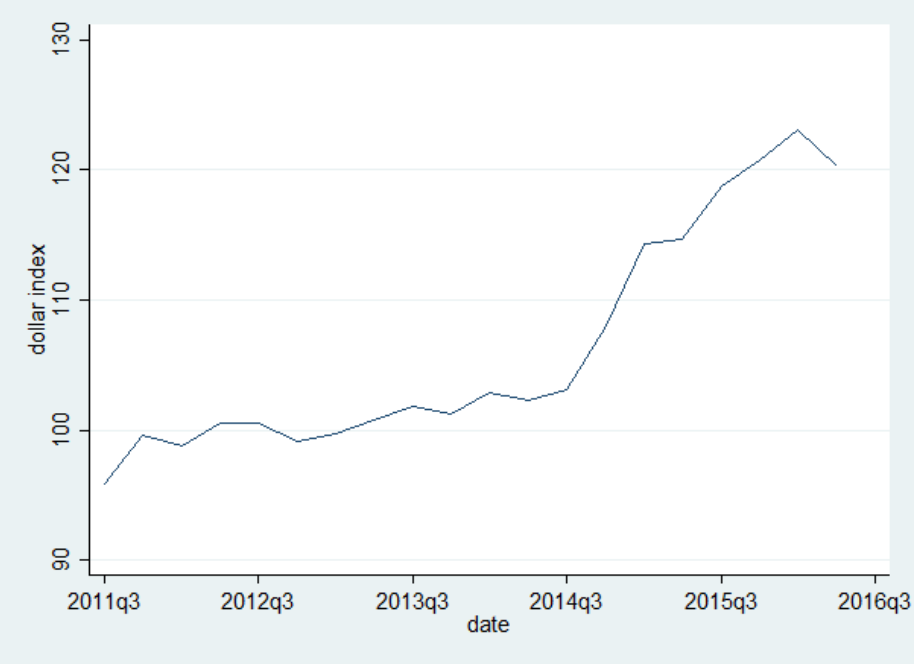
[11] Banks report corporate loans on schedule H.1. The data are confidential but available to researchers within the Federal Reserve System.

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

[13] 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.

[14] We drop countries whose currencies are pegged to the USD.

Figure 2: USD index, 2011q3 to 2016q2



Note: This figure shows the USD broad index, an index of the trade-weighted USD exchange rate against a basket of currencies calculated by Federal Reserve Board staff. The period shown goes from 2011q3 to 2016q2.

3.2 Dataset Facts

A significant portion of the loans is in non-local currencies. 50 percent of firm-quarter observations in the dataset borrow exclusively in USD. In contrast, 41 percent obtain loans in their local currency only. 4.5 percent take loans in a foreign currency other than the USD. And 5.5 percent of firms borrow in a variety of currencies. Table 2 shows the average and median loan size, maturity, probability of default and interest rate of lending in different currencies. As the table highlights, firms that only borrow in foreign currency take out larger loans than firms that borrow in the local currency. Firms that borrow in multiple currencies have the largest loan volumes, likely because they are larger. The median maturity of the loans is between 4.3 and 5 years. Local currency loans carry a higher interest rate than foreign currency loans, as also formally established in table 1, and have a slightly higher probability of default. Additional details on foreign versus local currency loans are discussed in section 4.2.

The majority of loans is not syndicated or participated. A large number of papers in the literature analyze syndicated loans. Information on these loans is available from commercial sources and has been collected for many years. While the loan-level data obtained from banks' Y-14 reports is only available for a relatively short time period, they have the advantage of

Table 2: Loan characteristics, by currency

	(1) USD		(2) oth foreign		(3) local		(4) mix	
	mean	p50	mean	p50	mean	p50	mean	p50
util. exposure ($m)	30.8	7.71	29.1	5.64	14.9	3.67	64.8	27.7
maturity (years)	5.79	4.53	5.61	4.70	4.93	4.32	6.19	5.00
prob. of default (pct)	2.28	0.68	1.76	0.64	2.42	0.71	2.08	0.71
interest rate (pct)	2.92	2.07	3.03	2.34	4.27	3.82	3.53	2.76
loans newly past due (pct)	0.41	0	0.42	0	0.27	0	0.22	0
loans past due (pct)	0.64	0	0.63	0	0.54	0	0.47	0
Observations	37019		3339		30313		4076	
Share of obs. (pct)	49.5		4.5		40.6		5.5	

Note: The table shows summary statistics of the baseline sample with 74,747 observations grouped by the currency denomination of loans. Column 1 includes observations where the borrower has loans denominated exclusively in USD. Column 2 has observations where the borrowers 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 has 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, a dummy variable which is one when the borrower becomes past due on (some of) its loans, and a dummy variable which is one when the borrower is past due on any of its loans in period t.

including a larger set of loans as table 3 points out. 84 percent of the observations in the sample are not syndicated. The average size of these loans is less than half of that of syndicated loans. Moreover, they have a slightly lower average maturity and carry higher interest. Interestingly, a similar share of loans in both groups is in local versus foreign currencies.[15]

The event that a borrower does not service its debt is rare. The Y-14 reports contain information on whether borrowers are late on their interest or principal payments, information which forms the basis of our analysis. Only a small fraction of borrowers is ever late on their loan payments: 0.6 percent of observations are associated with late payment status. For the regression analysis, we construct a variable that takes the value of 1 if a borrower becomes late on its loan payments in a given quarter. The event that a borrower misses a loan or principal payment for the first time is very rare and happens 255 times in our dataset. Tables 2 and 3 show the percentage of observations that have past due or new past due status split by currency and participation type. Of note, even though local currency loans have higher probabilities of default, which measure the banks' ex-ante assessment of their riskiness, they become less often past due than foreign currency and USD loans, i.e. they are ex-post less risky over the sample period. The fact that foreign currency loans turned out to be riskier than anticipated by banks might be a result of the unanticipated appreciation of the USD over that period. That is, based

[15] Around 2 percent of borrowers have a mix of syndicated and non-syndicated loans. In this table, borrowers with less than 50 percent of syndicated loans are classified as not syndicated.

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

	(1) non-syndicated		(2) syndicated	
	mean	p50	mean	p50
util. exposure ($m)	21.7	4.59	48.6	24.8
maturity (years)	5.35	4.09	5.97	5.01
prob. of default (pct)	2.17	0.71	2.97	0.64
interest rate (pct)	3.66	2.98	2.72	2.33
loans newly past due (pct)	0.37	0	0.21	0
loans past due (pct)	0.57	0	0.66	0
loans in for. currency (pct)	0.57	1	0.61	1
Observations	62439		12308	
Share of obs. (pct)	83.5		16.5	

Note: The table shows summary statistics of the baseline sample with 74,747 observations grouped into syndicated and non-syndicated loans. Column 1 includes observations where less than 50 percent of the borrower's loans are syndicated. 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 (some of) its loans, a dummy variable which is one when the borrower is past due on any of 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.

on our results, the appreciation made foreign currency loans relatively more risky than domestic currency loans ex-post.

The dataset covers loans in a variety of countries and industries. The 105 countries in the sample span various world regions. Table 4 shows loan characteristics by region. The largest share of the loans goes to high-income OECD countries, followed by countries in Latin America and the Caribbean. Borrowing in foreign currency is particularly prevalent in Europe and Central Asia, Latin America and the Caribbean, and Sub-Saharan Africa.

Table 5 displays loan characteristics by industry. 34 percent of observations belong to manufacturing firms. 18 percent belong to the finance and insurance industry. 14 percent each are in other service industries and in wholesale and retail trade. Loans in the finance and insurance sector are significantly larger and carry lower risk and interest compared to other industries. The event that a borrower becomes past due on its loan payments is relatively evenly distributed across regions and industries.

3.3 Additional Data Sources

The borrower-level dataset is complemented with several variables that come from a variety of sources. Information on bilateral exchange rates are from the IMF's International Financial

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 ($m)	24.7	6.20	36.1	8.33	27.4	6.71	21.3	4.67	24.4	5	17.0	7.53	24.4	5.54	23.6	7.92
maturity (years)	5.30	4.00	6.20	5	5.65	4.93	4.81	3.85	4.79	4.01	6.77	5.21	6.10	5.17	6.98	5.19
prob. of default (pct)	2.00	0.71	2.44	1.04	2.18	0.64	1.73	0.64	2.52	0.71	2.19	0.71	2.57	1.16	3.70	0.71
interest rate (pct)	4.08	3.50	5.00	3	2.73	2.54	2.07	1.61	4.11	3	4.18	4.25	5.06	4.01	4.34	3.80
loans newly past due (pct)	0.12	0	0.13	0	0.33	0	0.15	0	0.63	0	0	0	0.042	0	0.15	0
loans past due (pct)	0.26	0	0.57	0	0.62	0	0.15	0	0.90	0	0	0	0.10	0	0.31	0
loans in for. currency (pct)	0.63	1	0.88	1	0.45	0	0.82	1	0.72	1	0.47	0.18	0.44	0	0.75	1
Observations	8309		3141		34003		2750		19264		545		4797		1938	
Share of obs. (pct)	11.12		4.2		45.49		3.68		25.77		0.73		6.42		2.59	

Note: The table shows summary statistics of the baseline sample with 74,747 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 (some of) its loans, a dummy variable which is one when the borrower is past due on any of 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 ($m)	45.3	12.1	15.1	4.60	49.0	15.0	14.2	3.60	30.0	12.6	11.2	3.39
maturity (years)	6.72	4.44	5.02	4.42	5.81	5.00	4.37	3.87	8.33	5.76	4.76	4.12
prob. of default (pct)	1.45	0.64	2.36	0.71	3.19	0.71	1.70	0.64	2.93	0.71	2.60	1.16
interest rate (pct)	2.27	1.43	4.01	3.40	3.80	3.22	2.53	1.50	3.62	3.16	4.43	3.92
loans newly past due (pct)	0.59	0	0.100	0	0.47	0	0.65	0	0.29	0	0.17	0
loans past due (pct)	0.87	0	0.25	0	0.84	0	1.03	0	0.77	0	0.27	0
loans in for. currency (pct)	0.75	1	0.54	1	0.57	1	0.56	1	0.64	1	0.47	0
Observations	13424		25106		12670		10143		2713		10691	
Share of obs. (pct)	18.0		33.6		17.0		13.6		3.6		14.3	

Note: The table shows summary statistics of the baseline sample with 74,747 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 (some of) its loans, a dummy variable which is one when the borrower is past due on any of 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.

Statistics. Country-industry level variables (international sales over total sales, international assets over total assets, international income over total income) are constructed from Worldscope balance sheet data. We also include in the regression several country-level macroeconomic controls. Further details on variables and their sources can be found in the data appendix.

4 Empirical Analysis

This section explores whether and how exchange rate changes affects the currency denomination of loans and the probability that a firm does not service its debt. We proceed in four steps. First, we detail our baseline specifications. Second, we present evidence on the currency choice for bank loans. Third, we present our main results on the balance sheet effect. Finally, we provide an extensive set of robustness checks, corroborating our main findings.

4.1 Empirical Strategy

As a first pass, we estimate the following regression equation:

$$\text{past due new}_{it} = \beta \Delta ln(XR_{ct}) + \Gamma X_{cit} + \alpha_t + \epsilon_{ict} \tag{1}$$

The dependent variable takes a value of 1 if borrower i becomes past due on its loans from quarter $t-1$ to quarter t. $\Delta ln(XR_{ct})$ is the log difference in the quarterly average exchange rate over the same period. X_{ict} is a set of macro-, industry-, firm-, or loan controls, and α_t is a time fixed effect.

This regression equation is not yet a test of the balance sheet channel. Instead it allows us to gauge the broad effects of exchange rate changes, which may also work through the correlation of the exchange rate with broader economic conditions. For example, when local economic conditions deteriorate, the domestic currency tends to depreciate. To isolate the effect of exchange rate changes from other first-order macro developments, the regression includes several country-level macro controls: the country's risk index from the Economist Intelligence Unit, the country's credit-to-GDP gap, annual GDP growth, and inflation.

To test the balance sheet channel, we compare firms that borrow in local currency with firms that borrow in foreign currency. Specifically, we interact the change in the exchange rate with the borrower's share of foreign currency loans in total loans. This way, we test whether changes in the exchange rate have a larger effect on the probability that a firm's loan payments become past due for firms that borrow in foreign currency compared with firms that borrow in local

currency (the balance sheet effect). The regression equation is as follows:

$$\text{past due new}_{it} = \beta_1 \Delta ln(XR_{ct}) + \beta_2 \Delta ln(XR_{ct}) \times \text{FC}_{it} + \Gamma X_{cit} + \alpha_{c(k)t} + \epsilon_{ict}, \tag{2}$$

where FC_{it} is the share of loans of firm i that are denominated in a foreign currency. This specification allows us to include country-quarter, country-quarter-industry, or country-quarter-industry-rating fixed effects to control for time-varying country/industry-level factors that may affect the probability that firms do not service their debt and are correlated with exchange rate changes.

The identification assumption that underlies the above specification is that exchange rate changes affect firms' payment delays differentially between foreign and domestic currency borrowers in the same country and industry only through the balance sheet channel. Obviously, there is selection of firms into local versus foreign currency borrowing. For example, if firms that borrow in foreign currency saw a stronger deterioration of the demand for their goods in response to local currency depreciation compared with firms that borrow in local currency, our identification assumption would be violated.

We address this endogeneity issue by investigating which factors determine foreign currency lending using the Y-14 dataset in the subsequent section. After having identified these factors, we directly control for them in the regressions. In addition, we include extensive fixed effects to further abate any endogeneity concerns. Importantly, any remaining selection into currency would bias results against us finding stronger effects from exchange rate changes for firms that borrow in foreign currencies. In particular, firms should self-select into borrowing in a foreign currency if they are better able to repay foreign currency debt, either because they have a natural hedge or because they have better access to financial hedges. This rationale should apply even more to banks; they should be more willing to extend foreign-currency loans to firms that they asses to be better at tolerating exchange rate risk.

4.2 What Determines the Currency Denomination of a Loan?

This section explores country-level and firm-level factors, as well as loan characteristics that determine the joint currency choice of firms and banks. Apart from testing earlier findings of the literature, the ultimate goal of this analysis is to identify a set of variables that we can use to control for firms' selection into foreign currency borrowing.

As discussed in section 2, the literature has uncovered several firm characteristics that play a role in foreign currency borrowing. Firms with income or assets in foreign currency are more likely to borrow in a foreign currency. As shown by Gelos (2003) and Aguiar (2005), size also plays are 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 networth, 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.[16]

Using the Y-14 data, we study the role of macroeconomic, industry-level, firm-level, and loan-level factors. Consider the following specification:

$$\text{FC}_{lit} = \beta_M X_{ct}^M + \beta_F X_{it}^F + \beta_L X_{lit}^L + \alpha_t + \epsilon_{lit}, \tag{3}$$

where FC_{lit} takes a value of 1 if loan l of firm i in quarter t is denominated in a foreign currency. X_{ct}^M captures the macro controls: GDP growth, credit-to-GDP gap, country risk, consumer price inflation, and average exchange rate volatility. X_{it}^F stands for the borrower's rating and for industry-country level controls that capture the share of sales, assets and income that firms in that industry generate or hold abroad.[17] Finally, the loan-level controls X_{lit}^L are the log of loan size and maturity. The regression is estimated on a dataset that is composed of new loans only, that is, we keep a loan in the dataset if its origination date falls within the reporting quarter. Results are presented in table 6.

Column 1 includes the macroeconomic variables. Column 2 shows results with industry-level controls. In column 3, the borrower's rating is the explanatory variable. The ratings variable takes values between 1 and 10, where 10 is associated with the highest-risk firms.[18] Column 4 presents the results with loan-level regressors. Column 5 includes all explanatory variables. All of these columns include time fixed effects. Overall results are intuitive and in line with previous findings. The probability that a firm borrows in a foreign currency increases in its country's inflation and decreases in its country's exchange rate volatility. Also, foreign currency borrowing is more prevalent when credit is ample, i.e. when the credit-to-GDP gap is higher. Firms in industries that have a larger share of their sales abroad are more likely to have foreign-currency loans, in line with Brown et al. (2014b), for example. However, firms in industries with more assets or income abroad tend to have less foreign-currency loans, according to our data. The reason why this result is counter to some earlier papers could be that we rely on industry-level information and not on firm-level information as the other papers. Finally, foreign-currency loans tend to be larger and of shorter duration.

As discussed in the previous section, to address potential endogeneity concerns, we want to identify factors that predict the currency denomination so that we can include them in the regressions. The most stringent specification that we estimate includes country-time-industry-rating fixed effects. In this regression, we compare firms with foreign currency loans with firms with domestic currency loans in the same country, quarter, industry and with the same rating. Column 6 presents the currency regression with the same set of fixed effects. First, note that any

[16] See also Brown and De Haas (2012).

[17] We obtain information on firm balance sheets from Worldscope and calculate averages per country and industry.

[18] That is, a AAA rating gets the value of 1, whereas a loan that is in default (D) gets a value of 10.

Table 6: Characteristics of foreign vs. local currency loans

	(1)	(2)	(3)	(4)	(5)	(6)
GDP growth	0.688				-1.433	
	(1.263)				(1.226)	
Credit-to-GDP gap	0.00123				0.00415*	
	(0.00259)				(0.00234)	
Country risk	-0.00577				0.00671	
	(0.00875)				(0.00989)	
Inflation	0.168***				0.138***	
	(0.0256)				(0.0265)	
l_vola_av_pre	-0.0482***				-0.0451***	
	(0.0173)				(0.0158)	
% sales abroad		0.00671***			0.00954***	
		(0.00252)			(0.00203)	
% assets abroad		-0.00659**			-0.00637**	
		(0.00320)			(0.00285)	
% income abroad		-0.00198			0.0000841	
		(0.00271)			(0.00266)	
Rating			0.0123		0.0155	
			(0.0226)		(0.0253)	
Ln(loan size)				0.111***	0.115***	0.119***
				(0.0117)	(0.0207)	(0.0308)
Ln(maturity)				-0.155***	-0.141***	-0.0846**
				(0.0181)	(0.0260)	(0.0354)
Time FE	Yes	Yes	Yes	Yes	Yes	No
Ct-Time-Ind-Rat	No	No	No	No	No	Yes
Observations	7594	8250	11128	11645	6092	3513
Pseudo R^2	0.071	0.021	0.001	0.026	0.103	0.182

Note: This table explores the characteristics of foreign currency versus local currency loans. A dummy that takes a value of 1 if the loan is in foreign currency is regressed on macro variables (column 1), industry- (column 2), firm- (column 3), and loan-level characteristics (column 4). Column 5 includes all explanatory variables. Column 6, includes country-time-industry-rating fixed effects, in contrast to the other columns that include time fixed effects. Standard errors are clustered by country-time (columns 1, 5, and 7), industry-country (column 2), and firm (columns 3 and 4). *, ** and *** denote significance at the 10%, 5% and 1% level.

macroeconomic and industry variation is now fully absorbed by the fixed effects. Also the rating is now directly controlled for. The two remaining factors that are not absorbed by the extensive fixed effects, loan size and maturity, however, remain significant predictors of currency choice.

4.3 Evidence on the Balance Sheet Channel

This section presents our main findings on the balance sheet channel. Table 7 displays the baseline results.

Baseline results Column 1 shows that exchange rate changes are positively correlated with firms' payment status; that is, a depreciation (appreciation) of the local currency is associated

Table 7: Baseline results

	(1)	(2)	(3)	(4)	(5)	(6)
D ln(XR)	1.406***	2.340**	-0.977	-0.860	-2.464	
	(0.493)	(0.948)	(1.362)	(1.394)	(1.605)	
D ln(XR) X FC			2.954**	4.681***	7.165***	8.248***
			(1.477)	(1.693)	(1.975)	(2.410)
Lagged rating		0.115***		0.118***	0.127***	0.142***
		(0.0364)		(0.0370)	(0.0399)	(0.0356)
Country risk		-0.00823		-0.00659	0.0335*	
		(0.00554)		(0.00561)	(0.0190)	
Credit-to-GDP gap		-0.00633**		-0.00658**	0.00313	
		(0.00270)		(0.00264)	(0.00625)	
GDP growth		0.760		0.719	0.971	
		(0.565)		(0.573)	(0.708)	
CP inflation		0.00780		-0.00764	-0.163***	
		(0.0181)		(0.0194)	(0.0287)	
Ln(loan size)		-0.00674		-0.0146	-0.0232	-0.0190
		(0.0175)		(0.0168)	(0.0183)	(0.0194)
Ln(maturity)		-0.0620		-0.0663*	-0.0680	-0.0749
		(0.0390)		(0.0392)	(0.0471)	(0.0464)
FC			0.0101	-0.0447	-0.184*	-0.172
			(0.0819)	(0.0962)	(0.111)	(0.126)
Time FE	Yes	Yes	Yes	Yes	Yes	No
Ct FE	No	No	No	No	Yes	No
Ct-time FE	No	No	No	No	No	Yes
Observations	74747	50603	74747	50603	43761	23656
Pseudo R^2	0.020	0.047	0.024	0.055	0.106	0.080

Note: This table shows the baseline regression results. The dependent variable takes a value of 1 if a borrower becomes past due on its loan in period t. Columns 1 to 4 include time fixed effects. Column 5 has also country fixed effects. Column 6 includes country-time fixed effects. Standard errors are clustered by country-quarter. *, ** and *** denote significance at the 10%, 5% and 1% level.

with more (less) firms becoming past due on their loans. Column 2 shows that this finding is robust to the inclusion of the macroeconomic, loan-level, and firm-level controls discussed previously.

Column 3 turns to testing the balance sheet channel by including the interaction term between the exchange rate change and the foreign currency indicator. The associated coefficient is positive and highly significant. In contrast, the direct effect of the exchange rate change flips its sign and is no longer statistically significant.[19] Thus, column 3 provides support for the balance sheet channel: When a firm borrows a foreign currency, it is more (less) likely than a firm that borrows the local currency to become late on its loan payments when the local currency depreciates (appreciates).

Column 4 shows that this finding is robust to the inclusion of various control variables.

[19]We also included lagged exchange rate changes in the regressions but the associated coefficients were not significant at conventional significance levels.

Results become even stronger when country fixed effects and country-quarter fixed effects are added as regressors (see columns 5 and 6, respectively).

Economic significance The size of the effect is economically meaningful. Column 2 of table 8 displays the marginal effects for the baseline regression in column 5 of table 7. For a foreign currency borrower, a 10 percent decline in a country's exchange rate increases the probability of being late on a payment by 69 basis points. OLS, logit, and cloglog specifications give very similar results with effects ranging from 61 to 66 basis points.

Table 8: Marginal effects and different estimation methods

	(1) Probit	(2) Probit ME	(3) OLS	(4) Logit	(5) Logit ME	(6) CLogLog	(7) CLogLog ME
D ln(XR)	-2.464	-0.0237	-0.0139	-6.704	-0.0230	-6.675	-0.0230
	(1.605)	(0.0156)	(0.0169)	(4.854)	(0.0168)	(4.850)	(0.0169)
D ln(XR) X FC	7.165***	0.0689***	0.0605**	19.11***	0.0656***	18.94***	0.0654***
	(1.975)	(0.0202)	(0.0239)	(5.686)	(0.0207)	(5.658)	(0.0207)
FC	-0.184*	-0.00177*	-0.000485	-0.512	-0.00176	-0.508	-0.00176
	(0.111)	(0.00107)	(0.000912)	(0.335)	(0.00116)	(0.334)	(0.00116)
Lag. rating	0.127***	0.00122***	0.00108***	0.327***	0.00112***	0.323***	0.00112***
	(0.0399)	(0.000411)	(0.000395)	(0.110)	(0.000404)	(0.108)	(0.000400)
Ct FE	Yes	-	Yes	Yes	-	Yes	-
Time FE	Yes	-	Yes	Yes	-	Yes	-
Observations	43761	43761	43761	43761	43761	43761	43761
R^2	-	-	0.005	-	-	-	-
Pseudo R^2	0.106	-	-	0.105	-	-	-

Note: This table shows regression coefficients and marginal effects for different estimators. Column 1 shows the baseline regression results based on probit estimation. Column 2 presents the associated marginal effects. Column (3) is based on OLS regression. Column (4) and (5) report results from logit regressions. Column (6) and (7) employ the cloglog estimator. All regressions include country and time fixed effects. Standard errors are clustered by country-quarter. *, ** and *** denote significance at the 10%, 5% and 1% level.

Controlling for differences across local vs. foreign currency loans In section 4.2, we highlighted that the currency of a loan is not random but correlated with several observable factors. In the following, we address selection into currency by including interaction terms between the exchange rate change and the macroeconomic, industry-level, firm-level, and loan-level controls. Results are presented in table 9.

Columns 1, 2, and 3 subsequently introduce the macro, industry/firm-level, and loan-level interaction terms to the baseline regression. Column 4 includes all interaction terms. Columns 1 through 4 control for country and quarter fixed effects, while column 5 includes country-quarter fixed effects. The coefficient on the interaction term between the exchange rate change and the foreign currency indicator is highly significant and of a similar magnitude across all specifications, lending robust support to the balance sheet channel.

Table 9: Controlling for currency choice

	(1)	(2)	(3)	(4)	(5)
D ln(XR)	-0.771	-1.900	-5.227	-42.32**	
	(5.959)	(6.543)	(8.957)	(17.82)	
D ln(XR) X FC	7.697***	5.301***	7.367***	7.426***	6.987***
	(1.979)	(2.046)	(1.965)	(1.950)	(2.192)
D ln(XR) X country risk	-0.0175			0.391	
	(0.189)			(0.244)	
D ln(XR) X credit-to-GDP gap	-0.0525			0.103	
	(0.0702)			(0.0897)	
D ln(XR) X GDP growth	-20.67**			-24.18**	
	(9.867)			(9.776)	
D ln(XR) X CP inflation	-0.214			-0.732	
	(0.543)			(0.623)	
D ln(XR) X ln(vola)	0.437			-6.149***	
	(0.681)			(2.113)	
D ln(XR) X lag. rating		0.418		0.619	0.722
		(1.318)		(1.163)	(1.162)
D ln(XR) X for. sales		-0.0527		-0.106	-0.0671
		(0.0607)		(0.0651)	(0.0747)
D ln(XR) X for. ass.		-0.116		-0.105	-0.182**
		(0.0788)		(0.0815)	(0.0860)
D ln(XR) X for. inc.		0.0827		0.0809	0.124
		(0.0717)		(0.0758)	(0.0846)
D ln(XR) X ln(loan size)			-0.428	-0.871**	-0.718
			(0.382)	(0.397)	(0.464)
D ln(XR) X ln(maturity)			1.296	3.860**	4.420**
			(1.024)	(1.620)	(1.844)
FC	-0.204*	-0.184	-0.195*	-0.276**	-0.234*
	(0.111)	(0.123)	(0.111)	(0.123)	(0.137)
Time FE	Yes	Yes	Yes	Yes	No
Ct FE	Yes	Yes	Yes	Yes	No
Ct-time FE	No	No	No	No	Yes
Observations	43761	23658	43761	23658	14044
Pseudo R^2	0.109	0.106	0.107	0.126	0.102

Note: This table shows the regression results when macro variable as well as industry- and borrower-level variables are interacted with the exchange rate change $\Delta ln(XR)$ and included in the estimation. Columns 1 to 4 include time and country fixed effects. Column 5 has country-time fixed effects. Standard errors are clustered by country-quarter. *, ** and *** denote significance at the 10%, 5% and 1% level.

While not at the center of our analysis, the additional interaction terms provide some interesting results. Exchange rate depreciations have smaller effects on payment status when accompanied by strong GDP growth and in countries with higher exchange rate volatility. The latter finding indicates that firms might be better hedged when there is substantial exchange rate risk in their home countries. We also find that effects are smaller for firms in industries that hold a larger share of their assets abroad and for firms whose loans have a shorter average maturity.

Foreign sales as a natural hedge When firms sell a fraction of their production abroad, this can shield them from the adverse effects of currency depreciation in the presence of foreign currency debt. The higher debt burden resulting from local currency depreciation may be compensated for by higher revenues from foreign sales when these are priced in foreign currency. Table 10 tests for the role of foreign sales as a natural hedge. Columns 1 and 2 present results

Table 10: Sales as a natural hedge

	(1) low sales	(2) low sales	(3) high sales	(4) high sales	(5) triple	(6) triple
D ln(XR)	-3.260*		-2.760		0.218	
	(1.810)		(1.965)		(1.729)	
D ln(XR) X FC	8.782***	9.544***	6.236**	5.541	8.422**	11.52***
	(2.590)	(2.992)	(2.659)	(3.424)	(3.414)	(3.864)
D ln(XR) X FC X for. sales					-0.115*	-0.184**
					(0.0681)	(0.0793)
FC	-0.264*	-0.240	-0.0581	0.0274	-0.223	-0.264
	(0.153)	(0.170)	(0.153)	(0.175)	(0.210)	(0.236)
Lag. rating	0.0869	0.104**	0.159***	0.172***	0.118***	0.116***
	(0.0534)	(0.0514)	(0.0549)	(0.0511)	(0.0435)	(0.0423)
FC X for. sales					0.00100	0.00182
					(0.00337)	(0.00409)
D ln(XR) X for. sales					-0.0360	0.00351
					(0.0325)	(0.0336)
Ct FE	Yes	No	Yes	No	Yes	No
Time FE	Yes	No	Yes	No	Yes	No
Ct-time FE	No	Yes	No	Yes	No	Yes
Observations	15413	8591	17690	9833	23658	14044
Pseudo R^2	0.102	0.069	0.114	0.094	0.102	0.084

Note: This table analyzes whether the effect of exchange rate changes in the presence of foreign currency borrowing differs across industries with varying shares of international sales in total sales. Columns 1 and 2 include observations associated with borrowers in industries with low foreign sales (¡35 percent). Columns 3 and 4 are based on a sample of borrowers in industries with high foreign sales. Columns 5 and 6 are based on the full sample and include a triple interaction between the exchange rate change, the foreign currency indicator variable and the share of foreign sales in total sales of the industry in which the borrower is active. Columns 1 to 5 include time and country fixed effects. Column 6 has country-time fixed effects. Standard errors are clustered by country-quarter. *, ** and *** denote significance at the 10%, 5% and 1% level.

for firms in industries that have a low share of sales abroad, whereas columns 3 and 4 show results for firms in industries with high shares of sales abroad. Columns 5 and 6 present results from triple interactions between the exchange rate, the foreign currency indicator, and the share of sales abroad. All results imply that foreign sales reduce the adverse effects of exchange rate changes on loan payments through the balance sheet channel, and foreign sales work as a natural hedge.

Depreciations vs. appreciations Are firms affected differently depending on the direction of the exchange rate change? One might expect effects to be stronger for depreciations, a conjecture

that is tested in table 11. Columns 1 and 2 focus on appreciations, while columns 3 and 4 are

Table 11: Depreciation vs. appreciation

	appreciation		depreciation		both	
	(1)	(2)	(3)	(4)	(5)	(6)
D ln(XR)	-8.170		-5.151		-0.0990	
	(5.850)		(3.224)		(4.095)	
D ln(XR) X FC	2.212	1.997	10.30***	10.94***	-0.333	1.391
	(8.210)	(7.728)	(3.912)	(4.163)	(5.683)	(7.821)
D ln(XR) X FC X depr.					7.020	9.625
					(6.948)	(8.883)
FC	-0.259	-0.169	-0.350	-0.330	-0.322**	-0.165
	(0.225)	(0.225)	(0.237)	(0.245)	(0.160)	(0.218)
FC X depr.					0.184	-0.170
					(0.195)	(0.328)
Time FE	Yes	No	Yes	No	Yes	No
Ct FE	Yes	No	Yes	No	Yes	No
Ct-time FE	No	Yes	No	Yes	No	Yes
Observations	9149	5649	27689	18007	43761	23656
Pseudo R^2	0.084	0.090	0.110	0.078	0.107	0.081

Note: This table analyzes potential asymmetric effects of currency appreciations and depreciations. Columns 1 and 2 include country-quarter observations where the local currency appreciated against the USD. Columns 3 and 4 only include observations associated with local currency depreciation. Columns 5 and 6 are based on the full sample and include a triple interaction between the exchange rate change, the foreign currency indicator variable, and a dummy variable that is one if the exchange rate change is positive (associated with a depreciation). Columns 1 to 5 include time and country fixed effects. Column 6 has country-time fixed effects. Standard errors are clustered by country-quarter. *, ** and *** denote significance at the 10%, 5% and 1% level.

for depreciations. Columns 5 and 6 present results from triple interactions between the exchange rate, the foreign currency indicator, and an indicator variable that is one if the local currency depreciated and is zero otherwise. Note that over the sample period, the USD appreciated significantly, so that more observations in our sample are associated with a depreciation of the local currency. We find highly significant effects for depreciations but no significant effects for appreciations. The triple interaction coefficient has the right sign but is not significant at conventional levels. Still, these results suggest that the findings in favor of the balance sheet channel are largely driven by local currency depreciations.

4.4 Robustness

This section presents several robustness exercises. In particular, we show that our main result survives even more comprehensive fixed effects. It also persists when we drop the top three banks from our sample, which constitute a large share of our observations. Results are also robust to controlling for the interest rate charged and can be obtained from different estimators.

Adding more comprehensive fixed effects Results with more comprehensive fixed effects are shown in table 12. The main effect is still highly significant and has a similar magnitude to

Table 12: More extensive fixed effects

	(1)	(2)	(3)
D ln(XR) X FC	8.248***	9.103***	9.785**
	(2.410)	(3.216)	(4.827)
FC	-0.172	-0.255	-0.325
	(0.126)	(0.176)	(0.259)
Ct-time FE	Yes	No	No
Ct-Time-Ind FE	No	Yes	No
Ct-Time-Ind-Rat	No	No	Yes
Observations	23656	5040	2563
Pseudo R^2	0.080	0.124	0.149

Note: This table shows the baseline regression results when more extensive fixed effects are included. Column 1 corresponds to column 6 of table 7. Column 2 includes country-time-industry fixed effects. Column 3 has country-time-industry-rating fixed effects. Standard errors are clustered by country-quarter. *, ** and *** denote significance at the 10%, 5% and 1% level.

those resulting from the baseline regressions. Column 3 reports the results of the most comprehensive test, which compares differences in loan payments of firms in the same country, quarter, and industry and with the same credit risk rating.

Controlling for the lagged interest rate One may be concerned that the credit risk rating of a firm is not a perfect measure of its riskiness. To address this concern, we run regressions that also include the lagged average interest rate charged to the firm. Results are reported in table 13.

Controlling for the lagged average interest rate does not change the baseline results. In a next step, we add an interaction term between the interest rate and the exchange rate change to the regression. Results are presented in table 14. While the interest rate interaction is significant in some specifications, its inclusion does not affect our main results.

Using different estimation methods Finally, we rerun our regressions, employing other estimation methods besides probit. In particular, we use standard OLS, logit and cloglog estimators, which all produce very similar results as shown in tables 8 and 15.[20] Marginal effects displayed in the two tables are significantly different from each other. While marginal effects associated with the interaction term range from 61 to 69 basis points in table 8, they range from 110 to 161 basis points in table 15. This difference is due to a change in the sample that occurs when country-time fixed effects are included in the regressions in table 15.

[20]Because we estimate a large number of fixed effects, logit estimation tends to be very slow. Due to these computational reasons, we can rerun most but not all specifications with logit. Additional results are available

Table 13: Controlling for the interest rate I

	(1)	(2)	(3)
D ln(XR)	-0.750	-2.256	
	(1.351)	(1.465)	
D ln(XR) X FC	4.626***	6.872***	8.331***
	(1.620)	(1.823)	(2.295)
FC	-0.0724	-0.216**	-0.255**
	(0.0904)	(0.108)	(0.126)
Country risk	-0.00578	0.0347*	
	(0.00593)	(0.0190)	
Credit-to-GDP gap	-0.00632**	0.00335	
	(0.00273)	(0.00617)	
GDP growth	0.689	0.959	
	(0.590)	(0.700)	
CP inflation	-0.00742	-0.164***	
	(0.0198)	(0.0291)	
Ln(loan size)	-0.0172	-0.0266	-0.0228
	(0.0167)	(0.0177)	(0.0189)
Ln(maturity)	-0.0580	-0.0580	-0.0618
	(0.0409)	(0.0487)	(0.0480)
Lag. rating	0.122***	0.135***	0.148***
	(0.0388)	(0.0422)	(0.0386)
Ln(int. rate)	-0.0578	-0.0789	-0.107**
	(0.0526)	(0.0632)	(0.0515)
Time FE	Yes	Yes	No
Ct FE	No	Yes	No
Ct-time FE	No	No	Yes
Observations	50438	43650	23218
Pseudo R^2	0.057	0.108	0.085

Note: This table shows the regression results when the borrower's average interest rate is included in the baseline regressions. Columns 1 and 2 include time and country fixed effects. Column 3 has country-time fixed effects. Standard errors are clustered by country-quarter. *, ** and *** denote significance at the 10%, 5% and 1% level.

5 Conclusions

This paper exploits unique U.S. loan-level data to shed light on the balance sheet channel and its feedback effects to bank balance sheets. Firm performance—in our case captured by missing loan payments—deteriorates for firms with foreign currency debt relative to firms with domestic currency debt when the local currency depreciates. We calculate that a 10 percent depreciation of the USD leads to roughly $2.5 billion in late loan payments for U.S. banks.

Our findings of a strong balance sheet channel have implications for firms, banks and policy makers. Even in relatively tranquil times, firms do not seem to hedge sufficiently against currency swings, exposing both firms and banks to substantial risk. As a result, any economic policies that move the exchange rates are likely to create additional costs through the balance sheet

upon request.

Table 14: Controlling for the interest rate II

	(1)	(2)	(3)	(4)
D ln(XR)	-6.710**	-11.54**		
	(2.646)	(4.725)		
D ln(XR) X FC	4.194***	6.254***	7.692***	7.050***
	(1.551)	(1.675)	(2.155)	(2.278)
D ln(XR) X ln(int. rate)	-1.645***	-2.497**	-1.568	-1.751
	(0.582)	(1.141)	(0.977)	(1.255)
D ln(XR) X lag. rating				0.961
				(1.170)
D ln(XR) X for. sales				-0.0682
				(0.0749)
D ln(XR) X for. ass.				-0.182**
				(0.0886)
D ln(XR) X for. inc.				0.127
				(0.0852)
D ln(XR) X ln(loan size)				-0.815*
				(0.467)
D ln(XR) X ln(maturity)				4.671**
				(1.839)
Ln(int. rate)	0.0293	0.0501	-0.0234	0.113
	(0.0614)	(0.0692)	(0.0618)	(0.108)
FC	-0.0434	-0.179*	-0.222*	-0.238*
	(0.0891)	(0.104)	(0.121)	(0.130)
Time FE	Yes	Yes	No	No
Ct FE	No	Yes	No	No
Ct-time FE	No	No	Yes	Yes
Observations	50438	43650	23218	13881
Pseudo R^2	0.060	0.113	0.087	0.107

Note: This table shows the regression results when the borrower's average interest rate is included in the baseline regressions as well as an interaction term between the change in the exchange rate and the interest rate. Columns 1 and 2 include time and country fixed effects. Columns 3 and 4 have country-time fixed effects. Standard errors are clustered by country-quarter. *, ** and *** denote significance at the 10%, 5% and 1% level.

channel. Such unintended adverse effects could, for example, arise through monetary policy and fiscal policy spillovers.

Our evidence on the balance sheet channel is consistent with the views that deprecations might be contractionary, cause or worsen currency crises, and create systemic risk. In addition, they directly support the view that depreciations feed back onto bank balance sheets through higher credit risk, which in turn may cause a reduction in (cross-border) lending.

Table 15: Marginal effects and different estimation methods II

	(1) Probit	(2) Probit ME	(3) OLS	(4) CLogLog	(5) ClogLog ME
D ln(XR) X FC	8.248***	0.161***	0.110***	22.43***	0.152***
	(2.410)	(0.0469)	(0.0316)	(7.167)	(0.0484)
FC	-0.172	-0.00337	-0.00102	-0.635	-0.00430
	(0.126)	(0.00245)	(0.00176)	(0.386)	(0.00261)
Lag. rating	0.142***	0.00278***	0.00280***	0.305***	0.00206***
	(0.0356)	(0.000692)	(0.000730)	(0.106)	(0.000714)
Ct-time FE	Yes	-	Yes	Yes	-
Observations	23656	23656	23656	22278	22278
R^2	-	-	0.012	-	-
Pseudo R^2	0.080	-	-	-	-

Note: This table shows regression coefficients and marginal effects for different estimators. Column 1 shows the baseline regression results based on probit estimation. Column 2 presents the associated marginal effects. Column (3) is based on OLS regression. Column (4) and (5) employ the cloglog estimator. All regressions include country-time fixed effects. Standard errors are clustered by country-quarter. *, ** and *** denote significance at the 10%, 5% and 1% level.

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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, foreign income and foreign assets 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
- GDP growth: Annual GDP growth from the World Bank's World Economic Outlook.
- Country risk index: Quarterly data from The Economist Intelligence Unit.
- Inflation: Consumer Price Inflation from the International Financial Statistics (IFS) provided by the IMF.
- Credit-to-GDP gap: The difference between a country's credit-to-GDP ratio and its long-run trend. Published in the BIS database of total credit to the private non-financial sector.