Exchange Rate Fluctuations and Firm Leverage*

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Abstract

This paper quantifies the response of firm leverage to exchange rate fluctuations. When home currency appreciates, firms who hold foreign currency debt and local currency assets observe higher net worth as appreciation lowers the value of their foreign currency debt. These firms can borrow more as a result. When home currency depreciates, the reverse happens and firms have to de-lever with a negative shock to their balance sheets. Using firm-level data from 10 emerging market economies during the period from 2002 to 2015, we show that firms operating in countries whose non-financial sectors hold more of the debt in foreign currency, increase (decrease) their leverage relatively more after home currency appreciations (depreciations). The effect of a depreciation is quantitatively larger than that of an appreciation, especially for depreciations larger than 10 percent. By separating foreign currency debt of the corporate sector into loans and bonds, we show that our results are due to loans in foreign currency, rather than bonds.

JEL Classification: E0, F0, F1

Keywords: Capital Flows, Exchange Rates, FX Borrowing, Firm Leverage

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1 Introduction

Standard international macro theory postulates that countries should let their exchange rates carry the burden of adjustment when financial conditions change in the rest of the world. When external demand from the rest of the world decreases due to a tightening of monetary policy for example, the associated appreciation helps small open economies increase their exports to the rest of the world and cut back their imports from the rest of the world. If these small open economies are also net borrowers and experience capital outflows due to tightening of monetary policy in the rest of the world, then their depreciating currencies is the only way to combat reduced activity associated with capital outflows by switching external demand to their goods. This channel, known as the expenditure switching channel of the Mundell-Fleming model, highlights the virtue of flexible exchange rates.[1] The evidence on such expenditure switching in terms of higher net exports offsetting an external shock that depreciated the home currency is, however, weak. This is partly because under dominant currency pricing, expenditure switching is muted as it works mostly via imports and not exports as shown by Gopinath (2016) and Gopinath, Boz, Casas, Diez, Gourinchas and Plagborg-Moller (2019).

Policy makers in emerging market economies (EMEs) argue that flexible exchange rates can also hurt their economies as excessive exchange rate volatility will have negative effects on economic activity when a country has extensive debt denominated in foreign currency (FX).[2] There has been a large empirical literature which shows that exchange rate depreciations are contractionary, especially during sudden stops and balance of payments crises. Aguiar (2005), for example, considers the large depreciation episode during the 1995 Mexico debt crisis and finds that firms with heavy exposure to short-term FX debt before the devaluation experienced relatively low levels of post-devaluation investment. Kalemli-Ozcan, Kamil and Villegas-Sanchez (2016), using also firm-level data from six Latin American countries and highlighting the role of firm heterogeneity, show that non-exporters with a balance sheet currency mismatch decrease investment as argued by Aguiar (2005), but foreign-owned exporters

[1] If there is an expansionary monetary policy in the rest of the world, demand for exports of small open economies will increase but this will be counteracted by appreciating currencies of these small open economies. This mechanism has been at the center of the "currency wars" debate due to expansionary monetary policies in the United States in the aftermath of the 2008 crisis that depreciated the U.S. dollar and appreciated the emerging market currencies.

[2] See Calvo and Reinhart (2002) who documented a pervasive "fear of floating," where the "fear" can be linked to liability dollarization. Another argument for preventing exchange rate volatility is the high degree of pass-through into domestic inflation in emerging market economies as argued by Burnstein and Gopinath (2014).

with access to liquidity from their parents increase investment after the currency crises in these countries.[3] Another channel for the contractionary effects of depreciations is imported intermediate inputs, where such inputs will be more expensive after a depreciation as shown in Mendoza and Yue (2012) and Gopinath and Neiman (2013). Models such as Krugman (1999) and Céspedes, Chang and Velasco (2004) can justify the balance sheet channel due to currency mismatches between liabilities and assets that arise from financial frictions.

These models are symmetric. When home currency appreciates, the balance sheet effect should work in reverse, lowering the value of FX debt, which constitutes a positive net worth shock to the balance sheets of firms, allowing firms to borrow more, leading to a credit expansion and an investment boom in the economy. The same effect can be realized through credit supply of global banks if these banks' balance sheets also suffer from currency mismatches with liabilities in US dollars exceeding assets in US dollars, as argued by Bruno and Shin (2015a). Bruno and Shin (2015b), using bank-level data, provide evidence that a depreciation of the US dollar against many countries' currencies is associated with an increase in leverage of global banks and acceleration of cross-border banking flows into countries whose home currencies are appreciating against the US dollar. Avdjiev, Koch and Shin (2018a) show similar evidence that cross-border banking flows are higher when there are depreciations in major funding currencies. On the pricing side, Hofmann, Shim and Shin (2017, 2019) show that an appreciation of local currency vis-à-vis the US dollar in EMEs leads to a compression in government bond yields of those EMEs, which signals easier borrowing conditions for governments.[4]

There is a gap between these empirical literatures that study the effects of depreciations and appreciations. The former focuses on *firms'* investment and employment outcomes and the latter, so far, has focused on *global banks'* leverage and cross-border capital flows. It is important to know through which channel exchange rate fluctuations affect credit and investment. Many countries' banks do not have a balance sheet currency mismatch as they are required to be hedged by the regulatory policy. Hence, it might be that firms who have a currency mismatch on their balance sheets receive a positive net worth shock through an exchange rate

[3] See also Serena and Sousa (2017) who show similar results for 36 emerging market economies. Bleakley and Cowan (2008) argue that exporters will not have a balance sheet currency mismatch due to their natural hedge of revenue in foreign currency. Hence we do not expect to see a negative balance sheet effect for exporters as a result of a depreciation.

[4] See also Avdjiev, Du, Koch and Shin (2018c) and Avdjiev, Bruno, Koch and Shin (2018b) with similar results on prices.

appreciation and demand more credit and this channel will drive the credit expansion. Such a channel implies that the effect of exchange rate fluctuations will work through credit demand instead of credit supply and will have different policy implications. For example, di Giovanni, Kalemli-Ozcan, Ulu and Baskaya (2019) find no role for exchange rate fluctuations on credit growth once they focus on bank credit supply controlling firm credit demand, as the banks in their sample have no currency mismatch on their balance sheets.

This paper fills this gap between the two literatures on depreciations and appreciations. Although we cannot differentiate firm demand from bank supply, we can test the underlying mechanism in both of these literatures. That is whether or not firms increase (decrease) their borrowing due to a relaxation (tightening) of their financial constraints with the appreciation (depreciation) of the exchange rate defined as the local currency per US dollar. Such leveraging and de-leveraging will in turn affect firms' investment and hence aggregate output. If firms increase their borrowing "too much" as a result of an appreciation, this can be interpreted as "risk-taking" as argued by Bruno and Shin (2015a). On the depreciation side, too much de-leveraging can lead to precautionary savings, where firms will not invest but rather save due to a debt overhang problem that can potentially explain the persistent sluggish investment after a financial crisis.[5]

We use firm-level data from the ORBIS database for 10 EMEs in Asia over the period of 2002 to 2015. The ORBIS database allows us to have a granular look since it includes balance sheet variables for both listed and non-listed firms. This is a big advantage over other firm-level datasets such as Worldscope which covers only listed firms, and the Capital IQ database which has an extremely small coverage of non-listed firms (a few giant firms in most EMEs). ORBIS data may not be representative nationally due to the fact that it does not cover the *universe* of private firms. Thus, we will focus on 10 Asian EMEs with good coverage of the economy (over 45/50 per cent of aggregate output and corporate sector debt), as shown in Table 1.[6]

It is hard to obtain currency composition of debt at the firm level for private firms in any country unless a credit registry is used. These registries include banks' regulatory filings to the national authorities. In the aggregate form, such data can be obtained from banks report-

[5]See Kalemli-Ozcan, Laeven and Moreno (2019).

[6]The only exceptions are Hong Kong SAR and China. We ran robustness exercises without including these two economies, and obtained similar results.

Table 1: Coverage of Firm-Level Data

Economy	Aggregated Firm Sales/ Country Gross Output[1]	Aggregated Firm Debt/ Country Corporate Sector Debt[2]
China	59%	23%
Hong Kong SAR	33%	15%
Indonesia	48%	47%
India	45%	71%
Korea	50%	51%
Malaysia	69%	91%
Philippines	45%	85%
Singapore	49%	61%
Thailand	70%	77%
Chinese Taipei	67%	83%

This table shows the coverage of ORBIS database. Data sources: BIS; CEIC; ADB; World KLEMS; national data.
[1] This column shows the aggregated sales of all firms in our sample divided by the nominal gross output. The coverage numbers are calculated in every year from 2002 to 2015. The table reports the average of the yearly numbers for each economy. The gross output data are from World KLEMS for Korea and India, from CEIC for China and Indonesia, and from ADB and national statistics for Hong Kong SAR, Malaysia, the Philippines, Singapore, Thailand and Chinese Taipei.
[2] This column shows the aggregated debt outstanding of all firms in our sample divided by the national total credit to the private non-financial corporate sector. The denominator is from the BIS. The coverage numbers are calculated in every year from 2002 to 2015. The table reports the average of the yearly numbers for each economy.

ing to the BIS, through the BIS Global Liquidity Indicators (GLI) database. The GLI database is based on BIS Locational Banking Statistics and BIS International Debt Securities Statistics. This database provide FX debt exposures both for bonds and loans. As the database is at the aggregate level, firms', households' and governments' FX debt is aggregated into the total FX debt of the non-financial sector of a given country. Through another BIS dataset, we will separate the government sector and keep the non-financial sector as firms and households. This is important as results on the effects of appreciations change with and without government debt.

FX bonds are debt securities issued in the US dollar, euro and Japanese yen and issued in international markets by the residents in the non-financial sector of a given economy. FX loans are bank loans extended to the non-financial sector of a given economy both by domestic banks and international banks located outside the economy and denominated in the US dollar, euro and Japanese yen. The BIS GLI data cover 42 economies, 21 of which are advanced economies (AEs) and the rest are EMEs. The share of total FX debt of our 10 EMEs out of the 21 EMEs with FX debt data available in the GLI is 42% in 2000, and reached to 65% in 2015. The average share during the whole sample period is 53%. Thus, our sample of 10 EMEs account for a dominant share of global EME FX debt.

As Table 2 shows, for all our sample economies, FX loans constitute the larger share of FX debt of the non-financial sector over time. This is because FX loans can be obtained both from domestic and external lenders, whereas FX bonds are predominantly issued internationally. Since most small firms cannot issue internationally (and most of the private firms are small), studying effects of FX debt exposure through international bond issuance, as common in the literature due to data availability issues, will underestimate the “true” FX debt exposure of a given country.

Table 2: Share of FX loans in FX debt

	China	Hong Kong SAR	Indonesia	India	Korea	Malaysia	Philippines	Singapore	Thailand	Chinese Taipei
2002	93%	85%	96%	83%	29%	21%	36%	89%	71%	70%
2003	94%	86%	97%	84%	20%	18%	30%	83%	72%	60%
2004	93%	85%	92%	76%	21%	33%	30%	83%	70%	58%
2005	94%	87%	79%	68%	57%	41%	35%	84%	73%	56%
2006	95%	89%	74%	61%	62%	43%	29%	82%	74%	63%
2007	96%	90%	67%	60%	64%	46%	31%	85%	77%	69%
2008	97%	92%	59%	67%	73%	46%	28%	88%	74%	80%
2009	98%	93%	47%	65%	67%	55%	25%	86%	78%	86%
2010	98%	95%	61%	73%	66%	52%	33%	87%	85%	87%
2011	98%	95%	65%	80%	67%	57%	33%	90%	86%	86%
2012	99%	93%	62%	88%	60%	43%	35%	90%	88%	86%
2013	98%	93%	62%	86%	58%	49%	35%	93%	89%	86%
2014	99%	92%	63%	82%	57%	52%	35%	93%	86%	87%
2015	98%	93%	59%	83%	55%	56%	35%	93%	87%	86%

This table shows the share of FX loans in total FX debt (including loans and bonds) of the non-financial sector. Data source: BIS.

Most of the papers in the literature so far consider either FX loans or FX bonds to capture FX debt of a country but not both of these asset classes. For example, Maggiori, Neiman and Schreger (2018) analyze only FX bonds issued by the non-financial sector, and do not consider FX loans. At the other extreme, Avdjiev, Bruno, Koch and Shin (2018b) consider only dollar-denominated cross-border loans to EMEs. Lane and Shambaugh (2010) and Bénétrix, Lane and Shambaugh (2015) consider both FX loans and FX bonds, but they estimate these FX exposures using both BIS and balance of payments data in order to obtain a large cross-section of countries instead of using the actual FX exposures through BIS GLI database for BIS reporting countries.

In order to estimate the “share” of FX debt in total debt of the non-financial sector, we use the BIS Total Credit database. This database provides data on total loans and debt securities used for borrowing by the residents in the non-financial sector of a given economy, both in domestic and foreign currencies and from both domestic and foreign lenders. By dividing the sum of loans and bonds in FX from the GLI data set for the non-financial sector by the sum of total loans and bonds for the non-financial sector from the Total Credit database, we obtain the country-level non-financial sector FX debt share.

We run a firm-level leverage regression using annual data, where we regress firm-level leverage on firm fixed effects, standard leverage controls and sector-level exposure to FX debt. We interact FX debt exposure with dummies for exchange rate depreciation and appreciation in excess of 0, 5 and 10 per cent. We find that when home currency appreciates (depreciates), firms operating in the countries whose non-financial sectors hold a larger share of their debt in FX, increase (decrease) their leverage relatively more than those in countries with smaller FX debt shares. We show that our results are predominantly driven by FX loan exposures rather than FX bond exposures, which is not surprising given the fact that most of our firms are small and these firms will mainly borrow in loans rather than issuing in international markets.

In terms of economic significance, we find the effect of deprecations to be larger than that of appreciations. We hypothesize that this might be due to more sudden nature of large depreciations during sudden stop type phenomena as opposed to appreciations that happen slowly during booms. Using the mean ratio of FX debt to total debt for the 10 sample economies, we find that a depreciation of 10 percent or more decreases firm leverage by 0.0844. If we only focus on FX exposures through loans, then the effect of a 10 percent or more depreciation is a decline in leverage of 0.1517 and the effect of an 10 percent or more appreciation is an increase in leverage of 0.0265. Given the mean firm leverage is 0.16, a 10 percent or more depreciation represents a large change in leverage, equivalent almost to mean leverage. A 10 percent or more appreciation also represents quite a significant change as an increase in leverage of 0.03 represents a 20 percent increase in leverage over its mean.

Possible threats to our identification are through omitted time varying factors if these factors are correlated with the country-time level exchange rate fluctuations interacted with the share of corporate sector FX debt. One possibility is terms-of-trade shocks. To check the role of these factors, we use country$\times$time fixed effects by re-defining FX debt at the firm-level. We proxy firm-level FX debt share by assuming each firm's FX debt share is equivalent to their sector's share, controlling time-varying firm size as larger firms will have larger FX debts by construction. This exercise cannot replace having actual data on firm-level FX debt of course but nevertheless it allows us to control for time varying unobserved heterogeneity at the country-level which will be correlated with the exchange rate fluctuations and country-level FX debt shares. We obtain similar results from this exercise. We further explore the role of firms operating in non-tradeable sectors for possible selection effects and also rerun our regressions by separating long-term and short-term debt. Finally, we have run a placebo exercise where we use very small levels of deprecations and appreciations (less than 1 percent) and show that there are no effects of such small movements in the exchange rate on firm leverage.

The paper proceeds as follows. Section 2 describes the data and presents stylized facts. Section 3 presents the empirical methodology, results and robustness exercises. Section 4 concludes.

2 Data and Stylized Facts

2.1 Firm-Level Data

Our study uses accounting data of non-financial firms for the period of 2002 to 2015 in the following 10 economies: China, Chinese Taipei, Hong Kong SAR, India, Indonesia, Korea, Malaysia, the Philippines, Singapore and Thailand. We obtained annual data on firm-level balance sheet items such as total assets, total debt, long-term debt, short-term debt, sales, tangible fixed assets and earnings before interest and taxes (EBIT) from the ORBIS database produced by Bureau van Djik. Exchange rate data come from the BIS.

An important feature of our data is that it contains not only publicly traded companies, but also privately held firms which represent the majority of GDP for many economies in the sample. We exclude from the sample the firms inactive during the sample period and those in bankruptcy procedures. By taking advantage of the ownership and headquarter information provided in the ORBIS database, we also exclude those firms that are part of multinational networks, where decision making will be governed elsewhere than the firms' financial reporting location.[7] For example, a branch of a Korean company located in China reports the financial information to China. Such a branch is excluded from our sample because its decisions have little to do with the fluctuations in the value of the Chinese yuan against the US dollar. To avoid double counting, we use unconsolidated financial information for the firms reporting both consolidated and unconsolidated information. We further clean up the financial data following the procedures described in Kalemli-Ozcan, Sorensen, Villegas-Sanchez, Volosovych and Yesiltas (2015).

We combine the cleaned financial data from the ORBIS database and the country-level

[7] We exclude from the sample the firms that are identified as "branches of foreign companies" and those with their headquarters or ultimate parents located outside the financial reporting country in terms of the ISO country code.

nominal bilateral exchange rate data synchronized with each country's fiscal year applied to financial reporting. The fiscal year of the financial data reported before June is assigned to the year before the reporting-end year. The unit of observation in the sample is "firm-year". Our final sample contains 1,661,677 firm-year observations. Table 3 shows the number of observations and descriptive statistics of the main variables in the final sample after winsorization. All the variables are winsorized at 1 per cent to control for outliers before it is used in the regressions, while *Sales growth* is windsorized at 5 per cent.

Table 3: Summary Statistics†

Variables	Firm-year obs.	Mean	St. Dev.	Min.	Median	Max.
Leverage	1,661,677	0.162	0.241	0.000	0.000	0.998
Collateral	1,661,677	0.319	0.269	0.000	0.258	0.985
Profitability	1,661,677	0.077	0.175	−0.521	0.052	0.938
Size	1,661,677	0.815	1.906	−3.444	0.681	6.373
Sales growth	1,661,677	0.267	0.580	−0.464	0.120	1.993

†Based on unbalanced and winsorized sample of firms in 10 Asian economies.

Our dependent variable is a firm's financial leverage measured by the book value of total financial debt scaled by the book value of total assets. Total financial debt is the total value of the outstanding bank loans and financial bonds at the end of the fiscal year. We do not use the book value of total liabilities as the main measure of firm leverage in our benchmark analysis. This is because such liabilities contain information on trade credits or other forms of liabilities such as pension liabilities. We look at alternative measures of leverage for robustness and obtain broadly similar results.

We create dummy variables for exchange rate appreciations and depreciations. $\text{DummyXR}^k_{c,t}$, equals 1 when the nominal exchange rate against the US dollar decreases (i.e. the home currency appreciates) or increases (i.e. the home currency depreciates) between the end of the previous fiscal year and the end of the current fiscal year by more than k, where k takes values of 0, 5 and 10 percent between $t-1$ and t.

Following Rajan and Zingales (1995), we use other control variables that are typical for leverage regressions, such as *Collateral* measured by tangible fixed assets/total assets, *Profitability* measured by the EBIT/total assets, *Size* measured by the logarithm of total assets, and *Sales growth* measured by the growth in sales.[8] For all firms in our sample, total debt and other financial variables reported in local currency are converted into the US dollar by using the bilateral exchange rates of the nearest quarter-end of the reporting date. All the control variables are lagged by one year relative to the dependent variable.

2.2 Sector-Level FX Debt

Figure 1 shows that the ratio of total corporate debt to GDP has increased over time, especially in EMEs. We want to decompose this increase in corporate sector debt into FX and local currency components, regardless of the lender.

As explained in the introduction, the FX debt share is calculated as the sum of FX loans and FX bonds in the non-financial sector of a given country (from the GLI database of the BIS) divided by total debt (loans and bonds) of the non-financial sector of the same country (from the Total Credit database of the BIS). Figure 2 shows the level of the FX debt share for different regions using the entire GLI database for comparison to Asia where our 10 EMEs are from. This figure calculates the weighted average by using each country's FX debt as the weight. Under this weighting scheme, an economy with a larger amount of FX debt receives a greater weight since that economy is more likely to create instability in the region. Overall, the Latin American countries have the highest level of the FX debt share, though declining over time, while the advanced economies have the lowest level. The Asian EMEs are somewhere in between.

[8] In the literature, the market-to-book value or Tobin's Q is typically used to control a firm's growth opportunity. Since this is not available for non-listed firms in our sample, we use sales growth as a proxy for growth opportunity.

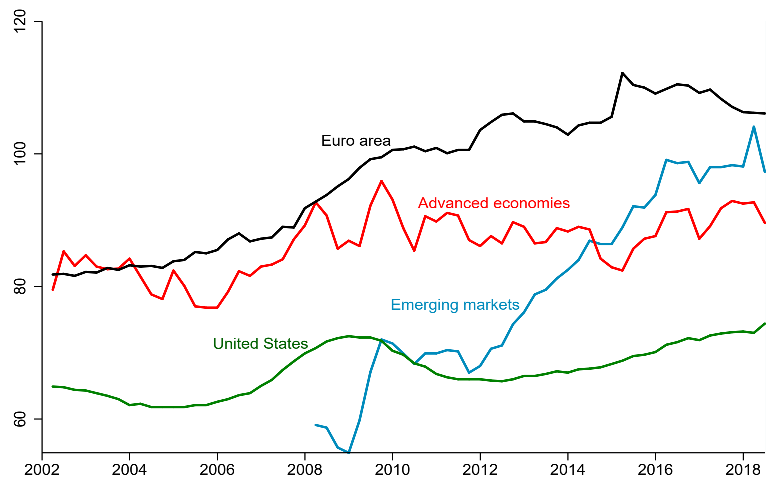

Figure 1: Ratio of Corporate Debt over GDP

This figure shows the ratios of total credit to the non-financial corporate sector over GDP, in percent. For advanced economies, emerging market economies and the euro area, the ratios are calculated as the aggregated corporate debt divided by the aggregated GDP of all economies in the region. Data source: BIS.

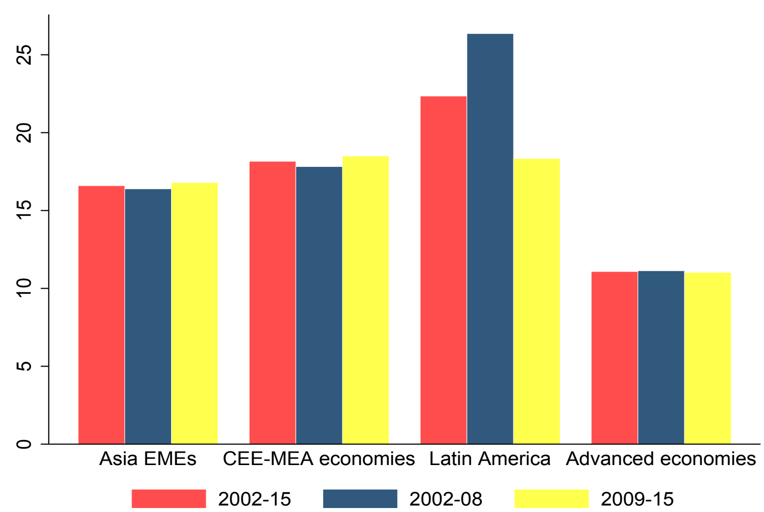

Figure 2: FX Debt Share in Total Non-Financial Sector Debt by Region (II)

This figure shows the weighted average of the ratio of FX debt to total credit to the non-financial sector of 42 economies in four different regions, using the economies' FX debt as the weight. Data source: BIS.

The non-financial sector includes non-financial corporations, households and government. Since we assume that households can't issue FX bonds (but they can borrow in FX loans), we can calculate the amount of FX bonds issued by non-financial corporates by deducting the FX bonds issued by the government from total FX bonds of the non-financial sector. We can also take out total debt of the government from the denominator. Doing this we end up with Figure 3 that shows the ratio of FX bonds issued by corporates divided by total credit to corporates. It seems like FX exposure in bonds is not large relative to total credit that includes loans to the corporate sector. These patterns imply that our results will mainly be driven by FX loan exposures.

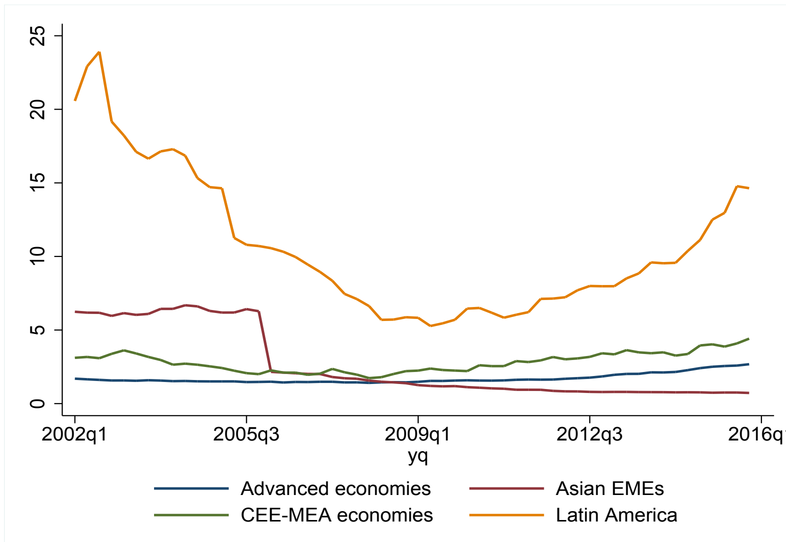

Figure 3: FX Bond Share in Total Debt: Corporate Sector

Table 4 shows the values of the share of FX debt in each of our countries for two points in time: beginning and end of our sample. There is both cross-country and time-series variation in the extent of non-financial sector FX debt shares, which will be useful for our empirical analysis.

Table 4: FX Debt/Total Non-Financial Sector Debt, 2002 vs 2015

	2002Q1	2015Q4		2002Q1	2015Q4
China	3.87	2.09	Hong Kong SAR	31.55	47.35
Indonesia	11.13	26.45	India	1.97	4.45
Korea	4.76	3.68	Malaysia	10.06	3.06
Philippines	35.18	22.08	Singapore	28.33	28.32
Thailand	12.76	7.93	Chinese Taipei	4.69	4.48

This table shows the level of the FX debt shares at the end of Q1 2002 and at the end of Q4 2015 in percent. Data source: BIS.

3 Empirical Analysis

3.1 Country-Level Evidence

We start by showing that there is a positive correlation between exchange rate appreciation and country-level total debt to GDP *only* in countries whose non-financial sectors hold a larger share of their debt in FX. There is no such relation for countries with low levels of FX debt. Using the entire GLI database, Figures 4 and 5 show the relation between the change in the logarithm of the exchange rate (LCU/USD) and the change in the ratio of total debt (total credit to non-financial corporates) to GDP. The countries are separated into two groups, high and low FX debt, according to the median of their initial FX debt share in 2002. The data is averaged over the sample period by country. Figure 4 shows that there is a significantly positive correlation between exchange rate appreciation and the change in the ratio of country-level total debt to GDP *only* in countries whose non-financial sectors hold a larger share of their debt in FX in 2002. By contrast, Figure 5 shows no significant relation for countries with low levels of FX debt. The figures support a balance sheet channel by showing that appreciation (depreciation) generates a larger increase (decrease) in debt for the countries with higher FX debt shares compared with those with lower FX debt shares.

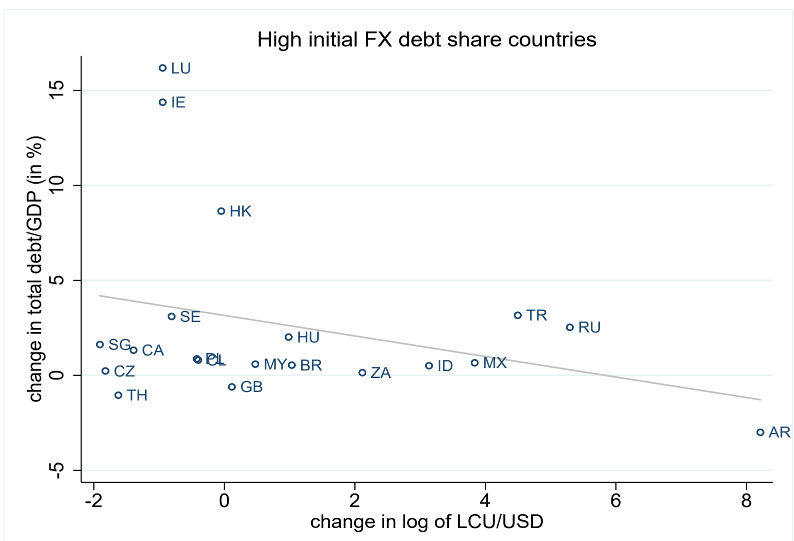

Figure 4: Total Debt and the Exchange Rate: Countries with High Initial FX Debt Share

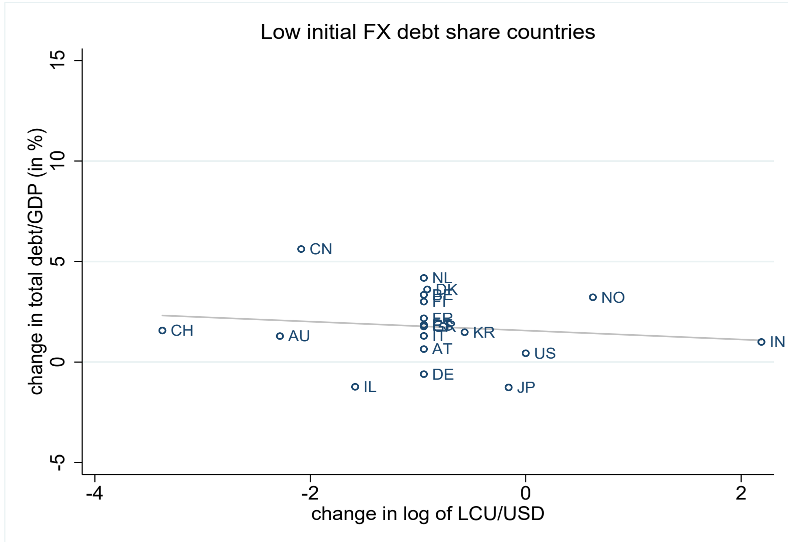

Figure 5: Total Debt and the Exchange Rate: Countries with Low Initial FX Debt Share

Of course, these figures plot correlations where such country-level correlations can be driven by other factors. To identify the relationship between exchange rate fluctuations and *firm* leverage, we turn to the firm-level data next.

3.2 Firm-Level Regressions

Our baseline specification (for firm i in industry j and country c in year t) is as follows:

$$\begin{aligned}\text{Leverage}_{i,j,c,t} = \beta \cdot \text{FXdebt}_{c,t-1} \times \text{DummyXR}^k_{c,t} + \lambda \cdot \text{FXdebt}_{c,t-1} + \rho \cdot \text{DummyXR}^k_{c,t} \\ + \theta \cdot X_{i,c,t-1} + \alpha_i + \gamma_c + \phi_{j,t} + \varepsilon_{i,j,c,t}\end{aligned} \tag{1}$$

where $\text{Leverage}_{i,j,c,t}$ is the firm-level financial leverage measured by financial debt/assets. $X_{i,c,t-1}$ is the set of lagged control variables that are firm size, collateral, profitability and sales growth, i.e., standard determinants of firm leverage. α_i captures the firm fixed effects, while γ_c, and $\phi_{j,t}$ are the country and industry-year fixed effects, respectively, which capture country-level time-invariant factors such as average differences across countries and also industry-level time-varying shocks which matter to a great extent for firm-level leverage. Notice that these industry-year effects are at a very granular 4-digit level and hence will also capture most of firm demand shocks as long as those shocks are specific to the 4-digit industry that the firm operates in.

FX debt variable is the share of FX debt in the total debt of the non-financial sector as we have explained above and it is lagged. DummyXR^k is a dummy variable for depreciations and appreciations that takes a value of 1 in years where the bilateral US dollar exchange rate appreciates or depreciates more than k percent, where k will be 0, 5 or 10. Both of these variables will be varying at the country-time level, preventing us from using country-time fixed effects. We estimate the regression model using the ordinary least squares (OLS) method. We also conducted a dynamic system general method of moments (GMM) estimation and obtained similar results.

3.3 Benchmark Results

Table 5 presents benchmark results. Columns (1)-(3) show the case for depreciations and columns (4)-(6) the case for appreciations. As expected, when the exchange rate depreciates, leverage goes down and when it appreciates it goes up. But this only happens in countries whose corporate sectors are heavily indebted in FX. In fact the effect of depreciations and appreciations in countries with no FX debt is the opposite: firm-leverage increases with depreciations and decreases with appreciations, though the effects are small. The effect of FX debt on leverage in the absence of exchange rate movements is always positive. All the other determinants of leverage enter to the regression with the expected signs.

The effects are economically significant: To calculate the total effects, we use the mean ratio of FX debt to total debt for the 10 Asian economies (0.1519) and show that a 10 percent or more depreciation decreases firm leverage by 0.0844. Also, the effects tend to become larger with the size of depreciations and appreciations. In general the effect of deprecations are larger than that of appreciations and appreciations larger than 10 percent deliver the wrong sign on the estimated coefficient as shown in column (6) first line.

One reason for this "wrong sign" interaction effect can be the role of government. Although we use lagged shares of FX debt and these shares are time-invariant mostly as shown before in Figure 2, it is still possible that governments of the commodity-exporting countries borrow less in response to an appreciation. We can subtract government bonds from FX bonds issued by the non-financial sector. Table 6 shows these results, and now all columns deliver the right sign on the interaction effect. Using the mean ratio of FX debt excluding government FX bonds to total debt (0.1191), a depreciation of 10 per cent or more decreases firm leverage by 0.1352, whereas an appreciation of same magnitude increases firm leverage only by 0.0108, an order of magnitude difference.

Table 5: Benchmark Results

Dependent variable: Financial debt/assets$_{i,j,c,t}$						
	(1)	(2)	(3)	(4)	(5)	(6)
Change in XR (k)	$k \geq +0\%$	$k \geq +5\%$	$k \geq +10\%$	$k \leq -0\%$	$k \leq -5\%$	$k \leq -10\%$
FXdebt$_{c,t-1}\times$ DummyXR$^k_{c,t}$	-0.0484***	-0.0805***	-0.5312***	0.0492***	0.0816***	-0.2620***
	(-6.5)	(-9.3)	(-19.0)	(6.6)	(10.8)	(-10.8)
FXdebt$_{c,t-1}$	2.3841***	2.3751***	2.4440***	2.3328***	2.3279***	2.4123***
	(76.4)	(75.3)	(78.4)	(69.6)	(68.5)	(71.5)
DummyXR$^k_{c,t}$	0.0189***	0.0324***	0.0699***	-0.0184***	-0.0108***	0.0132***
	(23.0)	(35.1)	(43.0)	(-22.5)	(-19.9)	(7.6)
Profitability$_{i,j,c,t-1}$	-0.0441***	-0.0442***	-0.0441***	-0.0441***	-0.0441***	-0.0442***
	(-23.6)	(-23.7)	(-23.6)	(-23.6)	(-23.6)	(-23.6)
Collateral$_{i,j,c,t-1}$	0.0650***	0.0652***	0.0661***	0.0650***	0.0644***	0.0653***
	(34.7)	(34.9)	(35.3)	(34.7)	(34.4)	(34.8)
Size$_{i,j,c,t-1}$	0.0204***	0.0202***	0.0200***	0.0204***	0.0204***	0.0209***
	(28.4)	(28.2)	(27.9)	(28.4)	(28.4)	(29.3)
Sales growth$_{i,j,c,t-1}$	-0.0009***	-0.0009***	-0.0009***	-0.0009***	-0.0010***	-0.0009***
	(-3.1)	(-3.2)	(-3.2)	(-3.1)	(-3.4)	(-3.0)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,373,080	1,373,080	1,373,080	1,373,080	1,373,080	1,373,080
R^2	0.78	0.78	0.78	0.78	0.78	0.78

This table reports the OLS regression results based on a panel data from 2002 to 2015 for 10 Asian economies. *Financial debt/assets* is the ratio of the book value of total financial debt over the book value of total assets. FXdebt is the country-level share of FX debt defined as non-financial sector FX debt divided by total credit to the non-financial sector. Collateral is tangible fixed assets scaled by total assets. Profitability is the ROA ratio (i.e. EBIT/total assets). Size is the logarithm of total assets. Sales growth is the growth rate in sales. t-stats based on clustered standard errors are in parentheses.

$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Next, we consider FX loans and FX bonds separately to see which type of FX debt drives the results. Table 7 shows that firms in a country where share of FX loans in the total non-financial sector debt is higher, tend to have higher (lower) leverage when the country experiences an appreciation (depreciation). Given much larger magnitudes in this table, it is clear that our results are driven by FX loan exposures. In particular, using the mean ratio of FX loans to total debt (0.0996), the effect of a 10 percent or more depreciation is a decline in leverage of 0.1517 and the effect of a 10 percent or more appreciation is an increase in leverage of 0.0265. Given the mean firm leverage is 0.16, a 10 percent or more depreciation represents a very large change in leverage, equivalent to the mean. An appreciation of 10 percent or more also represents a 20 percent increase in leverage over its sample mean.

Table 6: Benchmark Results: FX Debt—Excluding Government FX Bonds

Dependent variable: Financial debt/assets$_{i,j,c,t}$

	(1)	(2)	(3)	(4)	(5)	(6)
Change in XR (k)	$k \geq +0\%$	$k \geq +5\%$	$k \geq +10\%$	$k \leq -0\%$	$k \leq -5\%$	$k \leq -10\%$
FXdebt$_{c,t-1}\times$ DummyXR$^{k}_{c,t}$	-0.2061***	-0.3583***	-1.1352***	0.2061***	0.4327***	0.0908***
	(-14.2)	(-21.7)	(-19.1)	(14.2)	(27.7)	(2.8)
FXdebt$_{c,t-1}$	2.9789***	2.9547***	2.9972***	2.7714***	2.7816***	2.8315***
	(82.2)	(83.4)	(85.1)	(77.7)	(75.9)	(78.4)
DummyXR$^{k}_{c,t}$	0.0243***	0.0478***	0.0988***	-0.0240***	-0.0310***	-0.0157***
	(24.6)	(43.9)	(35.2)	(-24.4)	(-36.1)	(-8.6)
Profitability$_{i,j,c,t-1}$	-0.0444***	-0.0447***	-0.0445***	-0.0444***	-0.0444***	-0.0445***
	(-23.8)	(-23.9)	(-23.9)	(-23.8)	(-23.8)	(-23.8)
Collateral$_{i,j,c,t-1}$	0.0670***	0.0673***	0.0688***	0.0670***	0.0658***	0.0668***
	(35.8)	(36.0)	(36.8)	(35.8)	(35.2)	(35.7)
Size$_{i,j,c,t-1}$	0.0212***	0.0209***	0.0206***	0.0212***	0.0208***	0.0216***
	(29.6)	(29.3)	(28.9)	(29.6)	(29.1)	(30.3)
Sales growth$_{i,j,c,t-1}$	-0.0008***	-0.0008***	-0.0009***	-0.0008***	-0.0010***	-0.0009***
	(-2.9)	(-2.9)	(-3.1)	(-2.9)	(-3.3)	(-3.2)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,373,080	1,373,080	1,373,080	1,373,080	1,373,080	1,373,080
R^2	0.78	0.78	0.78	0.78	0.78	0.78

This tables uses FX debt of the non-financial sector after excluding FX government bonds. See notes to the previous table for the definitions of other variables.

$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table 7: Benchmark Results: FX Loans

Dependent variable: Financial debt/assets$_{i,j,c,t}$

	(1)	(2)	(3)	(4)	(5)	(6)
Change in XR (k)	$k \geq +0\%$	$k \geq +5\%$	$k \geq +10\%$	$k \leq -0\%$	$k \leq -5\%$	$k \leq -10\%$
FXloan$_{c,t-1}\times$ DummyXR$^{k}_{c,t}$	-0.1681***	-0.5514***	-1.5236***	0.1701***	0.5065***	0.2665***
	(-9.8)	(-26.8)	(-23.7)	(9.9)	(24.9)	(7.4)
FXloan$_{c,t-1}$	3.2094***	3.2292***	3.2194***	3.0413***	3.0571***	3.0670***
	(82.6)	(86.4)	(87.0)	(81.9)	(79.6)	(81.9)
DummyXR$^{k}_{c,t}$	0.0148***	0.0443***	0.0897***	-0.0149***	-0.0290***	-0.0234***
	(16.4)	(44.3)	(39.1)	(-16.6)	(-34.0)	(-14.9)
Profitability$_{i,j,c,t-1}$	-0.0445***	-0.0447***	-0.0445***	-0.0445***	-0.0445***	-0.0446***
	(-23.8)	(-24.0)	(-23.9)	(-23.8)	(-23.8)	(-23.9)
Collateral$_{i,j,c,t-1}$	0.0678***	0.0678***	0.0695***	0.0678***	0.0666***	0.0673***
	(36.3)	(36.3)	(37.2)	(36.3)	(35.6)	(36.0)
Size$_{i,j,c,t-1}$	0.0219***	0.0216***	0.0213***	0.0219***	0.0215***	0.0222***
	(30.6)	(30.2)	(29.8)	(30.6)	(30.0)	(31.1)
Sales growth$_{i,j,c,t-1}$	-0.0008***	-0.0007**	-0.0009***	-0.0008***	-0.0010***	-0.0009***
	(-2.8)	(-2.6)	(-3.1)	(-2.8)	(-3.3)	(-3.2)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,373,080	1,373,080	1,373,080	1,373,080	1,373,080	1,373,080
R^2	0.78	0.78	0.78	0.78	0.78	0.78

This tables uses FX loans only when defining the share of FX debt, that is this share is equal to FX loans/total credit to non-financial sector. See notes to the previous tables for all other variables.

$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

3.4 Country-Year Shocks and Firm-Level FX Debt

A threat to our identification is the omitted country-year shocks and factors. To be able to control for these, in this section, we will include country$\times$year fixed effects. Given the fact that our main variable of interest is at the country-time level (interaction of exchange rate movements with FX debt), we will redefine FX debt to be at the firm-level. To do this, we assume each firm's share of FX debt is equal to the aggregate share (after excluding government FX debt). Then we apply this share to each firm's total debt to get the firm-level FX debt. By construction larger firms will have more debt and hence more FX debt. Thus, it is important to control for time-varying firm size in the regressions. We use firm-level FX debt as a dummy in the regressions, where we create a time-invariant dummy variable for firm-level FX debt exposure, FX debt$_i$, that takes value 1 when the average value of FX debt of a firm is higher than the respective value of the median firm in the same country, and zero otherwise.

We interact the two dummies, that is firm-level FX debt and dummy for appreciations/depreciations. This interaction term corresponds to a "Difference-in-Differences" interpretation of the relative effect of an appreciation (or depreciation) on firms with different degrees of FX debt exposure. We also interact all the firm-level controls with the appreciation/depreciation dummy, to make sure our main variable of interest is not a proxy for these effects. We include firm, industry-year and country-year fixed effects. The firm fixed effects help to control the unobserved firm-level time-invariant heterogeneity and help us to identify from within variation as before. The industry-year and country-year fixed effects control all shocks, policy changes and unobserved time-varying heterogeneity at the industry and country levels. The dummy for appreciation (or depreciation) will be absorbed by the country-year fixed effects and the dummy for the firm-level FX debt will be absorbed by the firm fixed effects.

Our baseline specification is as follows:

$$\begin{aligned}\text{Leverage}_{i,j,c,t} = \beta \cdot \text{FXdebt}_i \times \text{DummyXR}^k_{c,t} + \theta_1 \cdot X_{i,c,t-1} + \theta_2 \cdot X_{i,c,t-1} \times \text{DummyXR}^k_{c,t} \\ + \alpha_i + \gamma_{c,t} + \phi_{j,t} + \varepsilon_{i,j,c,t}\end{aligned} \tag{2}$$

where Leverage$_{i,j,c,t}$ and $X_{i,c,t-1}$ are the same as in equation (1). α_i captures the firm fixed effects, while $\gamma_{c,t}$ and $\phi_{j,t}$ the country-year and industry-year fixed effects, respectively. We again estimate the regression model using the OLS method with robust standard errors clustered at the firm level. A dynamic system GMM estimation provided similar results.

Table 8 reports the results for depreciations and appreciations more than 10 percent in columns (1) and (2) respectively. Our results are similar to the results before, though with smaller coefficients given the fact that with so many fixed effects much of the variation is absorbed. The interaction of other firm controls with exchange rate movements shows the importance of controlling these effects as certain firms behave in the opposite way.

Table 8: Firm-Level FX Debt

Dependent variable: Financial debt/assets$_{i,j,c,t}$

	(1)	(2)
Change in XR (k)	$k \geq +10\%$	$k \leq -10\%$
FX debt$_i \times$ DummyXR$^k_{c,t}$	-0.0058***	0.0550***
	(-3.7)	(26.8)
Profitability$_{i,j,c,t-1}$	-0.0442***	-0.0427***
	(-23.9)	(-23.2)
Profitability$_{i,j,c,t-1} \times$ DummyXR$^k_{c,t}$	-0.0235***	-0.0151***
	(-2.7)	(-2.7)
Collateral$_{i,j,c,t-1}$	0.0690***	0.0704***
	(37.1)	(38.1)
Collateral$_{i,j,c,t-1} \times$ DummyXR$^k_{c,t}$	0.0364***	-0.0114***
	(12.7)	(-3.6)
Size$_{i,j,c,t-1}$	0.0202***	0.0212***
	(28.2)	(29.5)
Size$_{i,j,c,t-1} \times$ DummyXR$^k_{c,t}$	0.0040***	-0.0106***
	(6.9)	(-19.7)
Sales growth$_{i,j,c,t-1}$	-0.0006*	-0.0005*
	(-1.9)	(-1.8)
Sales growth$_{i,j,c,t-1} \times$ DummyXR$^k_{c,t}$	0.0002	-0.0023
	(0.2)	(-1.4)
Firm FE	Yes	Yes
Country-Year FE	Yes	Yes
Industry-Year FE	Yes	Yes
Observations	1,372,970	1,372,970
R^2	0.79	0.79

FX debt is a dummy that equals 1 if a firm's average FX debt during the sample period is higher than the country's sample median, and equals 0 otherwise. See footnotes for Table 5 for variable definitions. The standard errors are clustered at the firm level. t-statistics are reported in parentheses.

$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Next, we test the role of maturity by looking at the effect of currency appreciations (depreciations) on short-term and long-term debt based leverage. We again focus on the case of more than 10 percent depreciations and appreciations. Table 9 shows that the main effects are due to changes in long-term debt based leverage. In fact, for depreciations, the effect of FX debt on short-term debt is opposite: during depreciations more than 10 percent, firms with higher FX debt increase short-term based leverage and decrease long-term based leverage. The effects of appreciations are in the same direction but stronger in magnitude for the long-term debt based leverage.

Table 9: The Role of Debt Maturity

Dependent variable:[1]	LT	ST	LT	ST
	(1)	(2)	(3)	(4)
Change in XR (k)	$k \geq +10\%$	$k \geq +10\%$	$k \leq -10\%$	$k \leq -10\%$
FX debt$_i \times$ DummyXR$^k_{c,t}$	-0.0099***	0.0038***	0.0501***	0.0052***
	(-7.1)	(3.2)	(27.4)	(5.9)
Profitability$_{i,j,c,t-1}$	-0.0221***	-0.0207***	-0.0197***	-0.0219***
	(-14.0)	(-22.1)	(-12.6)	(-22.6)
Profitability$_{i,j,c,t-1} \times$DummyXR$^k_{c,t}$	-0.0249***	-0.0044	-0.0248***	0.0113***
	(-3.3)	(-0.8)	(-4.8)	(5.7)
Collateral$_{i,j,c,t-1}$	0.0596***	0.0093***	0.0609***	0.0094***
	(36.2)	(8.1)	(37.1)	(8.1)
Collateral$_{i,j,c,t-1} \times$DummyXR$^k_{c,t}$	0.0382***	-0.0031	-0.0058**	-0.0048***
	(14.1)	(-1.3)	(-2.1)	(-3.3)
Size$_{i,j,c,t-1}$	0.0109***	0.0098***	0.0118***	0.0099***
	(17.8)	(22.1)	(19.2)	(22.3)
Size$_{i,j,c,t-1} \times$ DummyXR$^k_{c,t}$	0.0045***	-0.0002	-0.0088***	-0.0020***
	(8.5)	(-0.6)	(-18.3)	(-8.1)
Sales growth$_{i,j,c,t-1}$	0.0014***	-0.0019***	0.0015***	-0.0020***
	(5.4)	(-10.4)	(6.3)	(-10.5)
Sales growth$_{i,j,c,t-1} \times$ DummyXR$^k_{c,t}$	0.0020*	-0.0017*	-0.0023	-0.0004
	(1.8)	(-1.6)	(-1.6)	(-0.6)
Firm FE	Yes	Yes	Yes	Yes
Country-Year FE	Yes	Yes	Yes	Yes
Industry-Year FE	Yes	Yes	Yes	Yes
Observations	1,372,970	1,372,970	1,372,970	1,372,970
R^2	0.74	0.75	0.74	0.75

See footnotes for Table 5 for variable definitions. t-statistics are reported in parentheses.
[1] LT and ST are short for LT debt/assets$_{i,j,c,t}$ and ST debt/assets$_{i,j,c,t}$, respectively. *LT debt/assets* is the ratio of the book value of long-term (remaining maturity more than 1 year) financial debt over the book value of total assets at the end of fiscal year t. *ST debt/assets* is the ratio of the book value of short-term (remaining maturity equal to or less than 1 year) financial debt over the book value of total assets at the end of fiscal year t.
$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

3.5 Robustness

This section provides the results of additional regressions of firm leverage as robustness checks.

First, we conduct a placebo test to see if there is still any effect when the exchange rate changes minimally. We redefine our appreciation and depreciation dummies for very little changes in the exchange rate, where we limit the appreciations or depreciations to less than 1 per cent. We also used alternative thresholds such as no more than 2 per cent for appreciation or depreciation, and obtained similar results. The results are reported in Table 10. We have run this exercise as an events analysis using only these years with limited exchange rate changes, which is why we lose observations. We show only the coefficient of interest, which is insignificant. This exercise shows the importance of the size of exchange rate movements to realize the effects on firm leverage.

Table 10: Placebo Test

Dependent variable: Financial debt/assets$_{i,j,c,t}$

	(1)	(2)	(3)	(4)
Change in XR (k)	$1\% \geq k \geq +0\%$	$1\% \geq k \geq +0\%$	$-1\% \leq k \leq -0\%$	$-1\% \leq k \leq -0\%$
FX debt$_i\times$ DummyXR$^k_{c,t}$	-0.0629	-0.0421	-0.0049*	-0.0049*
	(-1.1)	(-0.9)	(-8.9)	(-6.5)
Controls	Yes	Yes	Yes	Yes
Controls$\times$ DummyXR$^k_{c,t}$	No	Yes	No	Yes
Firm FE	Yes	Yes	Yes	Yes
Country-Year FE	Yes	Yes	Yes	Yes
Industry-Year FE	Yes	Yes	Yes	Yes
Observations	144,372	144,372	249,693	249,693
R^2	0.84	0.84	0.85	0.85

See footnotes for Table 8 for variable definitions. t-statistics are reported in parentheses.
$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

We further investigate the role of firms in the non-tradeable sector. Since firms in the tradeable sector have more capacity to generate revenues in foreign exchange, their borrowing in FX could be hedged by cash flows. The balance sheet channel therefore should work stronger for firms in the non-tradeable sector because they are likely to be more sensitive to the exchange rate shocks. As commonly classified in the literature, the tradeable sector includes agriculture, mining and manufacturing industries, while the non-tradeable sector includes construction, transportation, communication, utilities, wholesale/retail trade, and services. Therefore, we split the firms to see the different effects on firms in the tradeable and non-tradeable sectors.

As conjectured, Table 11 shows that the effects of depreciations are significant in the non-tradeable sector while insignificant in the tradeable sector. The effects of appreciations are significant in both sectors but stronger in the non-tradeable sector.

Table 11: Comparison between the Tradeable and Non-Tradeable Sector

Dependent variable: Financial debt/assets$_{i,j,c,t}$

	(1)	(2)	(3)	(4)
	Tradeable	Non-tradeable	Tradeable	Non-tradeable
Change in XR (k)	$k \geq +10\%$	$k \geq +10\%$	$k \leq -10\%$	$k \leq -10\%$
FX debt$_i \times$ DummyXR$^k_{c,t}$	-0.0037	-0.0048**	0.0341***	0.0643***
	(-1.5)	(-2.3)	(10.8)	(22.4)
Profitability$_{i,j,c,t-1}$	-0.0323***	-0.0554***	-0.0304***	-0.0550***
	(-15.4)	(-17.6)	(-14.8)	(-17.2)
Profitability$_{i,j,c,t-1} \times$DummyXR$^k_{c,t}$	-0.0410***	-0.0022	-0.0386***	0.0021
	(-3.0)	(-0.2)	(-4.0)	(0.3)
Collateral$_{i,j,c,t-1}$	0.0763***	0.0716***	0.0784***	0.0721***
	(35.5)	(21.6)	(36.6)	(21.9)
Collateral$_{i,j,c,t-1} \times$DummyXR$^k_{c,t}$	0.0415***	0.0356***	-0.0193***	-0.0022
	(10.0)	(8.3)	(-3.3)	(-0.5)
Size$_{i,j,c,t-1}$	0.0229***	0.0184***	0.0238***	0.0196***
	(26.3)	(15.4)	(27.2)	(16.4)
Size$_{i,j,c,t-1} \times$ DummyXR$^k_{c,t}$	0.0042***	0.0014	-0.0100***	-0.0111***
	(5.2)	(1.6)	(-11.8)	(-14.9)
Sales growth$_{i,j,c,t-1}$	-0.0020***	0.0012**	-0.0021***	0.0012***
	(-5.5)	(2.4)	(-5.7)	(2.7)
Sales growth$_{i,j,c,t-1} \times$ DummyXR$^k_{c,t}$	0.0016	-0.0024	-0.0003	-0.0035
	(0.8)	(-1.5)	(-0.1)	(-1.6)
Firm FE	Yes	Yes	Yes	Yes
Country-Year FE	Yes	Yes	Yes	Yes
Industry-Year FE	Yes	Yes	Yes	Yes
Observations	768,318	547,414	768,318	547,414
R^2	0.82	0.75	0.82	0.76

See footnotes for Table 5 for variable definitions. t-statistics are reported in parentheses.
$^*p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

4 Conclusion

This paper quantifies the response of firm leverage to exchange rate fluctuations. When home currency appreciates, firms who hold foreign currency debt and local currency assets observe higher net worth as appreciation lowers the value of their foreign currency debt. These firms can borrow more as a result. When home currency depreciates, the reverse happens and firms have to de-lever with a negative shock to their balance sheets.

Using firm-level data from 10 emerging market economies during the period from 2002 to 2015, we show that firms operating in countries whose non-financial sectors hold more of the debt in foreign currency, increase (decrease) their leverage relatively more after home currency appreciations (depreciations). The effect of a depreciation is quantitatively larger than that of an appreciation, especially for depreciations larger than 10 percent. By separating foreign currency debt of the corporate sector into loans and bonds, we show that our results are due to loans in foreign currency, rather than bonds.

Our findings have important policy implications. It is crucial to monitor firms' FX exposure and in particular, the extent of currency mismatch on their balance sheet. We show that currency appreciations combined with higher levels of FX exposure can prompt firms to increase their leverage during the good times (risk-taking), but that such firms are likely to become subject to de-leveraging pressures when their local currency depreciates. When the firms suffer from FX valuation losses and FX funding strains, the national authorities are often expected to step in to provide FX liquidity to these firms either directly or indirectly through their banks to minimize the negative impact on growth. Such circumstances require consideration of the adequate amount of available FX safety net in proportion to the size of FX mismatches both in aggregate and across firms. It might be hard to provide this type of safety net for many emerging markets.

The situation can get worse as FX debt leaves countries vulnerable to foreign monetary policy shocks. Diamond, Hu and Rajan (2018) shows that changes in the source country monetary policy, such as the United States, can lead to boom-bust cycles in emerging markets though currency appreciations and depreciations, which create positive and negative shocks on the balance sheet. In their model, easier monetary policy in the source country gets transmitted into domestic currency appreciation in the capital-receiving emerging markets. Since firms already have FX borrowing, their net worth is anticipated to increase as the domestic currency value of foreign borrowing diminishes. Such anticipated liquidity in the EME facilitates higher borrowing. This model is consistent with the evidence we show in this paper. Similarly, tighter source country policy will lead to anticipation of a depreciating currency and lower lending to emerging market corporates.

What about countries with low levels of FX debt and limited degree of balance sheet currency mismatches? Kalemli-Ozcan (2019) shows that changes in the source country monetary policy lead to boom-bust cycles also in these countries through funding and borrowing costs of banks and firms. She also shows that using the monetary policy to limit the exchange rate fluctuations in countries with high levels of FX debt and balance sheet mismatches as a response to changes in the source country monetary policy can be counter-productive. Such policies have negative effects on the domestic economic activity and incentivize accumulation of even more FX debt. Taken together with these works, our results in this paper highlight the importance of macroprudential policies to prevent the accumulation of un-hedged FX debt in the domestic economy at the first place.

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