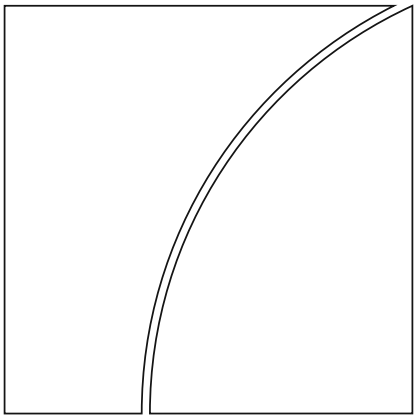

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Monetary and Economic Department

November 2025

JEL classification: F31, F34, G30, G32

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FX Debt and Optimal Exchange Rate Hedging*

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November, 2025

Abstract

This paper examines optimal foreign currency (FX) hedging by non-financial corporations globally. Using a cross-country, firm-level dataset, we first document key patterns of FX borrowing across advanced (AEs) and emerging market economies (EMEs). We find that while FX debt is prevalent in both groups, its intensity varies considerably. We assess the optimality of firms' exchange rate exposures using a risk-management framework where hedging serves to minimize the impact of cash flow volatility on firm value. Our results indicate that most firms hedge optimally, as exposures from FX debt are largely offset by other exposures, like foreign revenues and assets. While the distribution of exchange rate risk is broadly similar between AE and EME firms, the EME distribution has thicker tails, revealing a larger concentration of firms with significant, unhedged depreciation risk.

Keywords: Foreign currency debt, Currency risk, Currency hedging
JEL Classification: F31, F34, G30, G32

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1 Introduction

Major currencies, notably the U.S. dollar, are widely used for financial transactions worldwide,[1] thus exposing economic agents to exchange rate risk. As firms and banks borrow and lend in foreign currencies different from their underlying source of revenues and assets, financial exposures to the exchange rate arise. By impacting firms' balance sheet valuations and financial constraints, the relative prices of goods and services, and firms' investment opportunities, fluctuations in the exchange rates are important drivers of both real and financial activity.

But how much foreign currency borrowing do firms actually do? And do they optimally hedge their exchange rate risk? We address these questions in this paper.

We first document the pervasiveness of foreign currency (FX) borrowing worldwide. We do this based on a novel dataset of firm-level balance sheets and FX debt for large non-financial firms in 47 countries (26 EMEs and 21 AEs) in the period 2005-2023. One unique feature of the data is that it allows for a detailed breakdown of debt liabilities by currency. With this dataset in hand, we show that FX borrowing is widespread among large firms in both AEs and EMEs. For example, in both Mexico and Switzerland about 40% of firms in the sample report at some point a share of FX debt in total debt of at least 50%. That said, the extent of FX debt usage varies considerably across countries, both within AE and EME groups. There are some AEs where most large firms borrow in FX, and there are some EMEs where hardly any do so, and vice versa.

We then explore optimal hedging by non-financial firms based on the risk-management framework proposed by Froot, Scharfstein and Stein (1993). In this framework, optimal hedging does not imply total hedging of exchange rate risk. This is because there are capital market imperfections that make it costly to borrow or financially hedge to insure the risk, and there is upside risk also that the firm may benefit from. Rather, optimal hedging of the exchange rate implies currency movements do not have an impact on the firm's value due to increased volatility of cash flows (internal funds). We study a sample of over eight thousand firms in 38 countries (20 AEs and 18

[1] See, for example, Boz, Casas, Georgiadis, Gopinath, Le Mezo, Mehl and Nguyen (2022) and McGuire, von Peter and Zhu (2024). Foreign currency credit to the non-financial sector (eg US dollar credit to firms outside the US) is significant and has been growing for decades. The dollar's dominance in the international monetary system places the dollar as the primary currency for pricing in global trade (Goldberg and Tille, 2009; Gopinath, 2015), funding for bank and non-financial firms in capital markets (Bruno and Shin, 2015; Caballero, Fernández and Park, 2019; Eichengreen and Hausmann, 1999; Rey, 2015), and as reserve currency (Ilzetzki, Reinhart and Rogoff, 2019).

EMEs) in 2005-2023.[2]

We find that most firms in both EMEs and AEs appear to be optimally hedged to exchange rate movements, including those with significant FX debt. However, EME firms remain more at risk due to larger swings in exchange rate movements and larger deviations from optimal hedging. We also pair the balance sheet data with proxies for both FX revenues and FX assets and decompose the effects of the different FX exposures on firm value. We find that exchange rate exposure through FX debt is offset by other exposures of the firm, particularly those stemming from FX revenues or unobserved factors. We further find that EME firms' FX assets serve as a hedge for their FX debt, but this does not appear to be the case for AE firms.

The paper contributes to a long literature exploring the drivers and consequences of FX borrowing, particularly in developing and emerging market economies. Borrowing in foreign currency can have an impact on macroeconomic outcomes through various financial channels. For example, FX debt can magnify exchange rate shocks and affect firms' real economic outcomes via balance sheet effects. Indeed, exposure to FX borrowing was connected to the currency crises among EMEs in Asia and Latin America in the late 1990s and early 2000s. That literature emphasized the role of financial fragility and sudden stops in capital flows (Calvo, 2005; Cespedes, Chang and Velasco, 2004; Chang and Velasco, 1998; Corsetti, Pesenti and Roubini, 1999; Kaminsky and Reinhart, 1999; Krugman, 1999). More recently, fluctuations in the U.S. dollar have been linked to the risk appetite of global financiers, leading them to contract lending when the dollar strengthens (Bruno and Shin, 2015; Gelos, Patelli and Shim, 2024; Hofmann, Shim and Shin, 2025).

Empirical work at the firm-level has examined the drivers of FX borrowing in EME firms[3] and the real effects of depreciations. Studies have explored the impact on firms' capital investment (Aguiar, 2005; Bleakley and Cowan, 2008; Caballero, 2021; Hardy, 2023; Kim, Tesar and Zhang, 2015), financial fragility (Alfaro, Asis, Chari and Panizza, 2019), and R&D investment and innovation (Alfaro, Cuñat, Fadinger and Liu, 2022). This literature has found evidence for balance sheet shocks constraining investment among EME firms, but with considerable variation in timing and magnitude. While we do not explore the real effects of FX borrowing, our finding that many firms

[2]The sample is reduced because of availability of quarterly data on both firm's value and cash from operations, and the exclusion of firms headquartered in countries with hard pegs.

[3]See eg Allayannis, Brown and Klapper (2003); Brown, Ongena and Yeşin (2011); Eren, Malamud and Zhou (2023); Salomao and Varela (2022).

in EMEs seem optimally hedged offers a rationale of the mixed results in this literature.

Our findings also challenge the traditional view that FX debt among non-financial firms is a problem unique to EMEs. This view was often attributed to factors such as less developed financial systems and less credible monetary policy in EMEs, whereas AEs have more stable monetary policy and large and robust financial systems that provide credit in their domestic currency (eg Caballero and Krishnamurthy, 2003; Jeanne, 2005). However, in recent decades EMEs have drastically improved their policy frameworks and seen important development in their domestic financial systems (eg De Gregorio, 2014; Hardy, Igan and Kharroubi, 2024). This has bolstered resilience and contributed to greater local currency borrowing, particularly for sovereigns (Burger, Warnock and Warnock, 2012; Du and Schreger, 2022) but also for corporates (Avdjiev, Burger and Hardy, 2024). Our reexamination of FX debt exposures –leveraging a novel dataset with global coverage– highlights two important facts related to this literature: first, that the progress among EMEs has been uneven, with many still heavily reliant on foreign currency debt; and second, that firms in AEs also borrow significantly in foreign currencies.

Our exploration of optimal hedging also informs the corporate finance literature on currency risk and hedging. The early literature on the use of currency derivatives and its impact on firms document a very limited usage of derivatives, despite a positive impact on firm value (Allayannis, Lel and Miller, 2012; Bartram, 2019; Bartram, Brown and Conrad, 2011; Bartram, Brown and Fehle, 2009; Gatopoulos and Loubergé, 2013; Geczy, Minton and Schrand, 1997; Guay and Kothari, 2003). More recent studies have similarly found that the usage of FX derivatives only offers a partial hedging of the direct impact of FX exposures among firms in Japan (Adams and Verdelhan, 2021) and Chile (Alfaro, Calani and Varela, 2021). While invoicing in U.S. dollars may offer some isolation to currency movements, and firms do tend to invoice more in U.S. dollars if FX derivatives are more available (Fraschini and Terracciano, 2021), firms still face currency exposures due to the differing timing of export payments and the short maturities of FX derivatives (Alfaro *et al.*, 2021). Despite rapid growth in recent years, financial hedging in EMEs still remains limited compared to AE markets (Caballero, Maruin, Wooldridge and Xia, 2022). Many firms in EMEs, then, tend to hedge their exposures via operational factors (Allayannis, Ihrig and Weston, 2001), including matching to foreign currency revenues and by holding FX assets. Our results that most firms seem optimally hedged but there is large heterogeneity within countries, and EME firms are affected by

currency depreciations on average, squares well with the results of the existing literature.

The remainder of the paper proceeds as follows: the next section presents the data used in the analysis, Section 3 presents the key facts about FX debt, Section 4 presents our theoretical framework and empirical strategies, Sections 5 and 6 discuss our results on optimal hedging of exchange rate risk, and Section 7 concludes.

2 Data

Our primary data source is Standard & Poor's Capital IQ database. Capital IQ offers standardized balance sheet and other financial statements for larger firms (both public and private) across many countries. Capital IQ reports the data at the parent or holding company level, including both national and foreign subsidiaries as reported by firms in filings to supervisory authorities, and hence the datasets are consolidated at the highest level. Location is based on the company's headquarters. In addition to standardized annual and quarterly financial statements, Capital IQ provides two other linked annual datasets that we use in the paper.

First, we employ Capital IQ's debt structure dataset to measure firms' FX liabilities exposures. This dataset includes line by line items for all of the firm's debt liabilities at the end of the year. Importantly for our analysis, this includes details on the repayment currency. We classify the currencies either as local or foreign based on the currency where the firm has its headquarters.[4] We parse the available description for each item to compute its outstanding balance, and then sum these up to the firm-year level to obtain outstanding debt by currency.[5]

Second, we leverage Capital IQ's geographic segments dataset to proxy for firms' FX revenues and assets. This dataset includes information on the geographic location of firms' revenues and assets on an annual frequency. Because the locations are not standardized, we parsed the data to allocate positions to either domestic or foreign by comparing the location name with the firm's

[4]For items that do not specify the repayment currency, we assume it is USD.

[5]The outstanding debt from the itemized debt structure can be different from the reported total debt in the balance sheet due to (i) unamortized discounts, (ii) premiums, (iii) accrued interest or (iv) adjustments from hedging and derivatives. Capital IQ reports a line for the accounting adjustments needed for the two quantities to be equal. In our dataset we distribute the reported total adjustments proportionally into currencies. For the cases in which the total debt reported in the balance sheet is zero and there is no itemized debt structure for a given currency, we input zeros for our proxies of debt by currency.

headquarters location.[6] We assume that foreign revenues and assets are denominated in foreign currency.

We clean the annual dataset for outliers and inconsistencies. Specifically, we (i) drop all firms with reported negative assets at any point in time, (ii) drop all firm-year observations in which the difference between the sum of total liabilities plus equity is greater than 0.1% of total assets; (iii) drop all firm-year observations in which the amount of cash and cash equivalents are greater than total assets; (iv) drop all firm-year observations with no data for total assets or capital expenditures; and (v) drop all firm-year observations with negative values in total liabilities. We also exclude firms in the Financial, Utilities and Real Estate sectors. Our resulting baseline sample covers over 66 thousand non-financial corporations in 47 countries in the period 2005–2023 (26 EMEs and 21 AEs). Table A.1 in the Appendix lists the countries and the corresponding number of firms in our sample.

We further use Capital IQ's standardized quarterly financial dataset on income and cash flow statements to measure firms' cash from operations, as well as Capital IQ's quarterly equity dataset to proxy for firms' total enterprise value (TEV). TEV is measured by Capital IQ as: TEV = Market capitalization + Total debt + Preferred stock + Minority interest – Cash & Short Term Investments.

We complement our firm-level data with nominal exchange rates against the US dollar from the IMF.

3 FX Debt across the globe

Our large, cross-country panel of firms, including both advanced and emerging markets, allows us to make two key points about the use of FX debt by non-financial corporations.

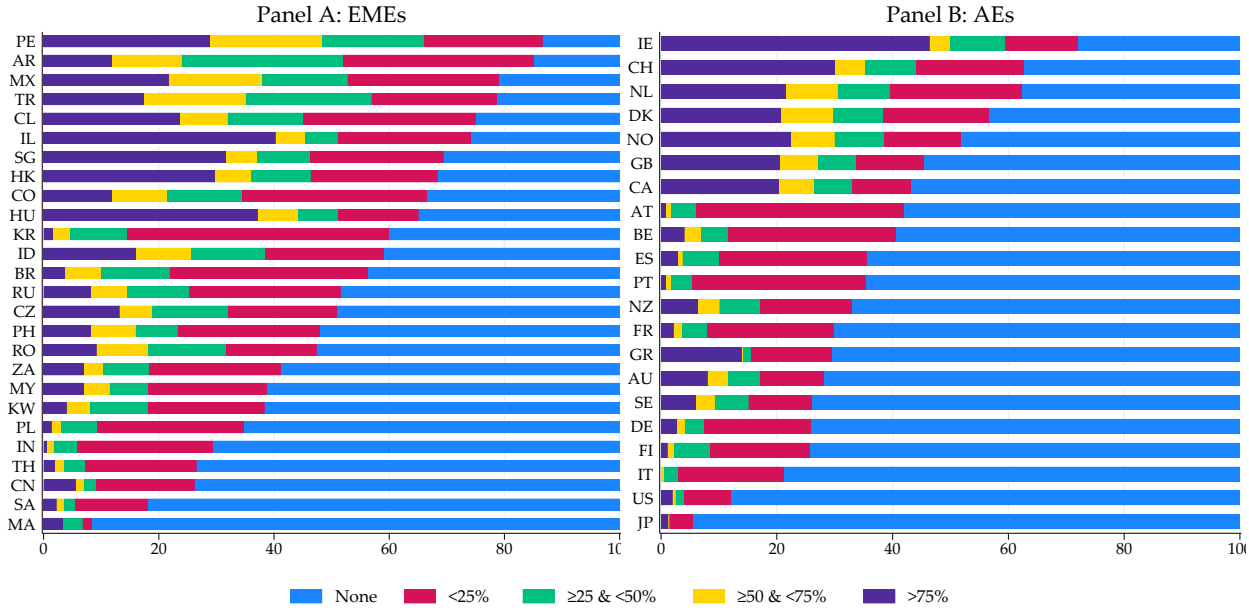
FX debt is prevalent in both AEs and EMEs firms

While the prevalence of FX borrowing in EMEs is well known, it is often glossed over for AEs. Figure 1 shows the share of firms that reported FX debt at some point in the sample period, broken down by the intensity of their use. It is striking to see the high share of FX borrowing in AEs (mostly among small open economies). In countries such as Mexico or Switzerland about 40% of

[6] If Capital IQ does not report any geographic breakdown for a given firm, we input zeros for foreign revenues and assets.

firms in the sample report at some point a share of FX debt in total debt of at least 50%. In fact, FX borrowing appears to be nearly equally as common in AEs as in EMEs, though firms in the latter group tend to report larger shares of FX debt.

Figure 1: Share of firms reporting foreign-currency debt at some point (2005-2023)



This figure shows the percentage of firms that reported a given level of FX debt as percentage of total debt at least once during the sample period 2005-2023. Levels of FX debt are broken down in four bins for no FX debt (0% of total debt), between 0% and 25%, between 25% and 50%, between 50% and 75%, and above 75%. EMEs are shown in Panel A, and AEs in Panel B. Countries are sorted in descending order, depending on the share of firms that report holdings of FX debt.

FX debt usage varies considerably within and across countries

Countries differ considerably in the share of firms' debt in FX as well as how this share has changed over time. This is true overall, within AE and EME groups, and across firms within a country. Notably, this means there are some AEs where FX debt is very prevalent, and some EMEs where it is little used. Figure 1 illustrates this fact with the shares of firms doing any borrowing in FX. Figure 2 shows this relationship for the aggregate share of these firms' debt that is in FX. Interestingly, while the country-level median FX usage across countries barely changed from 2010-2023 (+1% for EMEs, -1% for AEs), individual countries usage changed substantially. For instance, emerging Asia has significantly increased their local currency debt.[7] Despite the similarities in the median

[7]See Avdjiev *et al.* (2024) for further discussion of how local currency debt in EMEs has evolved alongside FX debt.

share of FX debt, the intensity of FX debt has grown much more in EMEs than in AEs. Interestingly, if we examine just firms with FX debt, most AE countries see an increase (Figure 3).

How intensely is FX debt used? For each country, we examine the share of firms with FX debt, the share of firms with high usage of FX debt (ie FX debt composes most of their total debt), and the aggregate share of FX debt from these firms. In every case, we see a common pattern: that the intensity of use of FX debt varies considerably, for AEs as well as EMEs. Still, there tend to be more firms in EMEs with a higher share of FX debt ($> 50\%$, purple and yellow bars in Figure 1).

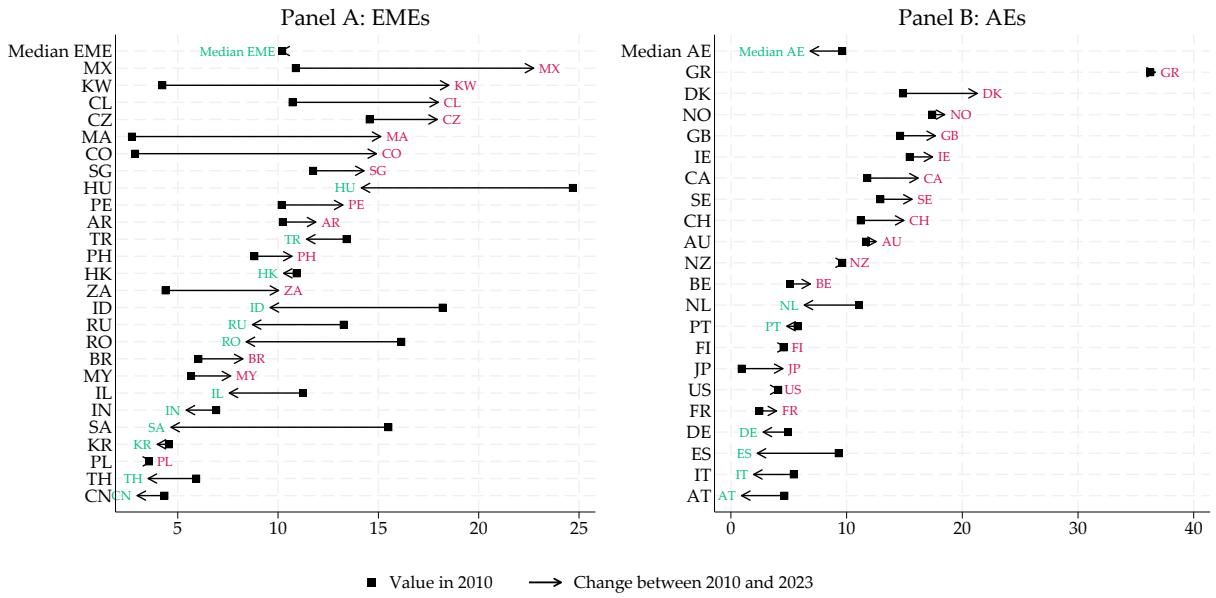
Figure 2: Share (%) of FX debt on total debt for country aggregates in 2010 and 2023

This figure shows the aggregate share of FX debt as percentage of total debt aggregating over all firms in a given country. EMEs are shown in Panel A, and AEs in Panel B. Countries are sorted in descending order, depending on the share of FX debt to total debt in 2023.

4 Optimal hedging of exchange rate risk: framework and empirical approach

The factors affecting firms' decision to take on FX debt are manifold, including things like borrowing costs in each currency, invoicing currency of inputs or sales, and demand fluctuations. Each of these, in turn, is shaped by a number of macroeconomic and firm-specific factors. Exposure

Figure 3: Share (%) of FX debt on total debt among firms with FX debt in 2010 and 2023



This figure shows the median share of FX debt as percentage of total debt across firms that report holdings of FX debt. EMEs are shown in Panel A, and AEs in Panel B. Countries are sorted in descending order, depending on the median share of FX debt to total debt in 2023.

to FX debt in this way could open the firm up to exchange rate risk. Do firms hedge this risk optimally? It is unclear to what extent firms hedge their FX borrowing, either financially (eg via derivatives) or operationally (eg via sales). In the Modigliani and Miller (1958) frictionless neoclassical framework, there is no role for hedging as it adds no value to the firm. The presence of market imperfections —such as financial frictions, transaction costs, and convex tax schedules— provides a rationale for the use of financial hedging as volatility becomes costly (Froot *et al.*, 1993; Rampini, Sufi and Viswanathan, 2014; Rampini and Viswanathan, 2010; Smith and Stulz, 1985).

Ultimately, it remains unclear how the resulting exposures to exchange rates stemming from these various factors affect the firm. Given the FX debt exposures documented in Section 3, we examine whether these firms are optimally hedged in their exchange rate exposure. We follow the methodology laid out in the seminal work of Froot *et al.* (1993). Section 4.1 draws largely from Alfaro, Calani and Varela (2024) to illustrate Froot *et al.*'s framework and its basic implications. We then apply this framework to analyze exchange rate risk.

4.1 Theoretical Framework

Consider a two-period economy in which a firm receives an initial endowment w in period $t = 1$. This endowment can be used to finance investment I. The firm may also access external finance e, hence total investment satisfies $I = w + e$. The production technology yields output in the second period, $\theta f(I)$, which exhibits diminishing returns to investment. Importantly, accessing external finance is costly.[8] Assuming a gross interest rate of one, the firm chooses I to maximize profit, which yields the first-order condition $f'(I) - 1 = C'(e)$.

Note first that due to the convex cost of external finance, the firm under-invests relative to the unconstrained benchmark $I^U = (f')^{-1}(1)$. As a result, fluctuations in internal funds w can reduce profits, particularly when the profit function $P(w)$ is concave.[9] Second, the interaction between production technology and financing frictions determines the firm's sensitivity to cash flow. In particular, hedging becomes valuable when two conditions are met: (i) marginal returns to investment are decreasing ($f''(I) < 0$), and (ii) capital markets are imperfect, so that fluctuations in internal funds are costly ($C''(e) > 0$). Together, these imply that internal liquidity impacts investment, thereby creating a rationale for hedging: firms facing a concave profit function can increase expected profits by stabilizing internal funds.[10]

Focusing on linear hedging strategies, such as forwards, the baseline framework can be used to discuss the optimal hedging ratio, h. Rewriting internal funds after hedging as: $w = w_0(h + (1 - h)\epsilon)$, where w_0 represents a baseline level of wealth and $\epsilon \sim N(1, \sigma^2)$, a shock to cash flow and h in $[0, 1]$ determines how much risk is eliminated: full hedging corresponds to $h = 1$, while $h = 0$ implies full exposure. Let $\theta = \theta(\epsilon)$ to allow for investment opportunities that vary with the shock.

The first order condition to maximize firm value is given by $\text{cov}(P_w, \epsilon) = 0$. This implies that the firm seeks to insulate the *marginal value* of cash, P_w , rather than the level of profits, $P(w)$, from fluctuations in ϵ. When investment opportunities are uncorrelated with shocks (ie θ is constant), full hedging $h = 1$ is optimal. However, when investment opportunities improve with positive shocks so that $\text{cov}(\theta, \epsilon) > 0$, partial hedging becomes desirable. In such cases, the firm prefers some exposure to risk in order to benefit from profitable investment opportunities when cash flows

[8] $f'(I) > 0$ and $f''(I) < 0$; the cost function $C(e)$ is strictly increasing and convex, with $C'(e) > 0$ and $C''(e) > 0$.

[9] Using the first-order condition, one can derive that: $P''(w) = \frac{-f''(I)C''(e)}{f''(I)-C''(e)}$.

[10] The benefits of hedging are greater when either the volatility of shocks or the curvature of $P(w)$ is higher.

are high. Conversely, in bad states, both investment opportunities and internal funds are weak, aligning incentives for reduced investment.

The broadest implication of this framework is that firms use hedging to reduce the variability of the shadow value of internal funds. In the model discussed above, this was achieved by choosing the hedge ratio h such that $\text{cov}(P_w, \epsilon) = 0$. This leads to a testable implication: *if firms are optimally hedged, the shadow value of internal funds should be uncorrelated with the underlying risk* ϵ.

To explore this empirically, consider a specification where firm value is a function $P = P(w(\epsilon), \epsilon)$. This formulation allows the risk variable ϵ to influence profits directly by altering investment opportunities and indirectly by affecting internal funds. Additionally, firm value may respond to other changes in w that are unrelated to ϵ. This motivates a simple empirical specification of the form:

$$P_{t,i} = \alpha + \alpha_1^i w_{t,i} + \alpha_2^i w_{t,i}\epsilon_t + \alpha_3^i \epsilon_t + v_{it} \tag{1}$$

where i indexes firms, t indexes time, and v_{it} captures all other exogenous shocks to firm value. The coefficient α_2^i captures the sensitivity of the shadow value of internal funds of firm i to the shock. According to the model's first-order condition, if the firm is hedging optimally, then this sensitivity should be eliminated, implying $\alpha_2^i = 0$.

Suppose we estimate $\alpha_2^i < 0$. This indicates that the marginal value of internal funds is higher in adverse states of the world (low ϵ), implying that liquidity constraints are more binding when external conditions worsen. In such a case, the firm could increase its value by shorting the risk associated with ϵ, that is by hedging more aggressively against downside shocks. Importantly, the model does not predict that α_3^i or α_1^i should be zero. The former would correspond to removing all exposure to the risk factor, which could be quite costly to do. Rather, what matters for optimal hedging is whether hedging has been used to neutralize the correlation between the marginal value of internal funds and the underlying risk ϵ ($\alpha_2^i = 0$).

4.2 Empirical Approach

We now apply this framework to exchange rate risk. While data constraints prevent us from considering financial hedging (ie via derivatives), we can examine how FX debt, FX assets, and FX revenues interplay with optimal hedging.

Rewriting Equation 1, we test for optimal exchange rate hedging by running firm-specific regressions of the following equation (without firm and time subscripts to reduce clutter):

$$FV = c + \alpha_1 CO + \alpha_2 \bar{CO}\bar{\Delta E} + \alpha_3 \Delta E + \epsilon \tag{2}$$

where FV is the enterprise value of the firm (in ratio to assets), CO is cash flow from operations (in ratio to assets), ΔE is the log change of the average nominal exchange rate of the firm's local currency against the US dollar (positive value indicates depreciation). This is the risk factor to be hedged against. The terms in the interaction are demeaned, $\bar{CO} = CO - \mathbb{E}[CO]$ and $\bar{\Delta E} = \Delta E - \mathbb{E}[\Delta E]$.[11] We run this regression separately for each firm, yielding firm-specific estimates for α_2 and α_3.

The main coefficient of interest is α_2. If the estimated coefficient is not different from zero ($\hat{\alpha}_2 = 0$), then changes in the exchange rate do not impact the shadow value of internal funds and the firm is optimally hedged. If $\hat{\alpha}_2 > 0$ (< 0), then the firm is under (over) hedged.

We use cash flow from operations (CO) as proxy for internal funds because this is the net cash generated by the firms' operations. It is calculated by adjusting net income for non-cash items (including depreciation) and changes in working capital (from non-cash items and net operating assets). This metric reflects the actual funds available to the firm stemming from regular business operations and hence captures the company's ability to generate cash to fund ongoing activities, pay debts, and invest in growth. This is a close accounting counterparty to the "internal funds" concept in Froot *et al.*'s framework.

The overall impact of the exchange rate is captured by α_3. As highlighted in the framework above, optimal hedging does not imply complete insulation from exchange rate changes. A depreciation could still impact the firm's net worth, credit, and investment when optimally hedged. This is because capital market imperfections make it too costly to borrow or financial hedge to smooth out the risk, and because there is upside risk that they may want exposure to. Hence, firms could have $\hat{\alpha}_2 = 0$ and $\hat{\alpha}_3 \neq 0$.

[11] As discussed by Balli and Sørensen (2013), including the demeaned interaction terms yields main coefficients that are similar to a specification without the interaction terms. That is, in our model including demeaned interaction terms α_3 would capture the total effect of ΔE, rather than the effect of ΔE when $\bar{CO} = 0$ in the model with non-demeaned interaction terms.

5 The Distribution of $\hat{\alpha}_2$

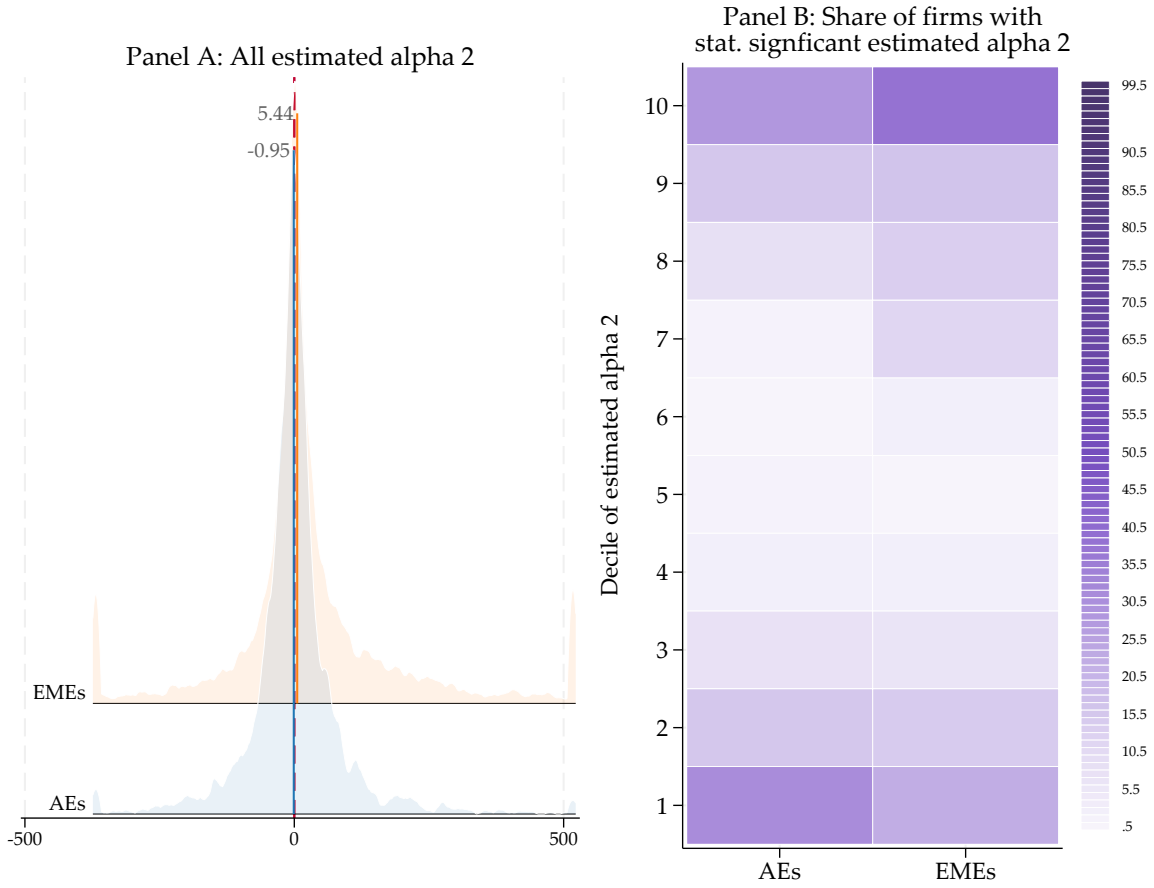
We estimate equation 2 in the sample of listed firms for which we have quarterly data on both firm's value and cash from operations and are headquartered in countries with no hard pegs to the US dollar. We also keep in the estimating sample firms with at least 32 quarters of data. This reduces our baseline sample to 8,256 firms in 38 countries (20 AEs and 18 EMEs). Table A.2 in the appendix shows the sample composition.

Our firm-level estimates of α_2 ($\hat{\alpha}_2$) suggest that most firms in both AEs and EMEs are optimally hedged, or close to it. That is, the effect of cash from operations on their enterprise value is uncorrelated with exchange rate movements. The left panel of Figure 4 shows the distribution of $\hat{\alpha}_2$ from equation 2 for the two country groups. In both cases the estimated alphas cluster around zero. The distribution of $\hat{\alpha}_2$ in EMEs is a little skewed to the right, with a positive median value (meaning more firms are exposed to depreciation risk than appreciation risk), while the median for AEs is closer to zero. The EME distribution also has fatter tails.

The vast majority of $\hat{\alpha}_2$'s are not different from zero in an statistical sense. At the 95% confidence level just ≈12% of the estimated alphas are statistically significant for both country groups. At the 90% confidence level, the shares increase to 20% for EMEs and 17% for AEs. The right panel of Figure 4 shows the share of firms with significant $\hat{\alpha}_2$ for each decile of the distribution for each group (evaluated at 95% confidence level). At most decile levels, the share of significant coefficients is quite low (below ≈20%). As it would be expected, at larger estimated values, both positive and negative, the share of significant $\hat{\alpha}_2$'s is larger. The share of significant positive $\hat{\alpha}_2$'s (depreciation risk) is a little larger in the group of EMEs.

The distributions and shares in Figure 4 mask important heterogeneity among firms across and within countries. Figure 5 shows the median and inter-quartile range of estimates for statistically significant $\hat{\alpha}_2$ (evaluated at 95% confidence level) for firms located in different countries. Positive median values of significant $\hat{\alpha}_2$'s are more prevalent in EMEs than in AEs, albeit the plots also highlight great heterogeneity *within* countries. That is, in both EMEs and AEs there are firms whose value is quite sensitive to movements in the exchange rate at both ends (negative and positive effects).

Figure 4: Distribution of $\hat{\alpha}_2$ and their statistical significance

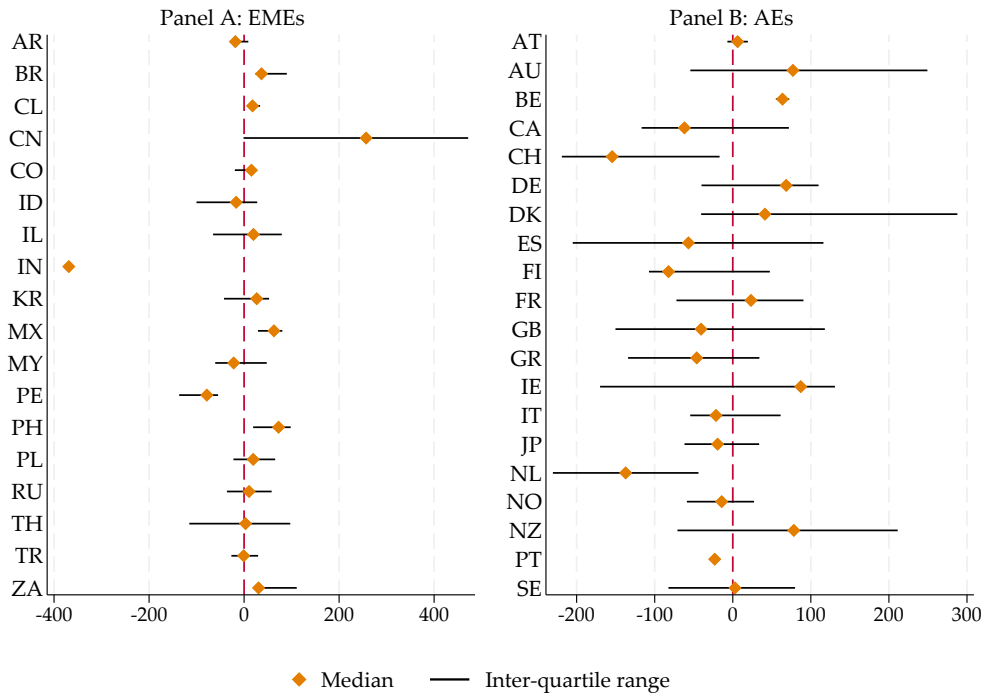


Panel A shows the distribution of $\hat{\alpha}_2$ for both EMEs and AEs. The vertical lines show the median value of $\hat{\alpha}_2$ for each country group. Values of $\hat{\alpha}_2$ are winsorized at 2% and 98%. Panel B shows a heatmap with the share of statistically significant $\hat{\alpha}_2$ at the 95% level by decile for each country group (a darker shade indicates a higher share of statistically significant coefficients).

What does the magnitude of $\hat{\alpha}_2$ imply? The impact on EME firms from suboptimal hedging will be determined by their own $\hat{\alpha}_2^i$ and the size of the exchange rate shock. Consider the simple case of $\hat{\alpha}_2 = 1$, and abstract from the direct effect of the exchange rate ($\hat{\alpha}_3$). For this value, the ratio of firm value to assets moves with cash flows to assets by the percent change in the exchange rate. If there is a 10% depreciation, then a 1pp decrease in the ratio of cash flows to assets results in a 0.1pp decrease in the ratio of firm value to assets. For EMEs, the median $\hat{\alpha}_2$=5.4 and the standard deviation of the exchange rate change is 1.2%. Thus for a 2-σ exchange rate shock, the median firm would see firm value rise by 0.13pp of assets for every 1pp of asset increase in cash flow, while a firm with $\hat{\alpha}_2$ of about 42 would see them move one for one.

For EME firms, a high $\hat{\alpha}_2$ indicates a large sensitivity of their enterprise value to cash flows

Figure 5: Country-level distributions of statistically significant $\hat{\alpha}_2$



This figure shows the median and interquartile range of the statistically significant $\hat{\alpha}_2$ coefficients at the 95% confidence level for each country in our estimating sample. EMEs are shown in Panel A, AEs in panel B.

when large exchange rate swings are realized. The average ratio of cash from operations to assets among EME firms in our sample is 1.3% (s.d. of 1.4%) and the average ratio of firm value to assets is 137.2% (s.d. of 101.2%). To see a firm lose 5% of the average firm value while experiencing average cash flows with a 10% depreciation, it would need $\hat{\alpha}_2$=53. Thus suboptimal hedging can lead to meaningful losses of firm value for reasonable realizations of $\hat{\alpha}_2$.

In contrast, advanced economy firms are generally much less sensitive to currency fluctuations. This is due to two reasons. First, exchange rate movements are much smaller on average. In our sample of AEs, the average quarterly change in the nominal exchange rate is 0.29% (s.d. of 0.37%). Second, the distribution of $\hat{\alpha}_2$ is narrower, with a median closer to 0 ($\hat{\alpha}_2 = -0.95$ for AEs). Thus, fewer firms would have the exchange rate change how cash flows impact firm value, and for those that do, they are much less likely to see a large enough exchange rate shock.[12]

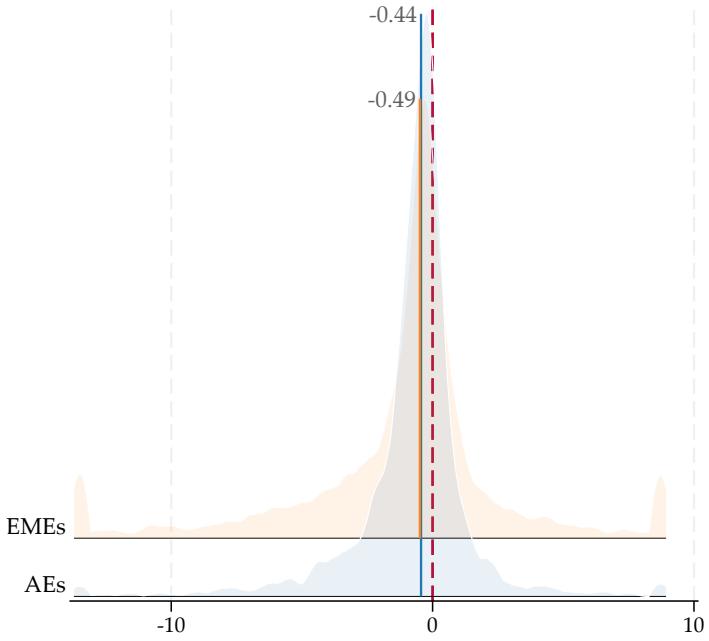
[12]For reference, the average ratio of cash from operations to assets among AE firms in our sample is 1.4% (s.d. of 2.9%) and the average ratio of firm value to assets is 132.2% (s.d. of 119.5%).

5.1 Relationship between $\hat{\alpha}_2$ and $\hat{\alpha}_3$

While firms may or may not be optimally hedged, they can still be impacted by the exchange rate. $\hat{\alpha}_3$ estimates the overall impact on firm value of the exchange rate for each firm. Figure 6 shows that the distribution of $\hat{\alpha}_3$ is also centered around zero for both EMEs and AEs. Still, for the median firm in both country groups, a currency depreciation has a negative impact on enterprise value.

That said, the EME distribution has fatter tails, meaning that more EME firms have larger estimated sensitivities of firm value to movements in the exchange rate. Also, the fatter left tail in the EME distribution of $\hat{\alpha}_3$ suggests that more EME firms are subject to depreciation risk.

Figure 6: Distribution of $\hat{\alpha}_3$



This figure shows the distribution of $\hat{\alpha}_3$ for both EMEs and AEs. The vertical lines show the median value of $\hat{\alpha}_3$ for each country group. Values of $\hat{\alpha}_3$ are winsorized at 2% and 98%.

Comparing $\hat{\alpha}_2$ (optimal hedging) and $\hat{\alpha}_3$ (exchange rate impact) allows us to group firms by their exchange rate exposure and hedging (Table 1). Firms that have neither $\hat{\alpha}_3$ nor $\hat{\alpha}_2$ significant are likely to have businesses that are largely insulated from the exchange rate (eg non-tradable

sectors, no FX debt, etc.). This constitutes a large share of firms in the sample: 65%. Roughly 21% of firms have enterprise values that are directly impacted by exchange rate fluctuations. Of these firms, about three-fourths optimally hedge their exchange rate exposure. About 14% of firms have no direct impact from the exchange rate on firm value, but the exchange rate still impacts the value of their cash flow on firm value. These firms may thus have investment opportunities that change with the exchange rate, thus affecting the value of additional cash in certain states of the world even if they have no direct exposure.

What is the relationship between $\hat{\alpha}_2$ and $\hat{\alpha}_3$? We expect that firms that have a larger direct impact of the exchange rate on firm value are also more likely to have cash flow value that is more sensitive to the exchange rate. Or in other words, larger exposures make it more likely that you are not optimally hedged. This is indeed the case. There is generally a positive, linear relationship between the absolute values of $\hat{\alpha}_2$ and $\hat{\alpha}_3$ (Figure 7).

Table 1: Relative frequencies of $\hat{\alpha}_2$ and $\hat{\alpha}_3$ (stat. significant at 90%)

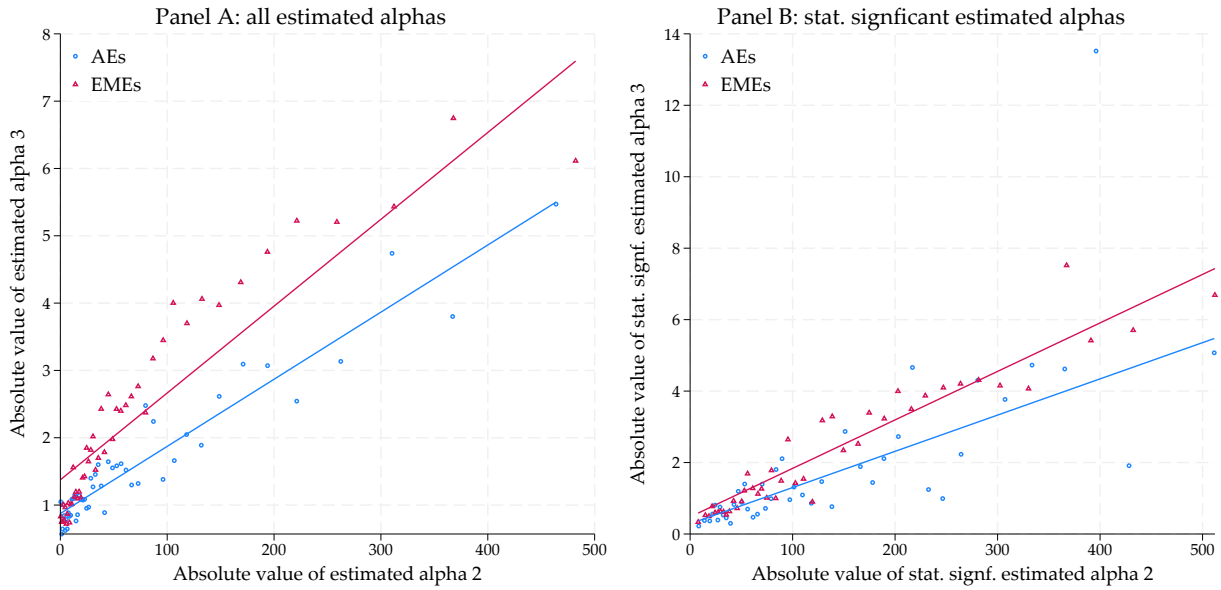
	Estimated α_3		
Estimated α_2	**0**	**1**	**Total**
0	65.31	15.36	80.67
1	14.12	5.21	19.33
Total	79.43	20.57	100

This table shows the relative frequencies of $\hat{\alpha}_2$ and $\hat{\alpha}_3$ estimated from Equation 2. Percentage of firms with estimated α_2 and α_3 at the 90% confidence level. Sample of 8,256 firms.

5.2 Are the results of optimal hedging, $\hat{\alpha}_2 = 0$, driven by firms with no FX debt exposures?

One obvious concern from the results presented so far is that the finding of optimal hedging for the vast majority of firms (ie most $\hat{\alpha}_2$ are centered around zero and are not statistically significant different from zero) is driven by the firms not having meaningful FX exposures, and particularly FX debt. Figure A.1 in the Appendix shows the results for the subset of firms with FX borrowing. As for the whole sample, we find that the estimated coefficients centered around zero (Panels A and B). The expected positive correlation between the absolute values of the estimated α_2's and

Figure 7: Relationship between $\hat{\alpha}_2$ and $\hat{\alpha}_3$



Panels A and B show binscatters of the absolute value of $\hat{\alpha}_3$ (in the vertical axis) and the absolute value of $\hat{\alpha}_2$ (in the horizontal axis). Panel A shows the plot for all estimates of $\hat{\alpha}_3$ and $\hat{\alpha}_2$, and Panel B only for estimated coefficients statistically significant at the 95% confidence level. In all panels, coefficients are winsorized at 2% and 98%. The binscatters are computed splitting the data in 50 bins.

α_3's is also found in the subset of firms with positive FX borrowing.

6 Decomposing $\hat{\alpha}_2$

While it appears that most firms are optimally hedged, it is not clear if this is because these firms have no FX exposures or because their FX exposures are indeed optimally hedged from other positions.[13] It is also not clear which exposures matter and how the individual parts may affect the firm's overall hedging. We thus decompose $\hat{\alpha}_2$ into factors driven by known exposures vs. other factors.

We first do this decomposition with just one factor at a time:

$$FV = c + \alpha_1 CO + \left(\alpha^i_{2,0}(1 - FXi) + \alpha^i_{2,1} FXi\right) \bar{CO\Delta E} + \alpha_3 \Delta E + \epsilon \tag{3}$$

where $i \in \{d, a, r\}$ indicates exposures via FX debt (d), FX assets (a), and FX revenues (r). FXd

[13] Section 5.2 shows that a sample of firms with FX debt still shows optimal hedging for many firms.

and FXa are in ratio to total assets, FXr is in ratio to total revenues.[14] This decomposition separates a firm's α_2 into the portion driven by specific FX exposure i and the portion driven by everything else. The relationship between $\alpha^i_{2,0}(1 - FXi)$ and $\alpha^i_{2,1}FXi$ shows whether the impact from FX exposures i are offset (hedged) by other FX exposures (eg stemming from operating strategies, such FX revenues or input costs, holdings of financial derivatives or FX assets, etc.).

The results for the decomposition of the exposures from FX debt are shown in Panel A of Figure 8. For both EMEs and AEs, we see a clear negative relationship between the optimal hedging impact from FX debt exposures and that from all other factors. This suggests that firms do indeed have exposure to exchange rate moves due to their FX debt positions, but the optimal hedging implied by the overall $\hat{\alpha}_2 = 0$ can be explained by other offsetting factors. Since we are viewing factors in isolation, these offsetting factors can be FX revenues or assets, and operational or financial hedging strategies that we do not observe directly.

Interestingly, the simple decompositions of the effect of FX revenues (Panel B) and FX assets (Panel C) show a similar offsetting feature: FX exposures stemming from one of these measurable factors are offset by other FX exposures that we do not observe.

6.1 Decomposing $\hat{\alpha}_2$ with multiple factors

When examined in isolation, each of our three identifiable FX exposures may pick up similar variation in the data. This is because firms that borrow more in FX typically also have more FX revenues (ie they are exporters) and are more likely to hold FX assets (ie they are multinational).[15]

To account for this and better disentangle how each FX exposure impacts optimal hedging, we do a decomposition using all three factors simultaneously:

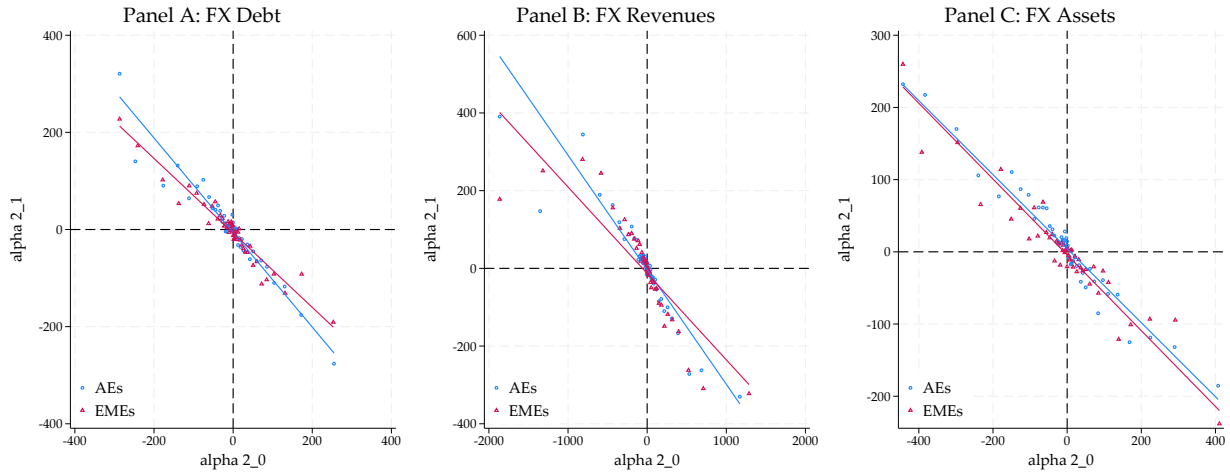
$$FV = c + \alpha_1 CO + \left(\sum_{i \in \{d,r,a\}} \alpha^i_2 FXi + \alpha^o_2(1 - FXd - FXr - FXa) \right) \cdot \bar{CO}\bar{\Delta E} + \alpha_3 \Delta E + \epsilon \quad (4)$$

Controlling for each of these measurable exposures simultaneously helps to separate out their individual effects. The remaining exchange rate exposure for which we do not have variables cap-

[14] We drop firms with values of these ratios larger than 2, as this suggests less reliable data, and winsorize the bottom and top 2% of observations. We further replace with 0 any observation less than 0 and with 1 any observation greater than 1.

[15] Indeed, the correlation between $\alpha_{2,1}FX_d$, $\alpha_{2,1}FX_r$, and $\alpha_{2,1}FX_a$ as computed above is positive.

Figure 8: Simple decomposition of known FX exposures

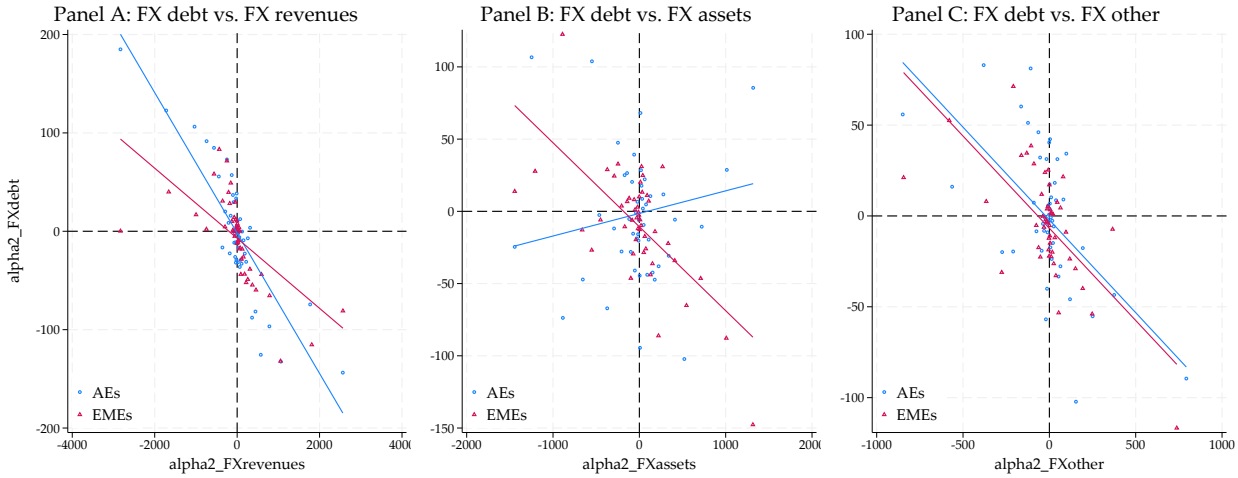


Panel A shows a binscatter of the decomposition of the estimated impact of FX debt exposures $\hat{\alpha}^d_{2,1} FXd$ (in the vertical axis) and its complement from other FX exposures $\hat{\alpha}^d_{2,1}(1 - FXd)$ (in the horizontal axis). Panel B shows a similar decomposition of the estimated effect of FX revenues and Panel C for FX assets. Coefficients are winsorized at 2% and 98% and the binscatters are computed splitting the data in 50 bins.

turing direct exposure are accounted for in $(1 - FXd - FXr - FXa)$, with the coefficient's o superscript indicating "other".

Figure 9 shows the key results form this multi-factor decomposition. The figure shows the relationship between the estimated coefficients of FX debt exposures ($\hat{\alpha}^d_2 FXd$) and FX revenue ($\hat{\alpha}^r_2 FXr$ in Panel A), FX assets ($\hat{\alpha}^a_2 FXa$ in Panel B) and "other" not observable FX exposures ($\hat{\alpha}^o_2 FX(\bullet)$ in Panel C). For EMEs, we see a negative relationship between the impact on enterprise value from FX debt with those of FX revenues and FX assets. Thus, FX debt exposures in EME firms are offset by both FX revenues and FX assets. For AEs, however, FX assets do not seem to play this offseting role to FX debt (Pane B of Figure 9). The positive correlation of the estimated impact of FX assets and FX debt among AE firms suggests that FX assets are not accumulated to facilitate such hedging.

Figure 9: Multi-factor decomposition of known FX exposures



The figure shows the results form the multi-factor decomposition of known FX exposures, focusing on the relationship of the estimated effect of FX debt exposures ($\hat{\alpha}_2^d FXd$) with the other FX exposures. Panel A shows the relationship of FX debt exposure with FX revenues, Panel B shows the relationship with FX assets, and Panel C shows the relationship with other exposures. Coefficients are winsorized at 2% and 98% and the binscatters are computed splitting the data in 50 bins.

7 Conclusion

Despite its prevalence, much is misunderstood about non-financial corporates' use of FX debt and their exposure to exchange rate risk. This paper leverages a global sample of firms to lay out key facts about this debt and analyze optimal hedging. We find that FX debt is widely used in both advanced and emerging markets, and that most firms are optimally hedged against exchange rate movements. We use the framework of Froot *et al.* (1993) to isolate optimal hedging from the overall impact of the exchange rate.

Many firms are optimally hedged because they do not have any direct exchange rate exposure. For those with exchange rate exposure, such as through FX debt, our analysis shows that these exposures are often offset by other factors influencing the optimal hedge.

Our results are important for better understanding the difference in exchange rate risks between advanced economies and emerging markets. Advanced economy firms are less likely to be impacted by the exchange rate both because they experience less volatile exchange rate movements and because they have less suboptimal hedging, on average. While the prevalence of currency crises in emerging markets has fallen (Hardy *et al.*, 2024), the real impact of exchange rate movements remains material.

An important open question is how investment opportunities change with the exchange rate. This lies at the core of understanding optimal hedging and the macroeconomic impact of the exchange rate, but remains a black box. Exploring this may reveal important insights into how and why firms hedge or don't hedge their exchange rate risk.

These results are important when evaluating the risks and financial stability implications of foreign currency debt. The high prevalence of optimal hedging is encouraging. But risks in the tails (both of exchange rate shocks and firm risk exposures) are central. Financial constraints are key to the need to hedge, and the dollar is an important driver of global financial conditions. Understanding how much suboptimal hedging is driven by a stronger dollar constraining financiers (and thus boosting the value of internal cash to the firm) compared to other risk factors will have important bearing for policy makers.

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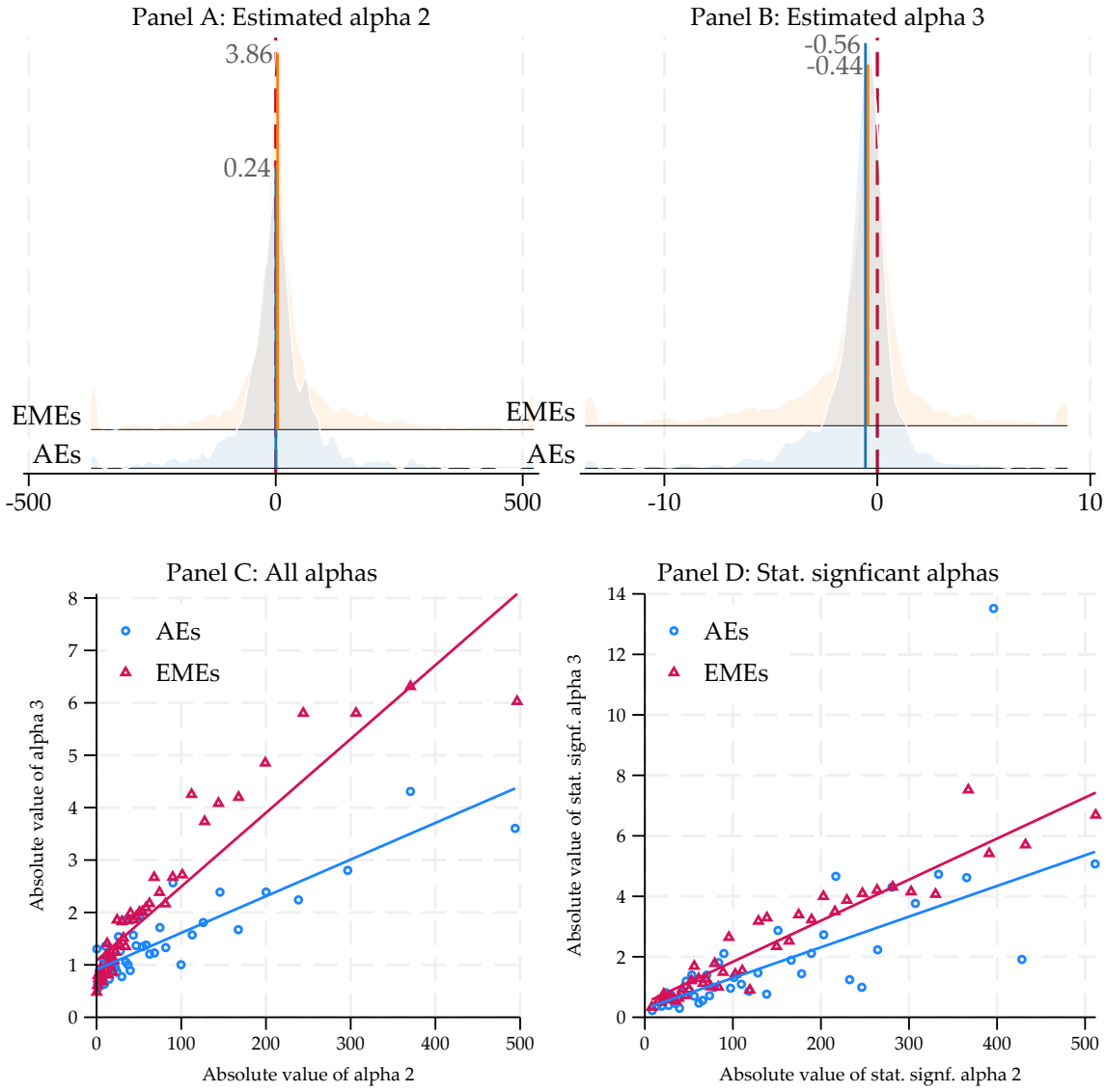
Appendix with Additional Figures and Tables

Figure A.1: Estimated $\hat{\alpha}_2$ and $\hat{\alpha}_3$ for subset of firms with positive FX debt



Panels A and B show the distribution of $\hat{\alpha}_2$ and $\hat{\alpha}_3$ for the subset of firms with positive levels of FX debt. Panels C and D show binscatters of the absolute value of $\hat{\alpha}_3$ (in the vertical axis) and the absolute value of $\hat{\alpha}_2$ (in the horizontal axis) for the subset of firms with FX debt. Panel C shows the plot for all estimates of $\hat{\alpha}_3$ and $\hat{\alpha}_2$, and Panel D only for estimated coefficients statistically significant at the 95% confidence level. In all panels, coefficients are winsorized at 2% and 98%. The binscatters are computed splitting the data in 50 bins.

Table A.1: Baseline sample for stylized facts on FX debt

EMEs		AEs	
Country	**N. of firms**	**Country**	**N. of firms**
Argentina	175	Australia	2,770
Brazil	858	Austria	114
Chile	397	Belgium	172
China	11,037	Canada	5,287
Colombia	84	Denmark	289
Czech Republic	53	Finland	259
Hong Kong	1,610	France	948
Hungary	43	Germany	1,019
India	5,399	Greece	315
Indonesia	773	Ireland	168
Israel	769	Italy	683
Kuwait	99	Japan	4,456
Malaysia	1,348	Netherlands	301
Mexico	216	New Zealand	297
Morocco	59	Norway	533
Peru	180	Portugal	110
Philippines	206	Spain	267
Poland	907	Sweden	1,150
Romania	390	Switzerland	379
Russia	434	United Kingdom	2,542
Saudi Arabia	220	United States	13,821
Singapore	924		
South Africa	393		
South Korea	2,711		
Thailand	786		
Turkey	467		
Total	30,538	Total	35,882

Table A.2: Sample for optimal hedging regressions

EMEs		AEs	
Country	**N. of firms**	**Country**	**N. of firms**
Argentina	36	Australia	336
Brazil	131	Austria	30
Chile	58	Belgium	44
China	2,053	Canada	310
Colombia	15	Denmark	52
India	11	Finland	83
Indonesia	223	France	283
Israel	137	Germany	227
Malaysia	585	Greece	105
Mexico	63	Ireland	26
Peru	39	Italy	92
Philippines	86	Japan	392
Poland	232	Netherlands	48
Russia	36	New Zealand	58
South Africa	104	Norway	46
South Korea	1,035	Portugal	24
Thailand	384	Spain	30
Turkey	212	Sweden	178
		Switzerland	87
		United Kingdom	365
Total	5,440	Total	2,816

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