WP/19/168

IMF Working Paper

Financial Development, Exchange Rate Fluctuations, and Debt Dollarization: A Firm-Level Evidence

by Minsuk Kim

INTERNATIONAL MONETARY FUND

 WP/19/168

IMF Working Paper

Asia and Pacific Department

Financial Development, Exchange Rate Fluctuations, and Debt Dollarization: A Firm-Level Evidence

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August 2019

Abstract

This paper examines how financial development influences the debt dollarization of nonfinancial firms in a sample of emerging market economies (EMEs). The macroeconomic channels are identified from an optimal portfolio allocation model and assessed empirically using the accounting information of nonfinancial firms from 21 EMEs during 2009–2017. The results show that financial development, measured by the private credit-to-GDP ratio, mainly reduces the influence of exchange rate volatility in determining a firm's debt currency composition, among other channels. Furthermore, the effect of exchange rate volatility becomes statistically insignificant beyond an estimated threshold credit-to-GDP ratio of 100 percent.

JEL Classification Numbers: F31, F34, G11

Keywords: Dollarization, Financial Development, Original Sin, Exchange Rate Volatility

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[1] I am grateful for helpful comments from Nina Biljanovska, Luis E. Breuer, Nan Geng, Jun Il Kim, Jonathan Ostry, Jay Peiris, Tahsin Sedik (all IMF), and Alberto Humala (Central Reserve Bank of Peru). All errors and omissions are my own.

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I. Introduction

The Taper Tantrum episode in 2013 and the series of subsequent emerging market stress events served as a reminder that debt dollarization continues to characterize emerging market economies (EMEs). Despite the significant progress in anchoring inflation expectations (IMF, 2018) and improvements in the current account balance over the past two decades, EMEs were once again at the center of market concerns, especially regarding foreign currency-denominated debt accumulated in the aftermath of the global financial crisis. These episodes demonstrated that debt dollarization remains a major financial stability issue just as in the run-up to the EME financial crises of the 1990s, with a notable difference that private nonfinancial firms now play a relatively larger role in incurring foreign currency-denominated debt (Avdjiev, Chui, and Shin, 2014).

What explains the persistence of debt dollarization in EMEs? What macroeconomic and initial conditions are at play behind the foreign currency borrowing by nonfinancial firms? This paper examines the role of financial development, measured by the private credit-to-GDP ratio. The point of reference is the *original sin* hypothesis (Eichengreen and Hausmann, 1999; Eichengreen, Hausmann, and Panizza, 2005; Hausmann and Panizza, 2011), which views EMEs' inability to borrow externally in their own currency as an inevitable consequence of underdevelopment in the domestic financial market. In this view, it is the incompleteness of domestic financial markets that necessitates firms' use of unhedged foreign currencies in order to borrow abroad. This paper examines whether and how financial development influences debt dollarization by developing a simple portfolio allocation model and empirically assessing the identified macroeconomic channels.

This paper contributes to the existing literature by using a large international firm-level dataset. This is in contrast to previous studies that investigate the original sin hypothesis using country-level data, unavoidably introducing the issue of endogeneity. The firm-level dataset comprises the accounting information of over 9,000 nonfinancial firms from 21 major EMEs during 2009–2017. Most firm-level studies that examine the balance sheet effects of macroeconomic fluctuations either rely on primary debt issuance data, or when balance sheet information is used, focus on Latin American countries due to data availability, with the notable exception of the study of Allayannis, Brown, and Klapper (2003). The balance sheet debt currency composition data used in this paper are, to the best of the author's knowledge, the broadest one to date in terms of geographical coverage, encompassing major EMEs from all regions of the world.

The analysis produces two main findings. First, higher exchange rate volatility lowers the share of dollar debt on firms' balance sheets, but this effect from exchange rate volatility diminishes as domestic financial markets develop. Such a relationship is not found between the local currency-dollar interest rate differential and financial development. Financial development per se is found not to affect the level of dollar debt share. Second, although financial development reduces the quantitative importance of exchange rate volatility as a determinant of firms' debt currency composition, it appears to matter only up to a certain point. This threshold is estimated at about 100 percent of the private credit-to-GDP ratio. On average, exchange rate volatility loses statistical significance as an explanatory variable beyond this level, as shown in Figure 2.

Firms' optimal debt currency portfolio problem is studied using a framework similar to that of Ize and Yeyati (2003). However, unlike their model, which describes both the deposit and credit-side dollarization of the banking system, this paper deliberately takes a partial equilibrium approach, given the narrower interest in debt dollarization among nonfinancial firms. The additional feature in this simple model is that firms earn their income both in the local and foreign currencies. Given the currency composition of future income, firms optimally choose the currency share of their debt to maximize their mean-variance utility in the presence of exchange rate and inflation risks. The minimum variance portfolio from this model nests that of Ize and Yeyati (2003) as a special case in which firms earn their income entirely in the local currency. This extension is important, considering that a large share of sample firms comes from export-oriented Asian economies. Meanwhile, the foreign currency in this model effectively plays the dual role of an invoicing currency of international trade and the primary unit of account for international debt contracts. Given these features, this paper focuses on debt dollarization in US dollars.

The empirical exercise confirms two main implications of the model. First, firms' dollar debt share is found to be negatively associated with exchange rate volatility and positively associated with the interest differential. Moreover, the magnitude of these effects is economically significant. Against a sample average dollar debt-to-total debt ratio of 10 percent, a one percentage point increase in the interest rate differential in a given year is associated with a 0.1 percentage point increase in the dollar debt ratio, whereas a one standard deviation increase in exchange rate volatility is associated with a 0.1 percentage point decrease in the dollar debt ratio. Second, the relationship between exchange rate volatility and the dollar debt ratio is found to be stronger for economies with less-developed financial markets, which hold under various alternative specifications and subsamples. In particular, the potential reverse causality between the dollar debt ratio and exchange rate volatility is tested using the average value of neighboring economies' exchange rate volatility. The role of capital controls was also examined as an alternative hypothesis. A horse-race test between measures of financial development and capital account openness shows that the main results are derived from financial development, not from capital controls. Finally, the paper exploits the Taper Tantrum episode as a natural experiment to further confirm whether firms in developed financial markets are better hedged against exchange rate shocks, as implied by these results.

The findings in this paper suggest that the relationship between financial development and debt dollarization may not be linear and is more complex than implied by a simple interpretation of the original sin hypothesis. Similarly, the results provide qualified support for the moral hazard hypothesis, which argues that fixed or managed floating exchange rate regimes encourage debt dollarization. The findings suggest that a low exchange rate volatility may not necessarily lead to higher foreign currency indebtedness, depending on the state of financial development.

The empirical results also point to the need for a differentiated policy approach to address corporate balance sheet currency mismatch. In the case of EMEs at relatively low or moderate stages of financial development, the priority appears to be in deepening and diversifying domestic financial markets. Furthermore, efforts to dampen exchange rate volatility through foreign exchange interventions could induce firms to take on more unhedged foreign currency debt. In the case of EMEs with more developed financial markets, the priority appears to be in enhancing macroprudential measures, especially when the interest differential is higher. The policy space to intervene in the foreign exchange market also seems to be relatively larger, considering the lesser importance of exchange rate volatility, than in less-developed financial markets.

II. Related Literature

This paper builds on several strands of the literature on dollarization, exchange rate fluctuations, and financial development.

Eichengreen, Hausmann, and Panizza (2005) and Hausmann and Panizza (2011) examine the link between exchange rate volatility and original sin, which they measure by subtracting the share of a country's international bonds and cross-border bank loans denominated in the local currency from one. Using cross-country data, they find that this measure of original sin is negatively associated with exchange rate variability, which they interpret as a result of the higher cost of hedging associated with exchange rate volatility. By contrast, several studies have taken the view that fixed exchange rate regimes encourage currency risk-taking by firms and banks by reducing their incentive to hedge (Burnside, Eichenbaum, and Rebelo, 2001; Mishkin, 1996; Obstfeld, 1998). Similarly, Harvey and Roper (1999) discuss how low exchange rate volatility could have induced Asian firms to take a bet by tapping into foreign currency debt markets in the run-up to the Asian financial crisis. However, using a panel of international macroeconomic data on dollarization, Arteta (2005) finds that floating exchange rate regimes exacerbate, rather than reduce, balance sheet currency mismatch in the banking system. Reinhart (2000) and Calvo and Reinhart (2001, 2002) find empirical evidence of the *fear of floating* among a sample of EMEs and discuss the role of liability dollarization as an explanation for these EMEs' reluctance to allow their exchange rates to float freely.

Most firm-level studies on the links between balance sheet dollarization, exchange rate fluctuations, and other macroeconomic variables focus on Latin American countries, as surveyed extensively by Galindo, Panizza, and Schiantarelli (2003). Notably, Martinez and Werner (2002) examine the balance sheet effects of the Mexican economy's transition from a fixed to a floating exchange rate regime and find that the regime shift contributed to reducing firms' dollar exposure. Studies on other regions are surprisingly scarce, largely reflecting a lack of available data. Allayannis, Brown, and Klapper (2003) analyze foreign currency debt use and currency hedging practices of 327 nonfinancial firms in East Asia from 1996 to 1998. As in this paper, they find that the interest rate differential is an important determinant of firms' debt currency composition. Brown, Ongena, and Yeşin (2011) examine a group of firms from 26 transition economies in Eastern Europe and Central Asia through bank loan data between 2002 and 2005 and find that the interest rate differential and exchange rate volatility are not robust explanatory variables of their foreign currency borrowing. These findings contrast with those of studies using macroeconomic data (Basso, Calvo-Gonzalez, and Jurgilas, 2011; Rosenberg and Tirpàk, 2008), which find that the interest rate differential is a significant determinant of foreign currency borrowing.

More recently, several studies have found that international bond issuance decisions by EME nonfinancial firms are driven by carry trade motives. Bruno and Shin (2017) find that EME firms with already large cash holdings are more likely to issue US dollar-denominated bonds when carry trade is profitable and that the proceeds are positively associated with higher cash holdings in the subsequent periods. Moreover, Bruno and Shin (2017) and Caballero, Panizza, and Powell (2016) find that stringent capital controls could explain this carry trade behavior. Acharya and Vij (2016) also find a similar effect of the interest rate differential for a sample of Indian firms during the post-crisis period.

As for the theoretical framework, Caballero and Krishnamurthy (2003) show how limited financial development in an EME can lead to excessive dollar indebtedness by making its agents undervalue the insurance against exchange rate risk that can be acquired effectively by issuing external debt denominated in domestic currency. Jeanne (2003) presents a model in which liability dollarization emerges as a result of a lack of monetary credibility. In this model, the trade-off between exchange rate and inflation risk is derived from the assumption of risk-neutral firms and a fixed cost to default. Ize and Yeyati (2003) show that the credibility of past macroeconomic policies can exert long-lasting effects on dollarization through the expected volatility of inflation relative to that of real exchange rate depreciation. Salomao and Varela (2018) develop a model in which the choice of debt currency composition is determined by the trade-off between the risk of default from exchange rate risk and growth. In this model, only highly productive firms find it optimal to borrow in foreign currencies.

Regarding firms' use of currency hedging, several studies from the corporate finance literature have identified hedging of foreign exchange exposure as an important motive for borrowing in foreign currencies (Allayannis, Brown, and Klapper, 2003; Allayannis and Ofek, 2001; Kedia and Mozumdar, 2003; Keloharju and Niskanen, 2001). Using a sample of S&P 500 nonfinancial firms, Allayannis and Ofek (2001) find that the use of currency derivatives significantly reduces firms' exchange rate exposure. Luca and Petrova (2008) use cross-country data for 21 transition economies in 1990–2003 and find evidence that a deep forward derivative market significantly reduces credit dollarization in the banking system. By contrast, Barajas and others (2017) study a sample of Colombian firms in 2005–2013 and find that the firms' uses of forward exchange derivatives are not consistent with their hedging needs as indicated by their foreign currency indebtedness or import status.

Finally, several studies have empirically examined the balance sheet effects of exchange rate fluctuations on corporate investment, reporting mixed results. Using a sample of nonfinancial firms in five Latin American countries in the 1990s, Bleakley and Cowan (2008) show that the investment performance of firms holding more dollar debt was not worse following a depreciation, compared with that of firms holding more peso debt. By contrast, Aguiar (2005) finds that Mexican firms with high exposure to short-term foreign currency debt before the 1994 peso crisis invested relatively less post-devaluation. Using six Latin American countries' crisis experience in 1990–2005, Kalemli-Ozcan, Kamil, and Villegas-Sanchez (2016) show that the availability of bank credit was an important differentiating factor in post-crisis corporate investment performance. Meanwhile, using a large sample of firms from 66 countries, Dao, Minoiu, and Ostry (2017) find that depreciation boosts profit and investment in less developed financial markets, especially for firms whose use of labor is relatively intensive. Jiang and Sedik (2019) analyze the impact of exchange rate depreciation on the default probability of a sample of Asian nonfinancial firms and find the net impact to be negative for firms with a large issuance of foreign currency-denominated debt.

The remainder of this paper is organized as follows. Section III presents a simple model of firms' optimal debt currency portfolio problem. Sections V.B and V.C discuss the empirical findings and the robustness test results, including those regarding reverse causality (Section V.C) and an alternative hypothesis (Section V.C). Section V.D presents further supporting evidence from the investment performance of sample firms during the Taper Tantrum period. Section VI discusses the policy implications of the findings.

III. An Illustrative Model

To structure the empirical analysis, this paper develops a theoretical framework similar to that of Ize and Yeyati (2003) to illustrate how a firm's choice of debt currency depends on macroeconomic variables and the currency composition of its output. Given the specific interest in debt dollarization, the model takes a partial equilibrium approach by abstracting from the creditor side of the economy.

The model economy is populated by a continuum of firms, indexed by $i \in [0,1]$, which live for two periods. In the first period, each firm borrows a fixed amount of funds to make its initial investment, set equal to 1. The bilateral exchange rate, denoted as s, is in units of local currency per US dollar and set equal to 1 in the first period. The second-period exchange rate is assumed to follow a normal distribution $\mathcal{N}(1,\sigma_s^2)$, which for now is assumed to be the only source of shock in the economy. In the second period, each firm earns income y_i, of which θ_i consists of the income denominated in the local currency and $1-\theta_i$ the income denominated in dollars. Expressed in local currency terms, firm i's second-period income is given by,

$$y_i = \theta_i + (1-\theta_i)s.$$

Firms can borrow part of their loans in the local currency (α_i) at the gross interest rate $R_i^l > 1$ and the remainder of the loan in dollars ($1-\alpha_i$) at the rate $R_i^d > 1$. Firms do not have access to alternative hedging instruments because of the less-developed domestic financial markets. Under this setup, firm i's second-period profit in local currency terms is given by,

$$\Pi_i = y_i - R_i^l \alpha_i - R_i^d (1-\alpha_i)s. \tag{1}$$

Firms are risk averse and choose the currency composition of their debt in the first period to maximize their second-period mean-variance utility given by,

$$U(\Pi_i) = \mathrm{E}(\Pi_i) - \frac{\psi_i}{2}\mathrm{Var}(\Pi_i),$$

subject to the constraint $0 \leq \alpha_i \leq 1$ and where $\psi_i > 0$ denotes the degree of risk aversion for each firm. From the first-order condition, the optimal share of dollar debt $(1-\alpha_i^*)$ is given by,

$$1-\alpha_i^* = \frac{R_i^l - R_i^d}{\psi_i \sigma_s^2 R_i^{d2}} + \frac{(1-\theta_i)}{R_i^d}. \tag{2}$$

The equation shows that the firms' incentive to borrow in dollars comes from two separate sources: funding cost saving and hedging against the exchange rate risk. These incentives are captured by the first and second terms on the right-hand side of the equation, respectively. Equation (2) can be rearranged as,

$$\frac{1}{\psi_i}\left[\frac{R_i^l - R_i^d}{\sigma_s^2 R_i^{d2}}\right] = (1-\alpha_i^*) - \frac{(1-\theta_i)}{R_i^d}, \tag{3}$$

which shows that currency mismatch is measured as the difference between the amount of dollar-denominated loan taken out in the first period (in dollar terms) and the discounted value of the dollar-denominated income.

A few testable hypotheses can be derived from equation (2). First, firms will borrow relatively more in dollars if the interest differential $R_i^l - R_i^d$ is high and the expected volatility of exchange rate depreciation (σ_s^2) is low. Second, *ceteris paribus*, firms that earn a dollar income $(\theta_i < 1)$ will take on more dollar debt given the need for exchange rate risk hedging.

An extended model with inflation. To examine the role of inflation, inflation (π) is now added as another shock in the economy, which is assumed to follow a normal distribution $\mathcal{N}(1, \sigma_\pi^2)$. In this case, firm i's profit in *real* local currency terms is given by,

$$\Pi^i = y_i - R_i^l \alpha_i \pi - R_i^d (1-\alpha_i) s\pi. \tag{4}$$

Under this setup, R_i^l and R_i^d now denote nominal gross interest rates. The first-order condition readily shows that the optimal dollar share of debt is given by,

$$1-\alpha_i^* = \frac{R_i^l - R_i^d}{\psi_i V} + \frac{(1-\theta_i)(R_i^d \sigma_s^2 + R_i^l \sigma_{s\pi})}{V} + \frac{R_i^l(R_i^l \sigma_\pi^2 + R_i^d \sigma_{s\pi})}{V}, \tag{5}$$

in which

$$V = (R_i^d)^2 \sigma_s^2 + (R_i^l)^2 \sigma_\pi^2 + 2R_i^l R_i^d \sigma_{s\pi},$$

and $\sigma_{s\pi} = \text{Cov}(s, \pi)$. This extended model nests the minimum variance portfolio in Ize and Yeyati (2003) as a special case in which the income is denominated entirely in the local currency ($\theta_i = 1$) and $R_i^l = R_i^d$ (the uncovered interest parity condition). In this extended model, dollar borrowing remains negatively associated with exchange rate volatility, provided that $R_i^l - R_i^d > 0$, and is positively associated with the interest differential and inflation volatility, σ_π^2 (see Appendix II for a proof).

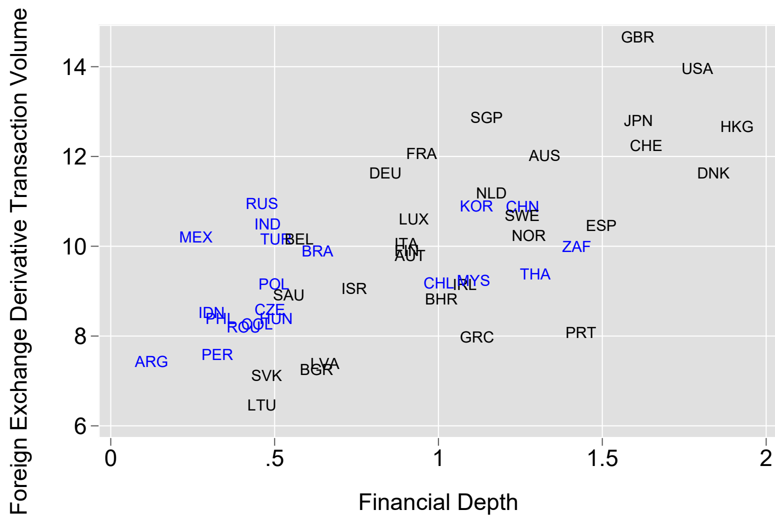
Financial market development. The model described so far is based on the assumption that domestic financial markets are incomplete, in which the only means to hedge against exchange rate risk is by adjusting the debt currency composition. But even in economies in which other hedging instruments exist, factors, such as market depth, transaction costs, information asymmetry, and regulatory restrictions, can effectively limit firms' access to these instruments.

As domestic financial markets develop and deepen,[1] firms will start to hedge their currency exposure more through foreign exchange derivatives as transactions costs decline. Figure 1 confirms this positive relationship between domestic financial depth and the size of foreign exchange derivative markets, proxied by the post-crisis average volume of daily turnover for foreign exchange derivatives. Furthermore, the variety of financial instruments that become increasingly available in domestic markets (for example, long-term maturity bonds) will reduce domestic firms' need to tap the dollar funding market, as posited by the original sin hypothesis.

To see how these developments affect firms' debt currency decision in the model, suppose firms now have the option to hedge their currency risk through a derivative contract that locks the second-period exchange rate at a predetermined value f, which for simplicity is assumed to be available at no cost. In this hypothetical setting, it is straightforward to show that firms will borrow exclusively in dollars ($1 - \alpha_i^* = 1$) if $R_i^l > R_i^d f$ and in the local currency if $R_i^l < R_i^d f$. Finally, if the covered interest rate parity holds ($R_i^l = R_i^d f$), firms will be indifferent between borrowing in dollars and in the local currency. From a financial stability perspective, however, an economy at this stage of market development could be considered as a *de facto* de-dollarized economy in the sense that firms no longer face exchange rate risks, regardless of the composition of their nominal debt currency (that is, between hedged dollar debt and local-currency debt).

[1] Financial development and financial deepening are used interchangeably in this paper.

Figure 1. Financial Depth and Size of Foreign Exchange Derivative Markets



Note: The blue-colored observations represent the economies included in the sample. The size of foreign exchange derivative markets is calculated as the logarithm of the average daily turnover volume (in millions of US dollars) of foreign exchange derivative instruments (including forwards, swaps, and options) for year 2010, 2013, and 2015. Sources: BIS, Triennial OTC derivatives statistics (Table D11.5); and IMF staff estimates.

The intuition above implies that in developed financial market economies with readily available foreign exchange derivatives, exchange rate volatility will play a relatively less important role as a determinant of firms' debt currency composition, in contrast to the interest rate differential. This hypothesis is tested using a firm-level dataset described in the next section.

IV. Firm-Level Data

This study uses a firm-level dataset constructed from the corporate balance sheet database provided by Capital IQ, S&P Global Market Intelligence. One advantage of the Capital IQ database over other commercial databases such as Worldscope and Orbis is the availability of detailed information on firms' outstanding debt held in their balance sheets. Its Debt Capital Structure database, in particular, provides information on the individual debt instruments held by each firm at a given point in time, including the principal amount due, the currency of denomination, and the type of instrument (for example, whether it is a bank loan or a bond).[2] Information on debt instruments is collected from company financial reports filed to national regulatory agencies, typically available in the supplementary note accompanying the main

[2] While more limited in terms of coverage, information is also available on the coupon type, coupon rate, date of issuance, maturity, level of seniority, and collateralization.

financial statements.[3] Compared with primary debt issuance databases, such as Dealogic and Thomson One, Capital IQ has the advantage of providing direct and comprehensive information on firms' liability exposure to exchange rate risks. For example, the database shows that Ayala Land, a Philippine real estate development company, had an outstanding US$1.5 million variable interest rate bank loan from a local bank as of the end of fiscal year 2016. Such information is unlikely to be included in international debt issuance databases but is important nonetheless to capture the full extent of firms' balance sheet currency exposure.

The sample in this study comprises nonfinancial sector firms owned by the private sector and includes both listed and nonlisted firms. The accounting information is on a consolidated basis at the ultimate corporate parent level and converted from the local currency to millions of US dollars by using the historical exchange rate at the end of each fiscal year. The currency breakdown of the outstanding total debt is obtained by aggregating the information on individual debt instruments for each firm-year pair. The value of the aggregated debt amount across all currencies is then cross-checked against the total principal due amount reported on the balance sheet. Appendix I provides additional details on data cleaning.

Regarding the currency of denomination, Capital IQ gathers information according to the following criteria: (1) If a company explicitly reports the repayment currency of a debt instrument, Capital IQ reports the same currency; (2) if a company reports the repayment currency as either "foreign currency" or "multiple currency," Capital IQ reports the currency information as unavailable; and (3) if a company does not state any specific repayment currency, Capital IQ assigns the financial statement's reporting currency as the repayment currency, which is usually the company's local currency. In this sample, the share of firms that report holding debt instruments denominated in "foreign currency" or "multiple currency" is significant. In 2015, for example, about 16 percent of firms reported carrying these unspecified foreign currency liabilities. In this paper, these liabilities are treated as a part of dollar debt. The dollar debt ratio estimates based on this definition are reassuringly comparable with estimates from available macro-level statistics and earlier studies, as shown in Table I.1 in Appendix I.[4] Finally, to mitigate the bias arising from firms that consistently do not report their debt currency denomination, the sample is restricted to firms that reported carrying a positive amount of foreign currency-denominated debt for at least one year during the period 2002–2017.

[3] Capital IQ employs a team of research analysts dedicated to collecting this specific information, who enter the gathered data in the Debt Capital Structure database separately from the main balance sheet database. Finally, information available in non-English documents is also collected after translation.

[4] The empirical results are similar when the narrower definition of dollar debt is used as the dependent variable (available upon request).

The final sample used for the analysis comprises a total of 9,317 firms or 33,905 firm-year observations during the period 2009–2017. This sample is obtained after discarding the top and bottom 1 percent of the firm-year observations for each firm-level explanatory variable. The sample firms belong to the following 21 economies on the basis of their main headquarters' locations: Argentina, Brazil, Chile, China, Colombia, Czech Republic, Hungary, India, Indonesia, Korea, Malaysia, Mexico, Peru, the Philippines, Poland, Romania, Russia, South Africa, Taiwan Province of China (POC), Thailand, and Turkey.

The panel is highly unbalanced and Asia focused, with about 63 percent of firms located in China, India, and Taiwan POC. The sample also comprises both operating and non-operating (for example, liquidated) firms to reduce the survival bias.

Finally, all statements filed before July 1 in any given calendar year are reassigned to the previous calendar year, and those filed after June 30 are assigned to the same calendar year in which they are filed to minimize the timing mismatch between macroeconomic and firm-level variables. This adjustment minimizes the mismatch to up to six months.

V. Econometric Analysis

This section examines the macroeconomic and firm-level determinants of firms' debt currency composition. Specifically, the following equation is estimated using the Tobit specification:

$$
\begin{aligned}
Y_{i,j,k,t} &= Y^*_{i,j,k,t}\mathbb{1}\left[Y^*_{i,j,k,t} \geq 0\right], \\
Y^*_{i,j,k,t} &= \alpha X_{k,t-1} + \beta F_{i,j,k,t-1} + \gamma Q_{k,t-1} + \mu_j + \mu_k + \mu_t + \varepsilon_{i,j,k,t}, \\
\varepsilon_{i,j,k,t} &\overset{iid}{\sim} \mathcal{N}(0, \sigma^2_\varepsilon),
\end{aligned}
$$

in which the dependent variable $Y_{i,j,k,t}$ denotes the ratio of dollar debt to total debt, bounded between 0 and 1. This ratio is regressed over a vector of accounting variables for firm *i* in industry *j* and economy *k* at the end of year *t-1* ($F_{i,j,k,t-1}$), as well as macroeconomic ($X_{k,t-1}$) and additional control variables ($Q_{k,t-1}$). All variables are lagged by one year to mitigate endogeneity issues. The variables μ_j, μ_k, and μ_t represent industry, country, and time fixed effects, respectively. The industry dummy variable is based on Capital IQ's proprietary industry classification system and defined at the *industry-sector* level, of which 28 industries are covered in the sample.[5] Finally, standard errors are adjusted for cluster effects at the country level.

[5] See Appendix I for the list of industries.

The main macroeconomic variables of interest are interest rate differentials and the volatility of real exchange rate depreciation. Interest rate differentials are measured as the difference between short-term local currency interest rates and the three-month US dollar LIBOR. Exchange rate volatility is calculated as the annualized standard deviation of the monthly real exchange rate changes (y/y) against the US dollar over 12 months. Another variable of interest is the private credit-to-GDP ratio, a measure of domestic financial market depth. The benchmark specification also includes real GDP growth and real exchange rate depreciation vis-à-vis the US dollar, calculated as the end-of-year change (y/y) of the US dollar per local currency nominal exchange rate multiplied by CPI_{local}/CPI_{USA}. Thus, a negative value of exchange rate depreciation indicates local currency depreciation against the US dollar. The benchmark specification also includes inflation rate and inflation volatility. Inflation volatility is calculated as the annualized standard deviation of monthly CPI inflation (y/y) over 12 months. The other control variables include real GDP per capita (PPP, 2011 international dollars), the exports-to-GDP ratio, and the composite country risk rating from the International Country Risk Guide Database, which captures the overall country risk. These variables are intended to control for various structural aspects of the sample economies other than financial development. Appendices I and III provide additional descriptions of the data. The macroeconomic data come from the IMF's World Economic Outlook Database and International Financial Statistics, unless otherwise stated.

The firm-level variables comprise the logarithm of total assets, the debt-to-total assets ratio as a measure of firm leverage, the tangible assets-to-total assets ratio, the cash-to-total assets ratio, and return on assets. In the absence of information on the currency composition of the sample firms' sales, a dummy variable that takes a value of 1 if a firm belongs to the tradable sector is also included. This variable is intended to capture the currency hedging demand arising from exporting firms' dollar income. The list of tradable sector industries used for the analysis is presented in Appendix I.

A. Data Description

Table 1 presents the summary statistics on the sample firms at the end of 2017. On average, Latin American firms hold the highest share of dollar-denominated debt at 29 percent, whereas firms in other regions hold between 8 and 13 percent. The percentile statistics also indicate that firms carrying dollar-denominated debt consist only of a small fraction of the sample firms in all regions except Latin America.

Table 2 presents the statistics for the macroeconomic variables (panel A) and their correlation with the dollar debt ratio in 2009–2017 (panel B). The correlations in panel B are mostly in line with the model prediction and findings from existing studies. As expected, the dollar debt ratio is positively correlated with interest rate differentials and inflation volatility, consistent with the model prediction, and negatively associated with financial depth, consistent with the original sin hypothesis. However, the dollar debt ratio has a positive correlation with exchange rate volatility, thereby contradicting the model prediction. The next section examines this relationship by using multivariate analyses. Appendix III presents additional statistics on firms' characteristics and by economy.

B. Main Results

Taking the implications from the model in Section III, this section conducts tests of the following two main hypotheses:

Hypothesis 1. *The dollar debt ratio is positively associated with interest differentials and negatively associated with exchange rate volatility.*

Hypothesis 2. *The deeper the financial markets, the weaker the relationship between the dollar debt ratio and exchange rate volatility. By contrast, the relationship between the dollar debt ratio and interest differentials is not affected by the level of financial development.*

In particular, the testing of hypothesis 2 involves checking the sign and statistical significance of the coefficients of the interaction terms between exchange rate volatility and financial depth and between interest differentials and financial depth. Given the model prediction that the coefficient for exchange rate volatility should be negative, hypothesis 2 implies that the coefficient for the interaction term between exchange rate volatility and financial depth should be positive whereas the coefficient for the interaction term between interest differentials and financial depth should be statistically insignificant.

Table 3 shows the coefficient estimates from the Tobit regressions. The results provide initial evidence in favor of hypotheses 1 and 2. In all the specifications, shown in columns (1)-(4), the coefficients for exchange rate volatility and the interest differential have the expected negative and positive signs, respectively, and are statistically significant. The size of these coefficients is also economically significant. Based on the estimates in column (4), a one percentage point increase in the interest differential is associated with a 0.1 percentage point increase in the dollar debt ratio whereas a one standard deviation increase in the exchange rate volatility (0.1) is associated with a 0.1 percentage point decrease in the dollar debt ratio.

When the interaction terms with financial depth are introduced, one at a time (columns 2 and 3) and simultaneously (column 4), the interaction term between exchange rate volatility and financial depth takes a positive and statistically significant coefficient whereas the interaction term between the interest differential and financial depth has a statistically insignificant coefficient,[6] in line with hypothesis 2. Meanwhile, the estimated coefficient of financial depth is highly insignificant across all specifications.

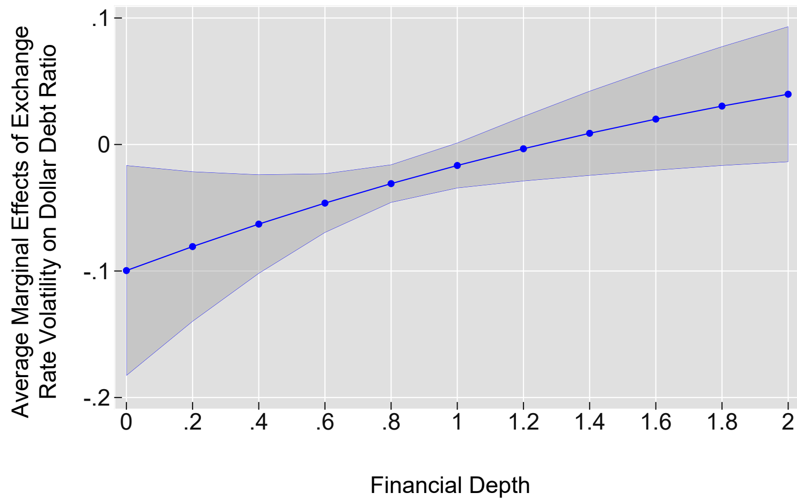
Figure 2 visualizes this interrelationship between exchange rate volatility, financial depth, and the dollar debt ratio. It shows that financial depth, measured by the private credit-to-GDP ratio, reduces the average marginal effects of exchange rate volatility on the dollar debt ratio when the private credit-to-GDP ratio is below 1. However, when the private credit-to-GDP ratio rises above the threshold of 1, exchange rate volatility loses statistical significance, implying that it no longer plays a statistically significant role in determining the dollar debt ratio. This is in contrast to the interest differential, which remains statistically significant independent of the level of financial depth.

The estimated coefficients for the other variables are consistent with the model predictions and the findings from existing studies. Inflation volatility and the tradable sector dummy are each positively associated with the dollar debt ratio, as implied by equation (5). The negative sign for the real exchange rate depreciation variable likely reflects the competitiveness effect of depreciation on export earnings, implying a relatively lower share of local currency income.

Regarding the firm-level variables, although not shown to conserve space, the estimated coefficients for the logarithm of total assets, the total debt-to-total assets ratio, and the tangible assets-to-total assets ratio are found to be positive and highly significant. These results are consistent with those of similar firm-level studies in the literature.

[6] The lack of statistical significance of the interaction term between the interest differential and financial depth variable appears to be in line with the finding in Allayannis, Brown, and Klapper (2003), in which currency hedging was negatively associated with the interest rate differential in a sample of East Asian firms. They interpret this relationship as suggesting that firms trade off the benefit of lower interest expense with exchange rate risk. If this type of speculative motive is indeed at play, financial development will not have much influence through the interest rate channel.

Figure 2. Average Marginal Effects of Exchange Rate Volatility on Dollar Debt Ratio



Note: The shaded area represents the 95 percent confidence interval.

C. Robustness Tests

Reverse Causality

A concern regarding the benchmark results in Section V.B is the possibility of reverse causality between exchange rate volatility and dollar debt ratio. To the extent that the dollar debt is unhedged, there is a possibility that exchange rate volatility is intentionally kept low to protect firms' balance sheets against unexpected exchange rate depreciation.

While the use of firm-level data greatly reduces this reverse causality problem, the potential influence on the benchmark results in Table 3 is tested using an alternative measure of exchange rate volatility. Specifically, the average value of exchange rate volatility from neighboring economies is used as an alternative explanatory variable for exchange rate volatility. To construct this variable, the sample economies are divided into subgroups based on their geographical regions, and the alternative exchange rate volatility of an economy is calculated as the average value of exchange rate volatility of each group excluding the economy itself.[7]

[7] The subgroups are as follows: Group A–China, India, Indonesia, Korea, Malaysia, the Philippines, Taiwan POC, and Thailand; Group B–Argentina, Brazil, Chile, Colombia, Mexico, and Peru; Group C–Czech Republic, Hungary, Poland, Romania, Russia, and Turkey. In the case of South Africa, the entire sample is used for the calculation of the alternative exchange rate volatility measure.

Table 4 shows the results using the alternative measure of exchange rate volatility and the otherwise identical specifications as in Table 3, although other variables not relevant for this test are not shown to conserve space. Overall, the estimated coefficients confirm that the benchmark results in Table 3 are not affected by the possible reverse causality. As shown in column (4), the preferred specification, both the coefficients for the alternative exchange rate volatility and its interaction term with financial depth, as well as interest rate differentials, all retain the expected signs and are statistically significant, whereas the coefficient for the interaction term between interest differentials and financial depth remains insignificant, consistent with the benchmark results in Table 3.

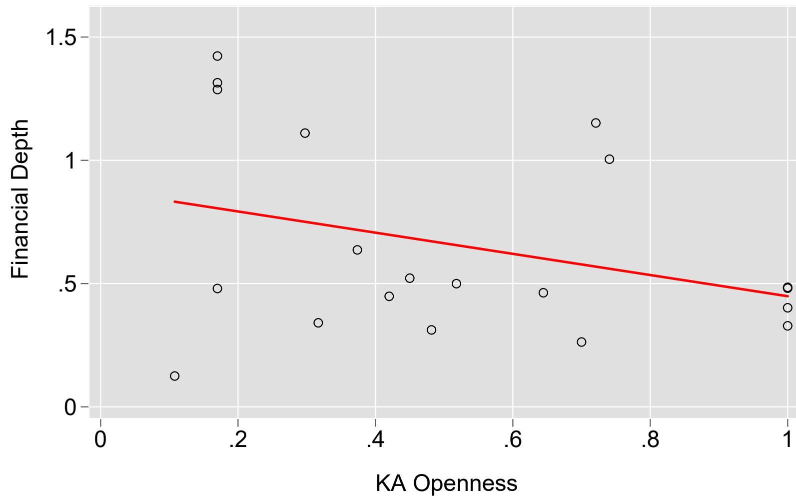
Alternative Hypothesis: Surrogate Financial Intermediaries

As a further robustness check, this section examines an alternative explanation for the results supporting hypothesis 2—that of EME nonfinancial firms playing the role of surrogate financial intermediaries.

In the aftermath of the global financial crisis, many EMEs had tightened capital controls in an effort to curb capital inflows (Caballero, Panizza, and Powell, 2016). Nonetheless, a considerable amount of dollar liquidity circumvented these controls through offshore subsidiaries of multinational EME firms, which issued US dollar-denominated bonds at relatively low interest rates and repatriated the proceeds to their headquarters in the home country through within-company transactions (Avdjiev, Chui, and Shin, 2014; Chui, Fender, and Sushko, 2014; McCauley, McGuire, and Sushko, 2015). Bruno and Shin (2017) and Caballero, Panizza, and Powell (2016) showed evidence that capital controls could be an important reason why nonfinancial firms undertake this carry trade-like activities, especially when interest rate differentials are large. To see whether this behavior could be an explanation for the results supporting hypotheses 1 and 2, Figure 3 plots the post-crisis relationship between financial depth and a measure of capital account (KA) openness by Chinn and Ito (2006). The figure shows that financial depth is negatively correlated with KA openness, implying that economies with less-open capital accounts are also those that have *deeper* financial markets over the sample period of 2009–2017. Thus, based on this relationship, the results in Table 3 could be viewed as also being consistent with the surrogate financial intermediary hypothesis.

To check for the possibility of capital controls effectively driving the relationship between financial depth and the macroeconomic variables, a horse-race test is run between financial depth and KA openness. For this, KA openness and its interaction terms with interest rate

Figure 3. Post-Crisis Correlation Between Financial Depth and KA Openness



Note: A larger value indicates greater capital account openness.

differentials and exchange rate volatility are added to the regression equations of Table 3, columns (2)-(4), respectively.

The results in Table 5 confirm that the interaction effects of financial depth in Table 3 are not driven by the difference in capital account openness across economies: in column (3), the coefficients for the interest differential and exchange rate volatility are significant at the 1 percent level with the expected signs. Similarly, the coefficient of the interaction term between exchange rate volatility and financial depth also remains robust under this alternative specification. Meanwhile, columns (2) and (3) show that the interaction term between the interest rate differential and capital account openness has a highly significant coefficient with a negative sign, implying that the quantitative importance of interest rate differentials will decline as the capital account opens up. This appears to be consistent with the surrogate financial intermediary hypothesis.

The results in columns (1)-(3) are obtained using the value of KA openness in year $t-1$. In practice, however, capital controls could be tightened preemptively in anticipation of capital inflows in the future. If this is the case, the results in columns (1)-(3) will suffer from the reverse causality between dollar debt ratio and KA openness. This issue is addressed by replacing KA openness in year $t-1$ with the value of KA openness in 2005 as an alternative proxy for capital account openness. The results from rerunning the same specifications in columns (1)-(3) are shown in columns (4)-(6), which are similar to columns (1)-(3) and especially for exchange rate volatility. Furthermore, the interaction term between the interest differential and KA openness is no longer statistically significant at the conventional levels.

To summarize, the results in Table 5 confirm that the benchmark results are not driven by the omission of capital account openness as an explanatory variable.

Additional Robustness Checks

This section further tests the robustness of the benchmark results with different subsamples, alternative dependent variables, and alternative estimation methods. For these tests, the sample is divided into high financial depth (FD) and low FD subsamples, which are defined as sample firms in economies with the private credit-to-GDP ratio greater than 1 and less than 1 in year t, respectively. For each of these subsamples, the specification in column (1) of Table 3 is used to run additional robustness checks.

Panel A in Table 6 shows the regression results for various subsamples of each group. From lines (2) to (4), the economies with the largest observations in each of these two groups are excluded. These comprise Brazil, India, and Indonesia for the low FD group and China, Taiwan POC, and Korea for the high FD group. Given the high share of Asian firms in the sample, separate regressions are run for Asian and non-Asian firms within the low FD group, shown in lines (5) and (6), respectively. Furthermore, given the highly unbalanced panel structure, an additional test is run to check whether the benchmark results hold when a balanced panel subsample is used (line 7).

Panel B in Table 6 shows the results using the foreign currency-denominated debt to-total debt ratio (line 8), the logarithm of the amount of dollar-denominated debt plus 1 (line 9), and the first-differenced dollar debt ratio as the dependent variable (line 10).[8] The test using the first-differenced dollar debt ratio is to address the concern on the serial correlation of the error terms. Finally, in panel C, the regressions are rerun using alternative estimation methods: fixed-effects, fractional probit, and two-part models. A common drawback with non-linear methods, such as the Tobit, is the incidental parameters problem, which prevents controlling for firm-level fixed effects. Whereas the linear fixed-effects model does not consider the bounded nature of the dependent variable, it allows controlling for unobserved time-invariant firm heterogeneity. On the other hand, the fractional probit model proposed by Papke and Wooldridge (2008) is more suited to the data at hand, as it does not take the limit values

[8] Although not reported here to conserve space, the benchmark results do not hold with the euro-denominated debt ratio for the low FD group.

of dollar debt ratio (that is, 0 and 1) as a result of censoring, which is not the case for this dataset, as the value of dollar debt ratio is bounded by construction. Finally, the two part-model from Cragg (1971) separately examines firms' decision on whether to take on dollar debt (first stage) and, conditional on carrying dollar debt, how much of it to carry (second stage).

Overall, the regression results shown in Table 6 confirm that the benchmark results in Table 3 are robust to these additional tests.

In unreported results, separate regressions are run with the following modifications: (a) restrict the sample to firms carrying a positive amount of foreign currency-denominated debt in year t to address the issue of non-reporting; (b) use the imports-to-GDP ratio instead of the exports-to-GDP ratio; and (c) use robust standard errors clustered at the firm level instead of the country level. The benchmark results are found to be robust to these additional tests.

D. Evidence From Taper Tantrum

The empirical analyses so far have shown that the influence of exchange rate volatility in determining a firm's debt currency composition diminishes as domestic financial markets develop, eventually becoming statistically insignificant when the private credit-to-GDP ratio exceeds an estimated threshold level of 1. If this finding is driven by the greater use of currency hedging derivatives by firms in more developed financial markets, as discussed in Section III, these firms should also be relatively less affected by exchange rate shocks than those in less-developed financial markets.

A direct test of this prediction, however, is not feasible due to lack of information on derivative hedging by sample firms. Instead, the paper uses the Taper Tantrum episode as a natural experiment to find indirect evidence supporting this hypothesis. During May–September 2013, the U.S. Federal Reserve Chairman Ben Bernanke made a series of remarks on the likelihood of tapering the Fed's asset purchase program. These comments led to large capital outflows from EMEs, accompanied by a sharp decline in asset prices and exchange rate depreciation across EMEs. For firms holding a significant amount of unhedged dollar debt, the exchange rate depreciation could have weakened their balance sheets by inflating the local currency value of the dollar debt, thereby negatively affecting investment.

This balance sheet channel of exchange rate depreciation is examined using the empirical framework similar to that of Bleakley and Cowan (2008). Specifically, the following equation is estimated for the period of 2012–2014:

$$I_{i,j,k,t} = \alpha DDR_{i,j,k,t-1} \times \Delta EXR_{i,j,k,t} + \beta F_{i,j,k,t-1} + \gamma Q_{k,t} + \mu_i + \mu_t + \mu_{j,t} + \varepsilon_{i,j,k,t},$$

in which $I_{i,j,k,t}$ denotes the ratio of firm i's capital expenditure in year t to total assets in year $t-1$. This variable is regressed over a set of firm-level variables (the logarithm of total assets, debt-to-total assets ratio, tangible assets-to-total assets ratio, cash-to-total assets ratio, dollar debt-to-total debt ratio, and sales growth), all lagged by one year, and a set of contemporaneous macro-level variables (real GDP growth, inflation, inflation volatility, country risk rating from the International Country Risk Guide Database, and the logarithm of real GDP per capita), as well as firm, year, and industry-year fixed effects. The sample is restricted to firms that hold dollar debt in year $t-1$.

The main variable of interest is $DDR_{i,j,k,t-1} \times \Delta EXR_{i,j,k,t}$, which denotes the interaction term between firm i's dollar debt ratio in year $t-1$ and real exchange rate depreciation against the dollar in year t. If the firm experiences a decline in the investment-to-assets ratio as a result of exchange rate depreciation, the coefficient of this variable should take a positive value ($\alpha > 0$). Furthermore, this coefficient will be more significant the less hedged the dollar debt, which is expected to be the case for less-developed market firms.

The results in Table 7 show evidence in support of this conjecture. The coefficient of the interaction term between the dollar debt ratio and exchange rate depreciation is positive and statistically significant at the 1 percent level for firms in the low FD economies (column 2), but insignificant in high FD economies (column 3).[9] These results indicate that the negative balance sheet effect of exchange rate depreciation was significant only for firms in less-developed financial markets, likely reflecting the larger portion of their unhedged dollar debt. Meanwhile, the coefficient for exchange rate depreciation is negative, indicating that real depreciation per se had a beneficial effect on investment (competitiveness channel).

VI. Concluding Remarks

The findings in this paper provide firm-level evidence in favor of the original sin hypothesis. The importance of exchange rate volatility as a determinant of firms' debt currency composition declines as domestic financial markets develop and statistically disappears when

[9] Kalemli-Ozcan, Kamil, and Villegas-Sanchez (2016) find evidence that this difference in investment performance could also reflect the difference in access to credit between these economies (lending channel) in addition to the degree of hedging.

the private credit-to-GDP ratio exceeds an estimated threshold level of 100 percent. These results could be explained by the greater availability of foreign exchange hedging instruments in more developed financial markets. The investment performance of sample firms during the Taper Tantrum period provides supporting evidence for this explanation. Taken together, these findings indicate that financial development promotes de-dollarization in the sense that it lowers *unhedged* dollar debt on firms' balance sheets.

Nevertheless, these findings do not imply that financial development is a sufficient condition for *redemption* from original sin. The estimated effects of financial development could, in fact, reflect differences in deeper structural aspects across economies, such as the strength of institutions and the credibility of macroeconomic policy regimes, which are beyond the scope of this paper.[10] Furthermore, this paper does not address the issue of whether low exchange rate volatility hinders financial development, especially the development of foreign exchange derivative markets. However, existing studies do not find a robust empirical link between exchange rate flexibility and foreign exchange derivative market development, especially compared with other variables such as trade, financial openness, and the size of domestic bond and equity markets (Gadanecz and Mehrotra, 2013; Mihaljek and Packer, 2010).

Finally, the analyses underscore the need for a differentiated policy approach for dealing with debt dollarization. In economies at relatively low stage of financial development, policies aimed at developing domestic financial markets could promote de-dollarization. Furthermore, a policy of maintaining low exchange rate volatility could be costlier than in more developed market economies, as it could worsen and prolong unhedged debt dollarization. On the other hand, in economies at relatively advanced stages of financial development, the priority appears to be in strengthening oversight and macroprudential policies to safeguard financial stability, especially when interest rate differentials are high.

[10]That said, Eichengreen, Hausmann, and Panizza (2005) examined the relationships between their measure of original sin and proxy variables for the rule of law and creditor rights and found no statistically and economically significant relationships between these variables.

Table 1. Firm-Level Variables: Summary Statistics

This table presents the summary statistics of the following firm-level variables at the end of fiscal year 2017: the dollar debt as defined in Section IV; the ratio of dollar debt to total debt; the debt-to-total assets ratio (*Leverage*); the tangible assets-to-total assets ratio (*Tangibility*); the cash-to-total assets ratio (*Cash*); the return on assets; and the total assets. Dollar debt and total assets are in millions of US dollars, converted from the local currency using the historical exchange rate at the end of fiscal year 2017.

	Number of firms	Minimum	Mean	25^{th} percentile	Median	75^{th} percentile	Maximum	Standard deviation
Asia								
Total assets (USD, millions)	4,650	2.00	1,471.21	88.75	315.68	1,131.99	29,621.49	3,307.22
Cash	4,650	0.00	0.11	0.04	0.09	0.17	0.48	0.10
Tangibility	4,648	0.00	0.27	0.11	0.24	0.40	0.90	0.20
Leverage	4,650	0.00	0.24	0.09	0.22	0.35	0.72	0.16
Return on assets	4,637	-0.12	0.03	0.01	0.03	0.05	0.21	0.04
Dollar debt ratio	4,650	0.00	0.08	0.00	0.00	0.00	1.00	0.22
Dollar debt (USD, millions)	4,650	0.00	31.18	0.00	0.00	0.00	10,703.92	258.93
Latin America								
Total assets (USD, millions)	356	3.05	1,723.79	120.28	412.54	1,290.24	26,669.64	3,619.63
Cash	356	0.00	0.06	0.02	0.04	0.09	0.35	0.06
Tangibility	352	0.00	0.36	0.13	0.32	0.57	0.89	0.26
Leverage	356	0.00	0.29	0.17	0.29	0.40	0.69	0.16
Return on assets	355	-0.10	0.04	0.01	0.04	0.06	0.18	0.05
Dollar debt ratio	356	0.00	0.29	0.00	0.11	0.59	1.00	0.34
Dollar debt (USD, millions)	356	0.00	218.03	0.00	1.26	83.28	7,372.86	671.67
Other Region								
Total assets (USD, millions)	464	2.01	985.70	30.36	115.04	563.53	18,843.12	2,487.17
Cash	464	0.00	0.07	0.02	0.05	0.09	0.48	0.06
Tangibility	464	0.00	0.35	0.12	0.32	0.53	0.88	0.25
Leverage	464	0.00	0.24	0.11	0.23	0.34	0.69	0.15
Return on assets	464	-0.12	0.04	0.01	0.04	0.06	0.20	0.04
Dollar debt ratio	464	0.00	0.13	0.00	0.00	0.08	1.00	0.27
Dollar debt (USD, millions)	464	0.00	83.26	0.00	0.00	0.00	7,690.00	479.30
Total								
Total assets (USD, millions)	5,470	2.00	1,446.46	81.73	301.27	1,098.35	29,621.49	3,270.39
Cash	5,470	0.00	0.11	0.03	0.08	0.15	0.48	0.09
Tangibility	5,464	0.00	0.29	0.11	0.25	0.42	0.90	0.21
Leverage	5,470	0.00	0.24	0.10	0.22	0.35	0.72	0.16
Return on assets	5,456	-0.12	0.03	0.01	0.03	0.05	0.21	0.04
Dollar debt ratio	5,470	0.00	0.10	0.00	0.00	0.01	1.00	0.24
Dollar debt (USD, millions)	5,470	0.00	47.76	0.00	0.00	0.00	10,703.92	328.56

Table 2. Macroeconomic Variables: Summary Statistics and Correlations

This table presents the summary statistics for macroeconomic variables over 2009-2017 for each economy (Panel A) and their pairwise correlations with the dollar debt ratio (Panel B).

Panel A. Summary statistics	Minimum	Mean	25^{th} percentile	Median	75^{th} percentile	Maximum	Standard deviation
Dollar debt ratio	0.00	0.07	0.00	0.00	0.00	1.00	0.19
Interest differential	-0.02	0.04	0.02	0.03	0.05	0.26	0.03
Exchange rate volatility	0.03	0.14	0.07	0.10	0.17	0.79	0.11
Inflation volatility	0.61	2.52	1.13	1.79	3.04	18.04	1.96
Exchange rate depreciation	-0.32	-0.00	-0.03	-0.00	0.03	0.17	0.06
GDP growth	-0.08	0.05	0.03	0.06	0.08	0.11	0.03
Financial depth	0.11	1.06	0.50	1.20	1.44	1.71	0.44

Panel B. Pairwise correlation	Dollar debt ratio	Interest differential	Exchange rate volatility	Inflation volatility	Exchange rate depreciation	GDP growth	Financial depth
Dollar debt ratio	1.00						
Interest differential	0.14	1.00					
Exchange rate volatility	0.13	0.23	1.00				
Inflation volatility	0.10	0.42	0.31	1.00			
Exchange rate depreciation	-0.04	0.01	-0.12	0.14	1.00		
GDP growth	-0.10	0.18	-0.38	0.09	0.43	1.00	
Financial depth	-0.22	-0.61	-0.40	-0.53	-0.07	-0.10	1.00

Table 3. Macroeconomic Determinants of Dollar Debt Ratio

This table presents the Tobit regression results with the ratio of dollar debt to total debt as the dependent variable. The displayed explanatory variables are defined as follows: Exchange rate volatility is the annualized standard deviation of the monthly real exchange rate changes (y/y) against the US dollar over 12 months; interest differential is the difference between short-term local interest rates and the US dollar three-month LIBOR; financial depth is the private credit-to-GDP ratio; inflation volatility is the annualized standard deviation of monthly CPI inflation (y/y) over 12 months; inflation is the average CPI inflation rate over 12 months; exchange rate depreciation is the end-of-year real exchange rate depreciation against the US dollar (y/y), in which a negative value indicates a local currency depreciation; and GDP growth is the annual real GDP growth rate. *Tradable(=1)* is a dummy variable that takes a value of 1 if a firm belongs to the tradable sector and 0 otherwise. The other control variables, although not shown to save space, include: the logarithm of total assets, debt-to-total assets ratio, tangible assets-to-total assets ratio, cash-to-total assets ratio, return on assets. The macroeconomic variables comprise real GDP per capita (PPP, 2011 international dollars), the exports-to-GDP ratio, the composite country risk rating from the International Country Risk Guide Database, as well as country, year, and industry fixed effects. All explanatory variables are lagged by one year. The standard errors, shown in brackets, are robust to clustering at the country level. The symbols ***, **, * denote statistical significance at the 1, 5, and 10 percent levels, respectively.

	(1)	(2)	(3)	(4)
Exchange rate volatility	−0.096***	−0.269***	−0.092***	−0.273***
	[0.032]	[0.065]	[0.031]	[0.066]
Exchange rate volatility × Financial depth		0.230***		0.242***
		[0.082]		[0.083]
Interest differential	0.724**	0.760***	0.985*	1.089**
	[0.338]	[0.280]	[0.540]	[0.444]
Interest differential × Financial depth			−0.566	−0.708
			[0.727]	[0.608]
Inflation volatility	0.006**	0.005**	0.005**	0.005**
	[0.002]	[0.002]	[0.002]	[0.002]
Inflation	−0.173	−0.118	−0.149	−0.085
	[0.115]	[0.116]	[0.110]	[0.120]
Exchange rate depreciation	−0.230***	−0.228***	−0.240***	−0.240***
	[0.077]	[0.067]	[0.081]	[0.070]
GDP growth	0.246	0.257	0.239	0.249
	[0.201]	[0.173]	[0.203]	[0.176]
Financial depth	0.000	−0.000	0.004	0.005
	[0.050]	[0.052]	[0.048]	[0.050]
Tradable(=1)	0.179***	0.178***	0.179***	0.178***
	[0.044]	[0.044]	[0.044]	[0.044]
Number of observations	33,905	33,905	33,905	33,905
Country FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes

Table 4. Reverse Causality

This table presents the Tobit regression results with the ratio of dollar debt to total debt as the dependent variable. The explanatory variables are the same as in Table 3, column (1)-(4), respectively, except for exchange rate volatility, which is replaced by the average value of exchange rate volatility in neighboring economies (*Alt. exchange rate volatility*). Interest differential is the difference between short-term local interest rates and the US dollar three-month LIBOR, and financial depth is the private credit-to-GDP ratio. The other control variables are now shown here to save space. All explanatory variables are lagged by one year. The standard errors, shown in brackets, are robust to clustering at the country level. The symbols ***, **, * denote statistical significance at the 1, 5, and 10 percent levels, respectively.

	(1)	(2)	(3)	(4)
Alt. exchange rate volatility	−0.205	−0.308*	−0.212	−0.312**
	[0.167]	[0.175]	[0.149]	[0.159]
Alt. exchange rate volatility × Financial depth		0.319***		0.312***
		[0.098]		[0.085]
Interest differential	0.756**	0.718**	1.086*	1.010**
	[0.365]	[0.304]	[0.561]	[0.451]
Interest differential × Financial depth			−0.703	−0.619
			[0.763]	[0.613]
Financial depth	0.010	−0.018	0.015	−0.013
	[0.061]	[0.057]	[0.058]	[0.054]
Number of observations	33,905	33,905	33,905	33,905
Country FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes

Table 5. Capital Account Openness

This table presents the Tobit regression results with the ratio of dollar debt to total debt as the dependent variable. Exchange rate volatility is calculated as the annualized standard deviation of the monthly real exchange rate changes (y/y) against the US dollar over 12 months. Financial depth is the private credit-to-GDP ratio. Interest differential is the difference between short-term local interest rates and the US dollar three-month LIBOR. Cash is the cash-to-total assets ratio. KA openness is the Chinn-Ito index of capital account openness (Chinn and Ito, 2006), which ranges between 0 and 1, with a larger value indicating greater capital account openness. The control variables, although not shown to save space, are the same as in Table 3. All explanatory variables are lagged by one year. The standard errors, shown in brackets, are robust to clustering at the country level. The symbols ***, **, * denote statistical significance at the 1, 5, and 10 percent levels, respectively.

	KA openness ($t-1$)			KA openness (2005)		
	(1)	(2)	(3)	(4)	(5)	(6)
Exchange rate volatility	−0.248***	−0.083**	−0.238***	−0.245***	−0.093***	−0.268***
	[0.064]	[0.037]	[0.071]	[0.070]	[0.035]	[0.087]
Exchange rate volatility× KA openness	−0.090		−0.090	−0.073		−0.045
	[0.109]		[0.125]	[0.100]		[0.132]
Exchange rate volatility× Financial depth	0.257***		0.251***	0.240***		0.251***
	[0.072]		[0.073]	[0.072]		[0.072]
Interest differential	0.770***	1.429**	1.509***	0.781***	1.777**	1.845***
	[0.283]	[0.612]	[0.553]	[0.285]	[0.841]	[0.711]
Interest differential× KA openness		−1.346***	−1.056***		−1.790	−1.628
		[0.454]	[0.402]		[1.298]	[1.197]
Interest differential× Financial depth		−0.627	−0.862		−0.755	−0.917
		[0.779]	[0.681]		[0.729]	[0.596]
KA openness	0.077	0.095	0.116	0.093*	0.175*	0.184**
	[0.081]	[0.085]	[0.083]	[0.049]	[0.096]	[0.081]
Financial depth	−0.048	−0.029	−0.038	−0.023	−0.003	−0.005
	[0.057]	[0.055]	[0.052]	[0.043]	[0.042]	[0.043]
Cash	0.125	0.125	0.124	0.126	0.123	0.123
	[0.094]	[0.095]	[0.095]	[0.095]	[0.096]	[0.095]
Number of observations	28,705	28,705	28,705	28,705	28,705	28,705
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes

Table 6. Additional Robustness Tests

This table presents the Tobit regression results with the ratio of dollar debt to total debt (dollar debt ratio) as the dependent variable except for panel B, where a different dependent variable is used for each regression as shown. Exchange rate volatility is defined as the annualized standard deviation of the monthly real exchange rate changes (y/y) against the US dollar over 12 months. Interest differential is the difference between short-term local interest rates and the US dollar three-month LIBOR. All regressions use the same set of explanatory variables as in Table 3, column (1). From line (2) to (4), Brazil, India, and Indonesia are excluded from the low FD sample, respectively. Similarly, China, Taiwan POC, and Korea are excluded from the high FD sample, respectively, in line (2) to (4). All explanatory variables are lagged by one year. The standard errors, shown in brackets, are robust to clustering at the country level. The symbols ***, **, * denote statistical significance at the 1, 5, and 10 percent levels, respectively.

	Low FD			High FD		
	Exchange rate volatility	Interest differential	Number of observations	Exchange rate volatility	Interest differential	Number of observations
(1) FD sample	−0.091***	0.706**	13,750	−0.116	1.707***	20,152
	[0.033]	[0.282]		[0.110]	[0.548]	
Panel A. Subsamples						
(2) Excluding: Brazil / China	−0.080**	0.695**	12,797	−0.094	1.755***	10,792
	[0.032]	[0.316]		[0.068]	[0.676]	
(3) Excluding: India / Taiwan POC	−0.122***	0.288	8,370	−0.227	2.550***	14,952
	[0.044]	[0.355]		[0.197]	[0.767]	
(4) Excluding: Indonesia / Korea	−0.079**	0.662**	12,860	−0.121	1.716***	18,832
	[0.036]	[0.275]		[0.108]	[0.646]	
(5) Region: Asia	−0.235***	1.787***	8,777			
	[0.074]	[0.307]				
(6) Region: Non-Asia	−0.150***	0.795***	4,973			
	[0.052]	[0.265]				
(7) Balanced panel	−0.198***	1.446***	2,925	0.211*	0.358	2,263
	[0.049]	[0.326]		[0.119]	[1.361]	
Panel B. Alternative dependent variables						
(8) Foreign currency-denominated debt	−0.073*	0.638***	13,750	0.000	−0.287	20,152
	[0.042]	[0.175]		[0.084]	[0.386]	
(9) log(1+dollar debt amount)	−0.290**	1.510*	13,750	−0.199	−0.679	20,152
	[0.145]	[0.907]		[0.196]	[1.105]	
(10) First difference(dollar debt ratio)	−0.192***	0.783***	13,753	−0.090	0.126	20,152
	[0.044]	[0.180]		[0.095]	[0.410]	
Panel C. Alternative estimation methods						
(11) Firm-level fixed effects	−0.052*	0.378**	13,754	0.036	0.095	20,161
	[0.028]	[0.172]		[0.034]	[0.254]	
(12) Fractional probit	−0.192*	1.418**	13,750	0.115	0.703	20,146
	[0.105]	[0.572]		[0.193]	[1.533]	
(13) Two-part model						
a. Hold/not hold dollar debt (1/0)	−0.106	0.994	13,750	−0.350	5.367***	20,146
	[0.108]	[1.179]		[0.264]	[1.508]	
b. dollar debt ratio for firms with dollar debt amount>0	−0.215**	1.380*	6,899	0.045	0.525	5,336
	[0.108]	[0.708]		[0.202]	[0.825]	

Table 7. Impact of Exchange Rate Shocks on Investment

This table presents the fixed-effects panel regression results for the sample firms with a positive amount of dollar-denominated debt in year $t-1$ over the period of 2012–2014. The dependent variable is the ratio of capital expenditure in year t to total assets in year $t-1$. Columns (1) shows the regression results for the full sample, columns (2) for the sample in EMEs with the private credit-to-GDP ratio less than 1 (Low FD), and columns (3) for the sample in EMEs with the ratio greater than 1 (High FD). Although not shown to conserve space, all regressions also include a set of lagged firm-level variables (the logarithm of total assets, debt-to-total assets ratio, tangible assets-to-total assets ratio, cash-to-total assets ratio, dollar debt-to-total debt ratio, and sales growth), contemporaneous macroeconomic variables (real GDP growth, inflation, inflation volatility, country risk rating from the International Country Risk Guide Database, and the logarithm of real GDP per capita), as well as year, country, and industry-year interaction fixed effects. The standard errors, shown in brackets, are robust to clustering at the country level. The symbols ***, **, * denote statistical significance at the 1, 5, 10 percent levels, respectively.

	(1) All	(2) Low FD	(3) High FD
Dollar debt ratio × Exchange rate depreciation	0.232***	0.246***	0.455
	[0.072]	[0.090]	[0.301]
Exchange rate depreciation	−0.107**	−0.169***	−0.241
	[0.042]	[0.057]	[0.169]
Number of observations	3,549	2,072	1,477
Year FE	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
Year × Industry FE	Yes	Yes	Yes

Table I.1. Average Dollar Debt Ratio in Select EMEs (Percent, End-2014)

Country	This paper: Number of firms	This paper: (1)	This paper: (2)	McCauley, McGuire, and Sushko (2015)	Other studies
Brazil	165	12.9 (19.8)	17.7 (23.9)	18	11.8,[a] 18.7[d]
China	2,138	2.7 (12.3)	4.6 (17.3)	5	7.0[d]
India	898	4 (13.1)	10.4 (21)	10	13.5[d]
Indonesia	136	35.7 (38.1)	38.4 (39)	52	33.8[d]
Korea	508	5.5 (14.8)	11.8 (21.6)	8	13.1[d]
Malaysia	337	5.4 (18.4)	15.5 (29.6)	10	14.4[d]
Mexico	63	39.2 (35.1)	45.4 (35.2)	66	34.6,[b] 42,[c] 32.5[d]
Russia	47	23.7 (37.6)	25.3 (37.7)	29	34.3[d]
South Africa	81	10.4 (23.2)	14.8 (26.1)	14	17.0[d]
Turkey	122	23.7 (29.9)	27.9 (32.1)	33	42.6[d]
All sample EMEs	6,126	6.8 (19.3)	10.7 (24)	10	

[a, b] Share of foreign currency-denominated debt for year 2000 from the firm-level data in Galindo, Panizza, and Schiantarelli (2003).
[c] Share of US dollar-denominated debt for year 2000 from the firm-level data in Martinez and Werner (2002).
[d] Share of foreign currency-denominated debt for non-government sectors in year 2014 from the banking and debt securities BIS statistics, presented in Chui, Kuruc, and Turner (2016).
Note: The figures in the parentheses denote standard deviations.

Appendix I. Data

Comparison with BIS Statistics

This section compares the dollar debt ratio estimates obtained from the Capital IQ database with those from the BIS banking and securities statistics estimated by McCauley, McGuire, and Sushko (2015). Note that a few differences exist between the two sets of estimates, attributed to a lack of granularity in the BIS statistics. For example, while the estimates from the BIS statistics include US dollar bank loans extended to local governments, non-bank financial firms, and households, these are excluded in the estimates of the present paper.

Despite these differences in scope, Table I.1 shows that the estimates from both sources are comparable. Two different estimates of the dollar debt ratio are calculated from the Capital IQ database: one using only liabilities explicitly reported as denominated in US dollars, shown in column (1), and the other including debt denominated in unspecified foreign currencies (reported as "foreign currency" or "multiple currency" in company financial statements), shown in column (2). The analysis in the paper is based on the second dollar debt measure.

Table I.1 shows that in the EMEs with the largest number of firms, which include China, India, Korea, and Malaysia, the estimates obtained from Capital IQ are similar to those obtained from the BIS statistics. The difference is relatively larger in Indonesia and Mexico, which could partly reflect the small sample size. Nonetheless, the average dollar debt ratio for the all 21 sample economies (10.7 percent) is remarkably similar to the 10 percent estimate in McCauley, McGuire, and Sushko (2015).

Data Cleaning Procedure

The data downloaded from Capital IQ are cleaned following the usual procedures in the literature, including the following steps:

- Drop all firm-year observations in which the difference between the sum of total liabilities and the equity and total assets is greater than US$ 10,000.
- Drop all firm-year observations in which the amount of cash and cash equivalents and that of tangible assets are greater than the total assets, respectively.
- Drop any firm with a negative value for total assets in any year.
- Drop all firm-year observations in which the difference between the sum of due amounts for individual debt instruments (downloaded from the Debt Capital Structure database) and the total principal due outstanding (downloaded from the main financial statements database) is greater than US$100,000.
- Drop all firm-year observations in which the outstanding debt denominated in individual currencies exceeds the total debt (for example, if the sum of euro-denominated debt amounts exceeds the total debt amount of an Eastern European firm).

Finally, all firms that do not carry any outstanding debt are excluded from the sample. Restricting the sample to firms with debt allows this paper to focus solely on firms' choice of funding currencies.

Select Variable Definitions

The following list provides additional information on variable definitions and sources.

- *Cash*. Cash and cash equivalent assets, divided by total assets. The numerator includes: cash, readily convertible deposits, and securities, as well as other instruments with original maturities of less than three months. Source: Capital IQ.

- *Tangibility*. Property, plant, and equipment, net of accumulated depreciation, divided by total assets. Source: Capital IQ.

- *Interest differential*. The difference between local currency short-term interest rates and the three-month US dollar LIBOR as of December of each year. The short-term interest rate for each country is presented in Table I.2. If available, 90-day interbank rates are used first over money market rates, followed by T-bill rates and short-term deposit or saving rates. Sources: IMF, International Financial Statistics; Haver Analytics; and national sources.

- *Financial depth*. The data come from the Global Financial Development Database, series GFDD.DI.12: "Private credit by deposit money banks and other financial institutions to GDP (%)," converted to decimal form by dividing the original series by 100. Sources: IMF, International Financial Statistics, and the World Bank.

- *Industry dummy variables*. The industry classification follows Capital IQ's proprietary classification system. The industry dummy variable is defined at the "industry-sector" level, which includes 28 individual industries in the sample.

  The tradable sector comprises the following industries: food, beverage, and tobacco; capital goods; technology hardware and equipment; materials; semiconductors and semiconductor equipment; household and personal products; pharmaceuticals, biotechnology and life sciences; healthcare equipment and services; automobiles and components; consumer durables and apparel; energy; industrials; consumer discretionary; consumer staples; and information technology.

  The nontradable sector comprises the following industries: utilities; media and entertainment; real estate; consumer services; software and services; transportation; commercial and professional services; retail; telecommunication services; food and staples retailing; communication services; and healthcare.

Table I.2. Short-Term Interest Rates

Economy	Interest Rate	Series Code (Source)
Argentina	Saving deposit rate, 30-59 days	N213RS30 (Haver)
Brazil	Money market rate	223FIMM_PA.M (IMF, IFS)
Chile	Money market rate	228FIMM_PA.M (IMF, IFS)
China	90-day interbank rate,	N924RI3 (Haver)
Colombia	Money market rate	233FIMM_PA.M (IMF, IFS)
Czech Republic	Money market rate	935FIMM_PA.M (IMF, IFS)
Hungary	T-bill rate	944FITB_PA.M (IMF, IFS)
India	91-day T-bill rate	N534RG3M (Haver)
Indonesia	3m interbank rate	R536I3M (Haver)
Korea	Money market rate	542FIMM_PA.M (IMF, IFS)
Malaysia	Money market rate	548FIMM_PA.M (IMF, IFS)
Mexico	Money market rate	273FIMM_PA.M (IMF, IFS)
Peru	interbank interest rate	C293RI (Haver)
Philippines	Money market rate	566FIMM_PA.M (IMF, IFS)
Poland	Money market rate	964FIMM_PA.M (IMF, IFS)
Romania	Money market rate	968FIMM_PA.M (IMF, IFS)
Russia	3m interbank credit rates	N922RC3M (Haver)
South Africa	Money market rate	199FIMM_PA.M (IMF, IFS)
Taiwan POC	3m deposit rate	N528R3M (Haver)
Thailand	Money market rate	578FIMM_PA.M (IMF, IFS)
Turkey	Deposit rate	N186RD3M (Haver)

Appendix II. Mathematical Proof

From differentiating equation (5) with respect to σ_s^2 and dropping the subscript i for simplicity, we have

$$\frac{\partial(1-\alpha^*)}{\partial\sigma_s^2} = -\frac{\left(R^l - R^d\right)(R^d)^2}{V^2} + \frac{\sigma_\pi R^l\left(1-\theta-R^d\right)\left[2\sigma_s\sigma_\pi R^l R^d + \rho\sigma_s^2(R^d)^2 + \rho\sigma_\pi^2(R^l)^2\right]}{V^2},$$

where $\rho = \sigma_{s\pi}/\sigma_s\sigma_\pi$.

By multiplying σ_s/σ_π and σ_π/σ_s to the numerators of the second and third term in equation (5), respectively, we have $\sigma_s\sigma_\pi R^l + \rho\sigma_s^2 R^d > 0$ and $\sigma_s\sigma_\pi R^d + \rho\sigma_\pi^2 R^l > 0$. Since by assumption $1-\theta-R^d < 0$ and $R^l - R^d > 0$, we obtain $\partial(1-\alpha^*)/\partial\sigma_s^2 < 0$. Similarly for inflation volatility, we obtain $\partial(1-\alpha^*)/\partial\sigma_\pi^2 > 0$ under the assumption that the uncovered interest parity holds $(R^l = R^d)$.

Appendix III. Additional Summary Statistics

This appendix presents additional summary statistics on the sample firms' outstanding dollar debt.

Table III.1 shows the characteristics of listed firms grouped by different ranges of the dollar debt ratio. A few facts are notable. First, the majority of the sample firms do not carry any dollar debt. This is despite the fact that as a result of filtering, these firms reported holding some dollar debt at least once during the period of 2002–2017. Second, firms that carry dollar debt are larger, more leveraged, and more profitable than those that do not carry any dollar debt. Finally, these differences do not carry over to the group of firms already holding dollar debt, regardless of the amount.

Table III.2 presents the unweighted average value of macroeconomic variables during the period of 2009–2017 for each economy (panel A) and year (panel B). As expected, the dollar debt ratio in panel A exhibits significant heterogeneity across the sample economies. The average values of interest rate differentials are also sufficiently large and away from zero, in line with the assumption underlying the model in Section III. Meanwhile, panel B shows a gradual fall in the dollar debt ratio, from 11.4 percent of total debt in 2011 to 9.8 percent in 2017, in line with the decline in the average interest differential. The drop in the number of sample firms in 2017 largely reflects delays in the submission of financial reports rather than an increase in bankruptcies or mergers and acquisitions.

Table III.1. Firm Characteristics By Dollar Debt Ratio

This table shows the firm-level summary statistics grouped by different ranges of the dollar debt ratio as of end-2017. Each column presents the median value of variables for firms with the dollar debt ratio lying within the interval shown in the column heading. All figures are in decimal form except for total assets and market Value, which are in millions of US dollars converted from the local currency by using the historical exchange rate at the end of 2017.

Dollar debt ratio	0	(0, 0.25]	(0.25, 0.5]	(0.5, 0.75]	(0.75, 1]
Total assets (USD, millions)	247	533	483	411	402
Market value (USD, millions)	234	317	374	240	338
Cash	0.090	0.066	0.069	0.064	0.066
Tangibility	0.232	0.283	0.310	0.335	0.339
Leverage	0.199	0.305	0.262	0.279	0.232
Investment/Assets	0.026	0.029	0.036	0.039	0.029
Return on assets	0.027	0.031	0.035	0.036	0.039
Observations	4,022	723	246	204	275

Table III.2. Sample Mean by Economy and Year

This table presents the average value of macroeconomic variables and the dollar debt ratio during the period of 2009–2017 for each economy and year. The variables are defined as follows: Exchange rate volatility is the annualized standard deviation of the monthly real exchange rate changes (y/y) against the US dollar over 12 months; interest differential is the difference between short-term local interest rates and the US dollar three-month LIBOR; and financial depth is the private credit-to-GDP ratio.

	Total number of firms	Dollar debt ratio	Interest differential	Exchange rate volatility	Financial depth
Panel A. By economy					
Argentina	69	0.362	0.165	0.162	0.127
Brazil	220	0.172	0.100	0.365	0.638
Chile	141	0.346	0.029	0.199	1.013
China	3,279	0.049	0.040	0.069	1.311
Colombia	32	0.194	0.041	0.263	0.452
Czech Republic	6	0.051	0.002	0.226	0.487
Hungary	17	0.049	0.023	0.243	0.466
India	1,383	0.102	0.066	0.173	0.480
Indonesia	202	0.399	0.062	0.179	0.318
Korea	803	0.132	0.015	0.219	1.172
Malaysia	510	0.136	0.023	0.152	1.115
Mexico	86	0.396	0.042	0.195	0.271
Peru	75	0.472	0.030	0.095	0.337
Philippines	89	0.153	0.026	0.111	0.355
Poland	273	0.049	0.020	0.246	0.501
Romania	76	0.212	0.025	0.196	0.393
Russia	70	0.246	0.091	0.265	0.500
South Africa	137	0.136	0.053	0.316	1.427
Taiwan POC	1,262	0.057	0.003	0.090	1.592
Thailand	422	0.058	0.013	0.135	1.328
Turkey	165	0.284	0.097	0.218	0.538
Total	9,317	0.107	0.038	0.138	1.061
Panel B. By year					
2009	4,539	0.112	0.024	0.286	0.916
2010	4,546	0.112	0.039	0.150	0.920
2011	4,876	0.114	0.045	0.155	0.956
2012	5,360	0.111	0.043	0.128	0.994
2013	5,910	0.110	0.049	0.090	1.048
2014	6,126	0.107	0.046	0.116	1.103
2015	6,510	0.102	0.035	0.113	1.148
2016	6,341	0.102	0.030	0.124	1.185
2017	5,470	0.098	0.029	0.128	1.180

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