Exchange Rate Exposure and Firm Dynamics

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October 2019

This paper develops a heterogeneous firm-dynamics model with endogenous currency debt composition to jointly study financing and investment decisions in developing economies. In our model, firms' foreign currency borrowing arises from a trade-off between exposure to currency risk and growth. We assess econometrically the pattern of foreign currency borrowing using firm-level census data on Hungary, calibrate the model and quantify its aggregate impact. Our counterfactual exercises show that foreign currency borrowing can lead to higher growth and that the efficiency of the banking sector to screen productive and capital-scarce firms is essential to reap up the benefits of this financing.

JEL-Codes: F31, F34, F36, F46.
Keywords: firm dynamics, foreign currency debt, currency mismatch, uncovered interest rate parity.

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1 Introduction

Capital flows play a critical role for economic growth. The textbook neoclassical growth model predicts that capital inflows into developing economies lead to higher capital accumulation and income per capita. Yet the international economic literature has associated these flows with deeper boom-and-bust cycles, and financial crises. One of the sources of these financial crises has been foreign currency borrowing by the corporate sector, as many firms employing this financing do not export or use financial instruments to shield their balance sheets from exchange rate shocks. In this paper, we assess the micro and macro channels leading firms in developing economies to borrow in foreign currency.

This paper makes three contributions. First, we develop a heterogeneous firm-dynamics model to microfund the emergence and heterogeneity in firms' foreign currency borrowing decisions, and show that this financing arises from a trade-off between firms' exposure to the currency risk and growth. Second, we exploit the deregulation of foreign currency loans in Hungary –that revoked a legal restriction banning firms from using foreign loans– to econometrically test the model's predicted pattern of foreign borrowing across firms. Finally, we employ our dynamic model as a laboratory to quantify the aggregate impact of this financing in normal and crisis times, and to show how different countries' characteristics and exchange rate policies affect the allocation of foreign loans across firms and, through it, the aggregate consequences of this financing. Our framework assesses then the implications of foreign currency loans by building up from firm-level decisions to country aggregates and cross-country analysis.

In our dynamic model, firms jointly choose the currency composition of their debt and their investment. Firms might borrow in foreign currency to take advantage from uncovered interest rate parity (UIP) deviations to increase investment. Yet this financing exposes firms to balance sheet effects that can lead to default. Critically, we demonstrate that this trade-off endogenously generates heterogeneity in foreign borrowing decisions across firms. At the extensive margin, only highly productive firms can tolerate the exchange rate risk and borrow in foreign currency. At the intensive margin, productive and capital-scarce firms –with high return to investment– employ this financing relatively more.

We test econometrically the model's firm-level implications by employing census data on firms' balance sheets and credit by currency denomination around the deregulation of foreign currency loans in Hungary in 2001. This policy reform serves as an exogenous source of time variation to identify the characteristics of firms using these loans. We validate the model by simulating firm-level panel data and estimating –in parallel– reduced-form regressions using the simulated and the Hungarian data. This exercise allow us to test both the *qualitatively* and *quantitatively* model's firm-level responses and to provide first evidence of the micro-mechanisms underpinning firms' foreign currency borrowing decisions.

Next, we use our dynamic model to quantify the aggregate impact of foreign currency borrowing in a set of counterfactual exercises. In our first set of exercises, we show that, when foreign currency loans are allocated towards productive and capital-scarce firms, they lead to higher aggregate capital accumulation and to lower default. Otherwise, when the local banking sector is not sufficiently developed to screen firms, foreign currency borrowing reduces capital accumulation, increases firms' default and leads to capital misallocation. In our second set exercises, we assess how different exchange rate policies shape the allocation of foreign borrowing across firms and, by this means, its aggregate consequences. We show that exchange rate market interventions can create systemic risk, as they increase the extensive and intensive margins of foreign borrowing. That is, not only they allow less productive and, thus, riskier firms to use these loans, but they also encourage them to tilt their liabilities towards foreign loans. In our last set of exercises, we show that, contrary to the common belief that currency depreciations necessarily lead to higher default, this effect is non-monotonic. Higher capital accumulation during *good times* might allow firms to survive better low and medium currency shocks. The impact of depreciations depends, ultimately, on the extend of the bonanzas prior to shock and the size of the depreciation.

Our paper makes three contributions to the literature on currency crises. First, this literature uses macro models with representative agents to account for emergence of currency mismatch, but it has so far paid little attention to the micro-level trade-offs driving firms' decisions. Our paper fills in this gap by building a firm-dynamic model that microfunds firms' debt portfolio choices and accounts for the heterogeneity in these decisions. Second, there is an empirical literature evaluating the consequences of large depreciations on firms' balance sheets using country cases. Our paper complements these studies by using –for the first time– firm-level census data to investigate the characteristics of firms using this financing and to document the extensive and intensive margin of foreign borrowing. Finally, this is the first paper that uses a quantitative framework to quantify the impact of foreign currency loans and to analyze how different countries' characteristics and policies affect the distribution of foreign loans across firms and, through it, the aggregate consequences of this financing.

We start by building a firm-dynamics model with endogenous debt composition in which firms jointly make financing and investment decisions. Firms are heterogeneous in capital stock, level of foreign and local currency debts, and face idiosyncratic productivity shocks and global shocks. Firms operate domestically and can finance their investment using debt, which can be denominated in local or foreign currency. Debt is non-contingent, so firms can default. A firm's idiosyncratic risk of default endogenously determines its cost of funds. The exchange rate is endogenously determined using an affine model of exchange rate determination in which the ratio of the local and foreign investors' pricing kernels defines the exchange rate change. The model endogeneously generate UIP deviations that arise from the difference in the pricing of the global risk between the local and foreign investors (as in Lustig, Roussanov, and Verdelhan 2011, Hassan 2013, and Farhi, Fraiberger, Gabaix, Ranciere, and Verdelhan 2015). Firms' currency-debt composition is driven by a trade-off between aggregate UIP deviations and firms' default probability. While UIP deviations can make the foreign rate relatively lower, foreign loans expose firms to the currency risk, affecting their default probability and, thus, costs of funds. A firm borrows in foreign currency to the extent in which the increase in its default probability (and thus its financing costs) does not exceed the lower relative cost from the UIP deviation.

The model offers two firm-level implications about the pattern of foreign currency borrowing and investment. First, at the extensive margin, there is *selection* into foreign currency borrowing, as –for a given level of capital– only high productivity firms find it optimal to be exposed to the currency risk and borrow in foreign currency. Given the persistence of the productivity shock, more productive firms today are less sensitive to default in the next period for any given level of capital, local and foreign currency debts. This lower default sensitivity allows them to tolerate the currency risk without significantly increasing their financing costs and to borrow in foreign currency. Second, at the intensive margin, high productivity firms with low capital (high marginal product of capital -MPK) use foreign loans more intensively following UIP deviations. High MPK firms have higher returns and exploit the lower foreign rate to increase their investment and reach faster their optimal scale.

To test the model's cross-sectional predictions, we combine two datasets: APEH, which provides information on firms' balance sheets reported to tax authorities for the population of firms, and Credit Register, which reports information on all loans by currency denomination with financial institutions in Hungary. The coverage of our database is unique as it reports information for all firms in all economic activities (from agriculture to services) over more than a decade (1996-2010) and allows building comprehensive measures of leverage by currency denomination and controlling for firms' exports and imports. It constitutes an advance over previous studies that, focusing on small samples of exporters and publicly listed firms and lacking information on leverage, can not account for the extensive and intensive foreign borrowing and the emergence of this financing among non-tradable domestic firms, which are the majority of firms using these loans in Emerging markets.

We start by documenting that foreign currency borrowing expanded rapidly in Hungary after their deregulation in 2001. By 2005, the share of foreign loans on total banking loans exceeded 45% and one-third of the firms borrowing in Hungary held foreign currency loans. These firms were typically domestically owned (90%) and accounted for 40% of aggregate value added and 34% of employment. Interestingly, these firms were highly exposed to exchange rate movements, as three quarters of them were non-exporters (73% of firms) and did not use financial instruments to hedge the currency risk.

We validate the model's cross-sectional predictions of foreign borrowing in three different ways. First, we calibrate the model to the period following the deregulation of foreign loans in Hungary and show that it successfully matches several non-targeted moments of the distribution of foreign borrowing.

Second, we test the model's predicted pattern of foreign borrowing across firms econometrically. To evaluate the first implication –namely, whether firms employing foreign loans are more productive and invest more–, we exploit the deregulation of foreign currency loans as an exogenous source of time variation. In line with this first implication, we find that a one percent increase in a firm's pre-reform productivity raises the probability of borrowing in foreign currency by 1.2 percentage points. Similarly, the share of foreign currency loans increases in firms' initial productivity. Our results also point that firms using this financing associate with 7% higher investment. We show that firms using foreign loans pay lower interest rates, as the model implies. To test the second implication of the model, we exploit UIP deviations across time to check how firms respond to changes in the interest rate differential. We find that UIP deviations associate with higher foreign currency borrowing and investment, particularly for high MPK firms. The estimated coefficients are economically significant and imply that a 10% increase in the UIP deviation, as seen in Hungary between 2005 and 2006, led to more than a thousand firms to borrow in foreign currency and a 30 percent increase in their foreign currency share. These results provide support to the mechanism proposed in this paper, namely high MPK firms using in foreign currency loans to lower their financing costs and increase their investment.

Third, to test whether the model captures quantitatively well firm-level responses, we employ it to simulate firm-level panel data –that follows the transition period of Hungary after the deregulation of foreign loans– and use these data to estimate the same reduced-form regressions than we did in the empirics. The model's responses mimic identically the coefficients estimated with the Hungarian data, demonstrating that the model matches well not only firms' *qualitative* responses, but also *quantitatively*.

Our dynamic model and empirical results argue for a theory of foreign currency borrowing where only high productivity firms with high MPK employ this financing. This theory indicates that firms borrowing in foreign currency are not gambling for resurrection, instead they are using foreign loans to the level of risk that they can tolerate. In the Appendix, we develop a two-period model to illustrate the risk profile of firms, and employ our simulated data to show that –even though the model allows for this force to be present– gambling for survival is not driving firms' foreign currency debt choices.

Having validated the model, we next use it as a laboratory to quantify the aggregate implications of foreign currency borrowing and to assess whether the distribution of foreign loans across firms affects its aggregate consequences. We conduct four set of exercises.

In our first set exercises, we start by quantifying the impact of foreign currency borrowing and compare two economies with and without this financing. We show that economies allowing for foreign currency loans have 8% higher capital growth and lower MPK dispersion, as lower financing costs promotes investment. Interesting, whilst foreign borrowing exposes firms to balance sheet effects, they default less. The reason is that higher capital accumulation allows firms to grow and become more resilient to idiosyncratic and aggregate shocks. Next, we conduct an additional exercise to assess how the allocation of foreign loans across firms could affect these results. We show that, when foreign loans are allocated irrespectively of firms' capital and productivity, firms' investment rate lowers and default surges. On the aggregate, the economy has 18% lower capital accumulation and three-times more MPK dispersion. This exercise sheds light on the current debate about the sequence of reforms in developing economies, by indicating that countries should have an outstanding banking sector able to screen firms before engaging in the deregulation of foreign currency loans.

In our second set of exercises, we study the impact of currency depreciations on firms' borrowing in foreign currency in two steps. First, we exploit the 10% exogenous depreciation of Hungarian Forint during the Financial crisis in 2008/09 to evaluate its impact on firms' balance sheets. We use the simulated and the Hungarian data to show econometrically that firms borrowing in foreign currency experience negative balance sheet effects –as they lower their investment, leverage and switch to local currency loans– but they do not exit more. Yet this low exit depends on the size of the depreciation. In a second exercise, we include the possibility of a rare, but extreme depreciation of 100% and show that, in this case, firms borrowing in foreign currency exit relatively more. This results show that, in contrast with the common belief that depreciations lead necessarily to higher exit, this relationship is non-monotonic. For small and moderate depreciations, firms indebted in foreign currency might be able to survive currency shocks better, as higher capital accumulation during good times makes them more resilient to shocks. For sufficiently large depreciations, the increase in debt repayment can be high enough that firms cannot fulfil their commitments and exit market. This non-monotonic relationship provides additional support for the mechanism proposed in this paper by showing that, in a dynamic setting with capital accumulation, firms might choose to borrow in foreign currency in order to accumulate more capital and, in turn, become more resilient to shocks.

In our third set of exercises, we explore the role of exchange rate market interventions on the allocation of foreign loans across firms and its aggregate consequences with three exercises. In our first exercise, we study the role of fixed pegs and show that the absence of currency risk lead least productive firms to start using foreign currency loans and only use this financing. The dramatic expansion of the extensive and intensive margin of foreign borrowing creates systemic risk and a lock-in effect precluding any possible change in the exchange rate.[1] In the second exercise, we assess the impact of manage floats that limit large depreciations and appreciations (more than 10% change). Since firms do not benefit from large revaluation effects that could reduce future debt repayment, firms have less incentives to use foreign loans. This reduces the intensive margin of foreign borrowing. Yet lower exchange rate volatility reduces the currency risk and lowers the productivity threshold to borrow in foreign currency, increasing the extensive margin. Hence, while managed floats lower the intensive margin of foreign borrowing, they can still rise balance sheet effects as they allow riskier firms to use this financing. In our last exercise, we show that implicit bailout guarantees taking the form of limits to depreciations can create systemic risk, as they encourage firms to switch the currency composition of their debt towards foreign loans and substantially lower the productivity threshold to use this financing. These exercises illustrate that exchange rate market interventions have non-trivial effects on the allocation of foreign loans along the intensive and extensive margins and, thus, on the aggregate implications of foreign currency borrowing.

In our last set of exercises, we study whether a country's stage of economic development can affect foreign currency borrowing patterns. With this end, we compare two economies that only differ in the initial size distribution of firms (capital stock). We show that, in the capital-scarce economy, firms are more prone to borrow in foreign currency and hold higher foreign currency shares, as lower financing term allows them to accumulate increase investment. However, since firms are small, they are less resilient to shocks and default more. On the aggregate, capital-scarce economies have high capital growth, but at the expense of higher default and balance sheets effects.

The empirical identification of the use of foreign loans in Hungary is based on the initial characteristics of firms employing these loans. To test that the observed effects correspond to firms' initial productivity and capital and not something else, we contact a full set of robustness tests. First, in our baseline specification, we exclude exporters and foreign-owned firms, as they might use foreign loans for trade purposes and show that results hold true when including them into the analysis.[2] Secondly, we show that results are not driven by sector-specific trends or demand shocks, as they are robust to including year, sector and sector-year fixed effects. Third, results are robust to controlling for valuation effects, as they hold true when using initial and past years exchange rate to construct the foreign currency share and when testing the extensive margin of foreign loans. Fourth, results hold true when measuring the UIP deviation with the realized exchange rate and to controlling for the country risk premium. Finally, note that the general context around the deregulation of foreign currency loans and its timing minimizes reverse causality concerns, as it was part of a general program of fourteen transition economies to join the European Union (EU). Importantly, by 2001, the Hungarian economy was already deeply integrated with the EU, trade and foreign direct investment flows remained constant in the years of the reform, and there were no other reforms that could affect firms' currency borrowing decisions.

[1]The currency board of Argentina during the 1990s could be an example of this result. In 1991, the new government implemented a fixed conversion between the local currency and the U.S. dollar that lasted until December 2001. The absence of currency risk and a persistent interest rate differential between the local and foreign rates led an extended use of U.S. dollar denominated loans. The years prior to the collapse of the currency board were marked by the fear that the currency could not be led to depreciate without seeing massive bankrupts in the corporate sector.

[2]Note, however, this does not significantly affect the sample size, as the bulk of firms using foreign loans are non-exporters and domestically owned.

Related Literature. This paper is related to a long literature studying currency crises and contributes to it theoretically, empirically and quantitatively. The theoretical literature has built macro models with representative agents to account for the emergence of currency mismatch (see Jeanne 2003; Caballero and Krishnamurthy 2003; Schneider and Tornell 2004; Rappoport 2008; Ranciere, Tornell, and Vamvakidis 2010; Kalantzis 2015; among others). However, it has so far paid little attention to the micro-level trade-offs driving firms' decisions and the cross-sectional heterogeneity in these choices. Our paper contributes to this literature by building a heterogeneous firm-dynamics model to dissect the trade-offs in firms' debt portfolios problem and by characterizing the distribution of foreign loans across firms and its aggregate consequences.

There is also an empirical literature that documents the consequences of large depreciations on firms' balance sheets using country cases. Among others, Aguiar (2005) reports that Mexican firms indebted in foreign currency reduced investment rates during the Tequila crisis in 1994-95 and Kim, Tesar, and Zhang (2015) show that Korean firms using these loans were more likely to exit during the Asian crisis in 1997-98.[3] Our paper takes a different perspective and studies the characteristics of firms borrowing in foreign currency. In doing this, our paper is closest to Ranciere, Tornell, and Vamvakidis (2010) who, using the survey data on Eastern European firms, document that firms using foreign loans are typically non-tradable firms and pay lower interest rates, which we also find in our data. Our paper contributes to these empirical studies in three aspects. First, our firm-level census data on credit and balance sheet is arguably richer and allows us to document additional relevant characteristics of firms sorting into the foreign-denominated loan market. In particular, we are able to document –for the first time– the extensive and intensive margin of foreign borrowing and the important role of firm productivity. Second, our firm-level data also allow us to analyze the balance sheets of these firms, which - in turn - informs about the mechanism leading firms to use these loans. In particular, while models based on systemic bailout guarantees imply that firm do not internalize the default cost and over-borrow, our data suggests otherwise. Firms that borrow in foreign currency have average levels of leverage - relative to the population of borrowing firms - and, in particular, they have similar leverage ratios to firms using only local loans. This finding is consistent with our model's mechanism under which there is no excessive leverage because the currency risk is priced correctly, and firms and creditors fully understand the default cost. Third, this is the first paper that uses an arguably exogenous policy reform to identify the pre-reform characteristics of firms using foreign loans. In absence of such reform, the empirical analysis raises endogeneity concerns as firms could be using foreign loans to increase productivity and, thus, questioning the direction of causality.

Our paper also contributes to the currency crises literature by quantifying –for the first time– the impact of foreign currency loans and using counterfactual exercises to assess how different countries' characteristics and policies affect the distribution of foreign loans across firms and, through it, the aggregate consequences of this financing.

This paper is also related to the literature that documenting systematic and persistent UIP deviations

[3]Kalemli-Ozcan (2015) and Alfaro, Asis, Chari, and Panizza (2017) document large increases in foreign currency borrowing in emerging markets after the Great Recession and a rise in their financial fragility (see also Figure B.1). Baskaya, di Giovanni, Kalemi-Ozcan, and Ulu (2017) document that exogenous capital inflows to emerging markets affect the credit supply of domestic banks and that Turkish firms can borrow at lower rates in foreign currency. Our paper also relates to Ahnert, Forbes, Friedrich, and Reinhardt (2018) who study the role of FX regulations on banks and firms.

across countries, particularly in Emerging markets (see for example Hassan 2013; Lustig and Verdelhan 2007; Lustig, Roussanov, and Verdelhan 2011; and Kalemli-Ozcan and Varela 2019). We show that the presence of these deviations has non-trivial implications, as they can induce firms to opt for foreign currency loans and become a source of systemic risk.[4]

The remainder of this paper is organized as follows. Section 2 describes the Hungarian data. Section 3 presents the model. Section 4 describes the calibration. Section 5 tests the model's firm-level implications using the simulated data and the Hungarian data. Section 6 conducts numerical exercises to study the aggregate impact of foreign currency borrowing. Section 7 concludes.

2 Data and Main Descriptive Statistics

We analyze firms' financing and investment decisions using firm-level data on the entire population of Hungarian firms. We combine two different datasets: APEH, which contains information on firms' balance sheets reported to the National Tax and Customs Authority, and the Credit Register data, which reports information on all corporate loans with financial institutions in Hungary. These datasets are provided by the National Bank of Hungary (NBH).

The APEH database covers the population of firms in all economic activities that are subject to capital taxation between 1992-2010. This database offers information on sales, value added, investment, assets, exports, employment and materials. Firm size varies significantly in the database, spanning from single-employee firms to large corporations. Since micro-enterprises are typically subject to measurement error problems, we retain firms that have at least three employees. We restrict our analysis to non-financial corporations on the agricultural, mining, manufacturing and service sectors.[5] Our analysis covers more than 86% of firms, and captures more than 89% of the value added and 92% of the employment of these sectors. To obtain real values, we use price indexes at four-digit NACE activities for materials, investment, value added and production. The information on firms' debt comes from the Credit Register database, which reports information on all corporate credit in the Hungarian banking system by currency denomination between 2005 and 2010. We use these two databases to obtain measures of leverage (debt over assets), foreign currency borrowing share (foreign currency debt over total debt) and revenue total factor productivity (RTFP).[6]

In Hungary, foreign currency borrowing expanded rapidly after the deregulation of international financial flows in 2001, which liberalized foreign currency denominated loans for domestically-owned

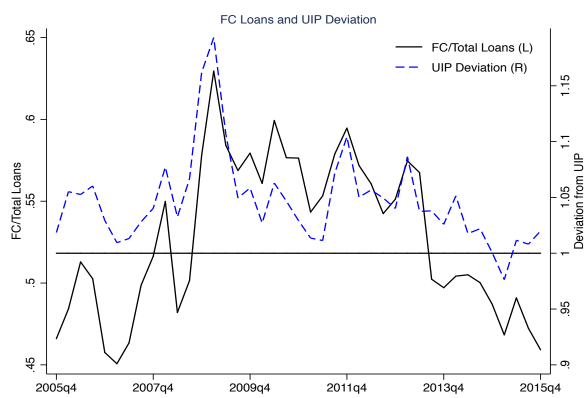
[4]In this paper, we focus on deviations from the UIP and abstract from covered interest rate parity (CIP) deviations arising after the Great Recession (Du, Tepper, and Verdelhan 2017) for three main reasons. First, as shown by Rime, Schrimpf, and Syrstad (2017), only large global banks can afford the high transaction costs of forward contracts and take advantage of this arbitrage. Second, future contracts play only a marginal role in developing economies. In Hungary, only 4% of firms borrowing in foreign currency employ financial hedges (Bodnar 2006). Finally, note that UIP deviations are the relevant object to study the risk taking behavior of firms, as CIP deviations do not affect risk.

[5]We exclude firms in financial and real estate activities, public administration, education and health, as these activities are subject to especial regulations. Appendix B and Table B.26 describe the sectors under analysis in detail.

[6]The RTFP measure is computed using the methodology of Petrin and Levinsohn (2011) with the correction of Wooldridge (2009) to estimate the parameters of the production function. We additionally conduct robustness tests using the methodology of Olley and Pakes (1996) and labor productivity (value added over labor). Unfortunately, given the lack of information on firms' prices, we are only able to measure RTFP. See Foster, Haltiwanger, and Syverson (2008) for a discussion of the distinction between physical and revenue TFP.

firms.[7] Foreign loans were channelled through the domestic banking system, which was mainly dominated by foreign-owned banks (Kiraly, Vargheli, and Banai 2009). Banks were not directly exposed to the currency risk, as their open positions in foreign currency were limited by banks' regulations (Ranciere, Tornell, and Vamvakidis 2010). By 2005, one-third of firms employing bank credit held foreign-currency loans. Firms borrowing in foreign currency were spread out across all economic activities, from agriculture and manufacturing to wholesale and entertainment activities, as shown in Table B.26 (Appendix B). Foreign currency borrowing firms made up for a non-negligible share of aggregate outcomes, accounting for 40% of value added and 34% of employment in the economy (Table B.27 in Appendix B). Importantly, the use of foreign currency loans was highly correlated with UIP deviations, as shown by Figure 1. The UIP deviation is computed with respect to the Euro at one-year horizon for the period 2005Q4 to 2015Q4 as $\text{Dev}_t \equiv \frac{s_t}{E(s_{t+1})} \frac{(1+r_t)}{(1+r_t^*)}$, and is adjusted by sovereign default risk using credit default swaps. As shown in Appendix B.1, this correlation is robust to considering different time horizons (3 and 24 months) and currencies (Swiss Franc and U.S. dollars), without adjusting for sovereign default risk and controlling for valuation effects in the share of foreign loans (i.e. computing it using the exchange rate of the last quarter 2005 and keeping it fixed for the entire period).[8]

Figure 1: Hungary: UIP Deviations and Foreign Currency Borrowing



Notes: Left axis: share of foreign currency loans on total loans in the corporate sector. Right axis: UIP deviations (1 year) with respect to the Euro adjusting the country's sovereign risk. Source: CHF Lending Monitor, Consensus Forecast and NBH.

Table 1 shows that firms borrowing in foreign currency used this financing intensively. In 2005, their share of foreign currency loans on total loans was 64%. Remarkably, most of these firms were non-exporters (73% of firms) and, hence, were not naturally hedged. Furthermore, two-third of these firms were neither exporters or importers and were domestically-owned firms (90% of firms) (Table B.28 in Appendix B). Notably, these firms did not employ derivative contracts to hedge the currency risk, as reported by Bodnar (2006).[9] This absence of natural and financial hedging shows that firms borrowing in foreign currency were substantially exposed to exchange rate movements.

[7]We describe the deregulation in Section 5.1.1 and Appendix C. See also Varela (2018) for a detailed description.

[8]We construct this measure with respect to the Euro as three-quarters of foreign currency loans were in this currency.

[9]In 2005, Bodnar (2006) conducts a survey on firms' hedging behavior in Hungary. She finds that only 4% of firms indebted in foreign currency employed foreign currency derivatives. This finding is not uncommon in developing economies. For example, data from the Central Bank of Peru reveals that only 6% of firms borrowing in foreign currency employ financial instruments to hedge the exchange rate risk, and a similar pattern is found in Chile and Turkey.

Table 1: Characteristics of Firms Holding Foreign Currency Loans in 2005

	Non FC Debt	FC Debt
	(1)	(2)
Share of FC Debt	0	64
Share of Non-Exporters	91	73
Interest Rate	13.4	12.3
Employment	17	45
Log RTFP	6.5	6.7
Corr(FC Share, Log RTFP)	-	0.02
Corr(FC Share, Log Capital)	-	-0.05
Number of firms	147,166	13,493

Notes: Rows 1-3 are in %. The difference in means and correlation are statistically significant at one percentage point. Source: APEH, Credit Register data BEEPs (World Bank and EBRD).

Foreign currency loans were mainly held by small and medium firms with less than 250 employees, which accounted for two-thirds of these loans (Table B.27 in Appendix B). Firms borrowing in foreign currency were –on average– more productive and paid lower interest rates, as shown in Table 1.Interestingly, their share of foreign currency loan positively relates with their productivity and negatively with their capital stock.[10] These features suggest that capital-scarce and productive firms were taking advantage of lower financing terms of foreign currency loans to invest more and reach faster their optimal scale. In the next sections, we develop an heterogenous firm-dynamic model that formalizes the trade-off between currency risk and growth, and employ the Hungarian data to test it econometrically and assess it quantitatively.

3 Model

Our firm-dynamics model has three main ingredients. First, there are heterogeneous firms that can raise external funds to invest and choose the currency composition of their debt. Second, the exchange rate is determined endogenously by an affine term structure model of interest rates. The stochastic nature of the exchange rate makes foreign currency borrowing risky and firms using these loans susceptible to default. Third, there are endogenous UIP deviations that affect the relative interest rates in local and foreign currency, and can make foreign borrowing relatively more attractive. We employ the model to study firms' optimal currency debt composition and the distribution of foreign currency borrowing in the cross-section of firms.

3.1 Environment

There is a continuum of heterogeneous incumbent firms that produce employing a decreasing returns to scale technology: $F(z, k) = zk^{\alpha}$, where z and k denote a firm's productivity and capital, and

[10] In all these variables, the difference in means is statistically significant at one percentage point.

$\alpha \in (0,1)$. The good is sold domestically at a price p denominated in local currency. Firms are subject to idiosyncratic productivity shocks, which dynamic is as follows

$$\log z' = \rho_z \log z + \sigma_z \epsilon_z. \tag{1}$$

The transitory productivity shock is $\epsilon_z \sim N(0,1)$. Additionally, firms face an aggregate productivity shock –Z– that negatively correlates with the exchange rate, such that a currency depreciation lowers firms' revenues mimicking a decline in aggregate demand. The exchange rate s –in units of local currency per foreign currency– is stochastic and determined by the pricing kernel of the local and foreign investors, which in turn are affected by a global state variable (ω). In each period, firms pay a fixed operational cost c_f and a cost $\psi(k, k')$ to adjust their capital. Capital depreciates at a rate δ.

Firms can finance their investment using retained earnings and/or external loans.[11] These loans take the form of one-period bonds, which can be denominated in local or foreign currency (b and b^*). Local and foreign currency bonds are issued at discounts q and q^*, where $q, q^* < 1$. Firms can then raise funds for $q\,b + q^*\,b^*$ in exchange for a promise to pay back the face value of the debt in the next period. Firms can default on their debt obligations, in which case they exit the market. There is a fixed credit cost c to raise external funds.[12] In each period, there is a constant mass of potential entrants, which together with the endogenous exit make the distribution of firms endogenous. Firms are heterogeneous in four dimensions: productivity, capital, and local and foreign currency debts. Firms' problem are solved in partial equilibrium. Appendix A presents all derivations.

3.2 Firms

In each period, incumbent firms choose whether to repay their outstanding debt and produce or to default and exit the market. The value of the firm is determined by the maximum between the value of repayment (V^R) and the value of default (V^D), where the latter is normalized to zero. In particular,

$$V = \max\left\{V^R, V^D\right\}. \tag{2}$$

If a firm repays, it chooses its capital and local and foreign currency debts to maximize its value:

$$V^R(\omega_{-1}, \omega, z, \upsilon) = \max_{\upsilon'} \; [e + \; E_{z',\omega'}\, \tilde{\beta}\, V\,(\omega, \omega', z', \upsilon')], \tag{3}$$

where $\upsilon = \{k, b, b^*\}$ is the set of endogenous state variables. Firms discount the continuation value using the discount factor $\tilde{\beta}$, which is the product of a time-invariant component factor β and a stochastic

[11] To focus on firms' currency debt decisions, we restrict firms from equity financing. This assumption does not affect the mechanism proposed in this paper and allows us to illustrate firms' optimal currency debt composition without incurring in the analysis of firms' optimal financing instruments. Furthermore, it is consistent with the empirical evidence in Hungary, where the vast majority of firms are not publicly traded.

[12] The credit cost is only included to discipline the calibration and does not affect the model's mechanism or its implications, as shown in Appendix A.

component m (which is the local currency pricing kernel) that varies with the global shock (ω).[13] Firms' equity payout e is given by

$$e = p\,[Zzk^{\alpha} - i(k,k') - \psi(k,k') - c_f] - [b + sb^*] + [qb' + q^* sb'^* - p\, c_{I_{(b'+b'^*>0)}}]. \quad (4)$$

The first term in equation (4) denotes a firm's revenues net of investment (i), capital adjustment cost (ψ) and fixed operational cost (c_f). Let capital adjustment costs be $\psi(k,k') = c_0 \frac{[k'-(1-\delta)k]^2}{k}$. The second term is current period debt repayment. The last term is new debt issuance net of the fixed credit cost. In this small open economy, we let the local price be a function of the foreign price: $p = p^* s^{\eta}$, where η is the exchange rate pass-through into local prices and the foreign price is normalized to one.

The timeline can be summarized as follows. At the beginning of each period, incumbent firms carry capital and debt repayments in local and foreign currency from the previous period. Upon observing the productivity and global shocks, they decide whether to repay the debt and produce or default and exit the market. Repayment occurs whenever total value of the firm -V^R- is positive and current equity (e) is non negative.[14] Active firms receive revenues net of fixed costs, adjustment investment costs and debt repayments, and choose capital and debt for the next period.

Risk-Free Rates and the UIP Condition

Investors can hold risk-free bonds denominated in local or foreign currency. Denoting R and R^* the gross risk-free rate of local and foreign currency bonds, investors' returns should satisfy $1 = E(m'R)$ and $1 = E(m'^* R^*)$, where m' and m'^* are their pricing kernel for local and foreign bonds. As in Bekaert (1996) and Bansal (1997), the ratio of the two pricing kernels determines the exchange rate change:

$$\frac{s'}{s} = \frac{m'^*}{m'}. \quad (5)$$

To define the structure of the stochastic discount factor, we consider a no-arbitrage model of exchange rate and interest rates. The model is an exponentially-affine pricing kernel model, following Backus, Foresi, and Telmer (2001), Lustig, Roussanov, and Verdelhan (2011) and Farhi, Fraiberger, Gabaix, Ranciere, and Verdelhan (2015). Following Farhi, Fraiberger, Gabaix, Ranciere, and Verdelhan (2015), we consider a minimal structure where the domestic and foreign pricing kernels are log normal and determined by a global state variable (ω).

[15]

[13] The time-invariant component of the discount factor –β– is a reduced-form stand-in for the preference of debt financing that comes from a tax benefit and/or from an exogenous default probability. The stochastic component governs the prices of state-contingent claims, such that they are the same for firms and investors.

[14] The non negativity constraint on equity comes from the fact that firms can not finance with external equity.

[15] We model the process as a function of only on one factor to keep the state space manageable. Note that our model has three endogenous state variables (k, b, b'^*), one idiosyncratic exogenous state (z), and each SDF factor adds two states to this problem. Hence, our model with a single factor has already six state variables. Adding an additional state would make the problem unsolvable. Furthermore, this structure keeps the dynamics of the exchange rate and the interest rate differential transparent. More importantly, this single factor follows well the evolution of the exchange rate in Hungary during the period under analysis. As discussed in Section 6.2, this specification mimics the exogenous depreciation of the Hungarian currency and the decrease in the foreign interest rates upon the collapse of Lehman Brother in 2008. Furthermore, it captures the dynamics of small open economies, where foreign interest rate shocks affect capital flows and

In particular,

$$
\begin{aligned}
-\log m' = &\quad \tilde{\delta} + \left(\gamma + \frac{\lambda^2}{2}\right)\omega + \lambda\,\omega^{1/2}\,\varepsilon'_\omega, \\
-\log m'^* = &\quad \left(1 + \frac{\lambda^{*2}}{2}\right)\omega + \lambda^*\,\omega^{1/2}\,\varepsilon'_\omega,
\end{aligned} \tag{6}
$$

where λ and λ^* are the market valuation of risk for the home and foreign bonds, as they determine the covariance between the shocks to m, m^* and ω and, thus, the risk characteristics of bonds. $\tilde{\delta}$ and γ are constants. As in Cox, Ingersoll, and Ross (1985), the state variable follows a squared root process

$$
\omega' = (1-\varphi)\kappa + \varphi\omega + \sigma_\omega\,\omega^{\frac{1}{2}}\,\varepsilon'_\omega, \tag{7}
$$

where ε'_ω is distributed normally and independently with mean zero and variance one. Note that this is a first-order autoregression process, where κ is the unconditional mean and φ controls the mean reversion of the process. Together κ and φ control the dynamic behavior of the state variable. Given equations (6) and (7), the global state variable ω becomes the foreign interest rate and the domestic interest rate is a function of this latter. We can define the UIP condition as

$$
\theta\,E(s')\,(1+r^*) = s(1+r), \tag{8}
$$

where θ represents the UIP deviation. If $\theta = 1$, the UIP condition holds and the exchange rate movement equals the interest rate differential. Otherwise, when $\theta \neq 1$, there are UIP deviations. If $\theta > 1$, the local interest rate is higher than the foreign rate once expected changes in the exchange rate are taken into account, and foreign currency borrowing is relatively more attractive.

This model endogenously generates exchange rate fluctuations and UIP deviations. Given the different market valuation of risk of local and foreign investors, shocks in the global factor affect the ratio of their pricing kernels and the exchange rate evolution. As shown by Hassan (2013), different valuations of risk can arise from countries' asymmetric ability to diversify risk. In particular, since larger countries are less able to diversify risk, they price the risk relatively more. In a small economy setting, this implies $\lambda^* > \lambda$. In Appendix A, we show that, when the foreign investor has a higher price for the risk factor, a negative shock in the factor leads to an increase in the ratio of the pricing kernels (m'^*/m') and to a currency depreciation. Furthermore, whenever $\lambda^* > \lambda$ and the foreign rate is positive, the model endogenously generates UIP deviations that make foreign loans relatively cheaper ($\theta > 1$).

Debt Contract and Debt Pricing

Investors can buy firms' risky bonds denominated in local or foreign currency. Let $\Delta(\upsilon)$ be the set of global and productivity shocks for which a firm chooses to default: $\Delta(\upsilon) = \Big\{(\omega, z)\text{ s.t. } V^R(\omega_{-1}, \omega, z, \upsilon) \leq 0\Big\}$.[16] Firms' bonds prices are sold at a discount, given by

exchange rates (see for example Rey 2015).

[16]For simplicity, we let no recuperation cost post default and firms default in local and foreign debts simultaneously.

$$q(\omega, z, \upsilon') = E_{\omega', z' \notin \Delta(\upsilon)}(m) \qquad \text{and} \qquad q^*(\omega, z, \upsilon') = E_{\omega', z' \notin \Delta(\upsilon)}(m^*). \tag{9}$$

While UIP deviations can make foreign currency borrowing more attractive and allow increased investment, foreign bonds expose firms to currency risk, potentially raising their default probability and overall cost of funds. This trade-off drives firms' foreign borrowing decisions as discussed below.[17]

Entrant Firms

In each period, there is a constant mass of potential entrants that receives a signal about their productivity in the next period. After observing their signal, potential entrants choose their capital stock. The value of entry is as follows

$$V_e(\omega, \chi) = \max_{k'} \left[-p\, k' + E_{\omega', z'}\, \tilde{\beta}\, V(\omega, \omega', z', \upsilon') \right].$$

Firms enter if their expected continuation value exceeds the sunk cost if entry (c_e) : $V_e(\omega, \chi) \geq p\, c_e$. Appendix A describes the stationary firm-distribution.

3.3 Firms' Optimal Decisions

Consider a firm's Euler equations for local and foreign currency debts:

$$b' : \quad \underbrace{\underbrace{q(z, \omega, \upsilon')}_{\text{direct effect}} + \underbrace{\frac{\partial q(z, \omega, \upsilon')}{\partial b'} b' + \frac{\partial q^*(z, \omega, \upsilon')}{\partial b'} s b'^*}_{\text{indirect bond price effect}}}_{\text{total benefit}} \leq \beta\, \underbrace{E_{z', \omega'}[m'(1 - \Delta(\upsilon'))]}_{\text{expected cost}}, \tag{10}$$

$$b'^* : \quad \underbrace{\underbrace{s q^*(z, \omega, \upsilon')}_{\text{direct effect}} + \underbrace{\frac{\partial q(z, \omega, \upsilon')}{\partial b'^*} b' + \frac{\partial q^*(z, \omega, \upsilon')}{\partial b'^*} s b'^*}_{\text{indirect bond price effect}}}_{\text{total benefit}} \leq \beta\, \underbrace{E_{z', \omega'}[m' s'(1 - \Delta(\upsilon'))]}_{\text{expected cost}}. \tag{11}$$

Equations (10) and (11) show that firms optimally choose to issue local and foreign currency bonds until the funds raised by each type of debt equal their expected future cost. Importantly, the total benefit of one extra unit of debt depends *directly* on the current bond price of this debt and *indirectly* on its endogenous effect on the firm's overall cost of funds. This indirect effect comes from the impact of debt issuance on firms' next period default probability and, thus, current bond prices. Note as well that higher debt issuance in one currency also affects the price of the bond of the other currency, as when firms default they do so in all debt. The expected cost of bonds is the face value of the debt

[17]This specification assumes that banks offer firms a lower risk-free rate in foreign currency, and pass on the benefit from the UIP deviations. Importantly, this is consistent with the empirical evidence across countries showing that the interest rate of corporate foreign currency loans is lower (Ranciere, Tornell, and Vamvakidis 2010). This interest rate differential was also present on Hungarian firms. Between 2005 and 2015, there was a 4 percentage points differential (8.04% vs 3.88%) between loans denominated in local and foreign currency (NBH). This difference could arise from market segmentation in the financial sector. In this paper, we take this difference as given and focus on firms' debt portfolio problem.

at states of repayment. In the case of foreign bonds, their expected cost also depends on the future exchange rate, which highlights its additional risk arising from the exchange rate uncertainty.

Mechanism: Foreign Currency Borrowing Decisions

To assess the forces leading firms to borrow in foreign currency, we evaluate the relative benefits and costs of this financing vis-à-vis local currency borrowing. In particular, we focus on the optimal choice of a firm issuing local currency bonds and deciding whether to issue foreign currency bonds, for a given level of k, w and z. In Appendix A, we show that Euler equation of foreign bonds relative to local bonds can be expressed as follows:

$$\underbrace{(\theta-1)E(s'|\omega)E_{z',\omega'\notin\Delta(v')}(m') + scov(m'^{*}s - m'\frac{1+r}{1+r^{*}}, 1-\Delta(v')) - \beta cov_{z',\omega'}(s', m'(1-\Delta(v')))}_{\text{relative benefit of FC debt}} + \tag{12}$$

$$\underbrace{\left(\frac{b}{1+r}+\frac{sb'^{*}}{1+r^{*}}\right)\left\{\frac{\partial E(1-\Delta(v'))}{\partial b'^{*}} - E(s'|\omega)\frac{\partial E(1-\Delta(v'))}{\partial b'}\right\} + \left\{\frac{\partial cov(m'b'+m'^{*}sb'^{*}, 1-\Delta(v'))}{\partial b'^{*}} - E(s'|\omega)\frac{\partial cov(m'b'+m'^{*}sb'^{*}, 1-\Delta(v'))}{\partial b'}\right\}}_{\text{relative cost of FC debt}} \leq 0.$$

The first line in equation (12) shows the relative benefit of foreign bonds vis-à-vis local currency bonds. The second line represents the potential relative cost of foreign currency bonds. Firms borrow in foreign currency when the relative benefit is equal to the relative cost of this financing, i.e. equation (12) holds with equality. Appendix A presents a full characterization of equation (12) but, to illustrate the mechanism more clearly here, we let the discount factor of the firm only have a time-invariant component (β). Under this assumption, we can rewrite equation (12) as

$$\underbrace{(\theta-1)E(s'|\omega)E_{z',\omega'\notin\Delta(v')}(m') - \beta cov_{z',\omega'}(s', (1-\Delta(v')))}_{\text{relative benefit of FC debt}} + \underbrace{\left(\frac{b}{1+r}+\frac{sb'^{*}}{1+r^{*}}\right)\left\{\frac{\partial E(1-\Delta(v'))}{\partial b'^{*}} - E(s'|\omega)\frac{\partial E(1-\Delta(v'))}{\partial b'}\right\}}_{\text{relative cost of FC debt}} \leq 0. \tag{13}$$

The first two terms in equation (13) represent the relative benefit of foreign currency loans. The first term is a function of the UIP deviation and shows the relative benefit of financing at a lower rate. This term is always positive whenever $\theta > 1$, and increases in the UIP deviation (θ). The second term captures the covariance between the future exchange rate and the firm's discounted repayment probability. This covariance is always negative, which –together with the negative sign before it– makes this term positive. Intuitively, a currency appreciation (low s') decreases the value of next period foreign currency debt repayment and increases a firm's repayment probability (higher $1-\Delta(v')$). The last term represents the potential cost of foreign currency debt vis-à-vis local currency bonds. This cost depends on the relative decrease in the repayment probability stemming from the exposure of firms' liabilities to the currency risk. As we show in Appendix A, given the risk profile of firms, the sensitivity of the repayment probability tends to be lower for foreign debt. In particular, when $\frac{\partial E_{z',\omega'}(1-\Delta(v'))}{\partial b'^{*}} \leq E(s'|\omega)\frac{\partial E_{z',\omega'}(1-\Delta(v'))}{\partial b'}$, foreign currency loans lower firms' repayment probability. This decrease in the repayment probability makes this term negative and foreign loans costly.[18]

[18]In Appendix A, we show that this is always true for firms with default probability lower than 50% and is always

Importantly, while the relative benefit only affects the marginal unit of foreign debt, the relative cost is affected by the *entire debt issuance* (i.e. the relative change in the repayment probability is multiplied by the stock of debt). Hence, if the increase in the cost of funds is high enough, the cost of foreign bonds could exceed its benefit, and the firm chooses not borrow in foreign currency. Firms issuing foreign currency debt choose levels such that the relative benefit is equal the relative cost of this financing - i.e., equation (13) holds with equality. We present below two lemmas that summarize firms' foreign currency borrowing decisions. Their analytical derivations are presented in Appendix A.

-Lemma 1. Selection into foreign currency borrowing: Given firms' risk profile choice, only highly productive firms borrow in foreign currency. The share of foreign currency borrowing increases in firms' productivity, for a given state υ.

To see the intuition behind this lemma, note that equations (3) and (4) define a productivity level below which a firm –with state υ' and the exchange rate realization s'– has negative equity and defaults. Given the persistence of the productivity shock, highly productive firms today are more likely to be above this productivity level next period. Therefore, the higher a firm's productivity, the easier is to tolerate the currency risk and the less increases its default probability when issuing foreign bonds, for a given υ' and s'. Importantly, there is a productivity threshold below which the increase in default probability is sufficiently high that the optimal decision is not to issue foreign currency debt. A corollary of this lemma is that firms borrowing in foreign currency should have higher investment rates, as they enjoy lower financing rates.

-Lemma 2. UIP Deviations: Higher UIP deviations promote foreign currency borrowing and decrease the productivity level to employ this financing, for a given state υ.

As shown in equation (13), higher UIP deviations increase the relative benefit of issuing foreign bonds, allowing firms hold higher levels of foreign debt. Furthermore, the higher these deviations, the lower is the productivity level required to start issuing this financing, i.e. equation (13) binds for lower levels of z. A corollary of this lemma is that as the UIP deviation increases, the investment rate should increase.

4 Calibration and Non-Targeted Moments

We calibrate the model to match data moments in Hungary in 2005 –i.e. the first year for which the dataset reports information on foreign currency loans. Since Hungary only fully deregulated these loans in 2001 and was transitioning in 2005, we calibrate the model to mimic this transition period (instead of focusing on a stationary equilibrium with foreign loans).

We conduct the simulation in three steps. First, we simulate an economy without foreign currency debt and find the stationary distribution of firms. This first step gives an initial condition for the

the case in our simulation. Given that firms are risk neutral only when their default probability is zero but they become risk averse for positive default probabilities, firms make choices to keep their default probabilities low and be far from the default threshold. For example, our simulated firm-level data shows that all firms borrowing in foreign currency have either zero default probability or default probability (significantly) lower than 50%. In Appendix A.6 we develop a two-period model that illustrates the risk profile of firms, and in Appendix we discuss this risk profile in light of our simulated data.

economy prior to the deregulation of foreign currency loans. Second, we solve an economy with foreign currency borrowing and obtain firms' optimal capital, and local and foreign currency debt policies. Finally, we simulate approximately 160,000 firms starting from the distribution without foreign currency debt (which is the number of firms we observe in Hungary), using the realized foreign interest rate shocks between 2001 and 2010 and the firm-level optimal policies of the model with foreign currency. This simulation strategy allows us to create firm-level panel data that tracks the evolution of firms over 2001-2010, and follows the path of the exchange rate in Hungary.

The seventeen parameters of the model are calibrated to Hungarian data on yearly basis. Thirteen parameters are externally calibrated and four are internally calibrated to match moments of the firm-level data for Hungary in 2005. We parametrize the parameters governing the global factor to the one year German government bond between 2001 and 2015. The mean of the foreign rate is $\kappa = 0.007$, the mean reversion parameter is $\varphi = 0.58$, and σ_ω is 0.196. We obtain $\tilde{\delta}$ and γ using the model's implied relationship between the domestic and foreign rates: $r_t = \tilde{\delta} + \gamma r_t^*$. Estimating this regression, we obtain $\tilde{\delta} = 0.043$ and $\gamma = 1.065$.[19] We deduct the credit default swaps from the government bond prices to obtain the risk-free rates. We choose $\lambda = 1.4$ and $\lambda^* = 2.7$ to match the mean UIP deviation and mean depreciation rate in Hungary between 2001 and 2015. It worth mentioning that despite these parameters are choose to match the mean, they also match well the volatility of the UIP deviation and depreciation rate and, hence, the relative dynamics of these two factors.

We follow Bloom, Floetotto, Jaimovich, Saporta-Eksten, and Terry (2012) and Gopinath, Kalemli-Ozcan, Karabarbounis, and Villegas-Sanchez (2017) and estimate the firms' productivity process as

$$\log z_{ijt} = \rho_z \log z_{ijt_{t-1}} + \phi_i + \mu_{jt} + \varepsilon_{ijt},$$

where μ_i and ϕ_{jt} denote firm-fixed and four-digits sector-year fixed effects. Based on this regression, we set $\rho_z = 0.63$ and $\sigma_z = 0.57$. We let the depreciation rate (δ) be 10% and the elasticity of capital (α) be 0.6, which is the value estimated for Hungarian firms. We set the exchange rate pass-through onto local firms' prices to zero ($\eta = 0$), as two-third of firms borrowing in foreign currency in Hungary are non-exporters and non-importers and their prices are set in the local market. To characterize the relationship between aggregate productivity and the e xchange rate, we regress aggregate productivity on the exchange rate change and denote this elasticity with ζ. Using TFP data from the Penn World Table 8.0 for Hungary between 1992 and 2015, we obtain $\zeta = -0.43$, indicating that currency depreciations associate with decreases in aggregate productivity.

We jointly calibrate the fixed credit cost (c), the investment adjustment cost (c_0), the fixed operational cost (c_f) and the time-invariant discount factor (β) to match main moments of firms in Hungary in 2005.[20] In particular, we calibrate the credit cost to match the share of firms borrowing (30%), the investment adjustment cost to match their investment rate (12%), operational cost to match the default rate (2%), and the discount factor β to match firms' leverage (7%).[21] Table 2 summarizes the

[19]Note that $\gamma > 1$ is in line with a macro literature showing that foreign interest rate shocks propagate in Emerging markets by increasing the spread and the domestic interest rate relatively more, see Neumeyer and Perri (2005), Tornell and Westermann (2005), Uribe and Yue (2006) and Varela (2017) among others.

[20]The credit cost is equivalent to a flotation costs of 0.5% per unit of debt.

[21]The default probability in Hungary was estimated by Bauer and Endresz (2016), who reports 2% for 2005. Two

parameters and targeted moments.

Table 2: Parameter Values

	Parameter Values	
	Value	Target
Parameters of the Affine Model		
Foreign interest rate	$\kappa = 0.007$ $\varphi = 0.58$ $\sigma_\omega = 0.196$	German Bund, 1 year rate
Domestic Interest rate	$\tilde{\delta} = 0.043$ $\gamma = 1.065$	Hungarian Government Bond, 1 year rate
Pricing of risk	$\lambda = 1.4$ $\lambda^* = 2.7$	UIP Deviation and Depreciation Rate
Firm-level Parameters		
Firms' productivity	$\rho_z = 0.63$ $\sigma_z = 0.57$	Hungarian firms
Return to scale	$\alpha = 0.6$	Hungarian firms
Depreciation rate	$\delta = 10\%$	
Exchange rate pass-through	$\eta = 0$	
Demand shock	$\zeta = -0.43$	
Jointly calibrated parameters		
Fixed operational costs	$c_f = 4.33$	Default rate
Investment adjustment cost	$c_0 = 0.05$	Investment rate of borrowing firms
Fixed cost of credit	$c = 0.1$	Share of firms borrowing
Constant discount factor	$\beta = 0.998$	Leverage

Notes: This table shows the parameters selected independently and the calibrated parameters with their respective targets.

Non-Targeted Moments

To assess whether the model matches firms' foreign currency borrowing decisions and their investment patterns, we break down firms with credit into three groups according to their exposure to exchange rate shocks : 1) firms borrowing only in local currency, 2) firms borrowing in both local and foreign currency, and 3) firms borrowing only foreign currency.

Table 3 shows that the model is able to replicate closely main moments of the distribution of foreign currency borrowing and main characteristics of each group of firms. First, the model tracks closely the share of firms borrowing only in local currency (21% in the model and in the data), borrowing both in local and foreign currency (8% in the model vs 6% in the data), and only borrowing in foreign currency (1% in the model vs 3% in the data).

Second, the model matches closely the productivity and capital of each group. Relatively to all firms with credit –which are normalized to one–, firms that borrow in foreign currency are more productive both in the model and the data. Notably, firms that only borrow in foreign currency are 8% more productive in the model and 5% in the data (row 2). Interestingly, these firms have lower level of

additional parameters were calibrated: the fixed entry cost and the mass of firms, (c_e, M). They were set such that average entry equals exit, so that over time the firm distribution is stable. Similarly, the entrants' productivity signal is estimated in the same support as the incumbents productivity.

Table 3: Non-Targeted Moments

Moment	Group	Model (1)	Data (2)
1. Firm share (%)	LC debt only	21	21
	LC & FC debt	8	6
	FC debt only	1	3
2. Relative productivity*	LC debt only	0.97	0.99
	LC & FC debt	1.07	1.02
	FC debt only	1.08	1.05
3. Relative capital*	LC debt only	0.95	0.97
	LC & FC debt	1.10	1.06
	FC debt only	1.05	0.99
4. Investment rate (%)	LC debt only	10	9
	LC & FC debt	15	18
	FC debt only	17	19
5. FC Share (%)	LC debt only	0	0
	LC & FC debt	41	50
	FC debt only	100	100
6. Leverage (%)	LC debt only	21	17
	LC & FC debt	33	25
	FC debt only	21	18
7. LC Leverage (%)	LC debt only	21	17
	LC & FC debt	20	14
	FC debt only	0	0
8. FC Leverage (%)	LC debt only	0	0
	LC & FC debt	13	9
	FC debt only	21	18

Notes: This table shows data and model moments firms in 2005. We simulate approximately 160,000 firms from the stationary distribution of no foreign currency. In this simulation, we use the foreign interest rate shocks between 2001 and 2010 and the optimal policies of the model with foreign currency borrowing to obtain the moments for 2001-2010. *Relative productivity and capital are considered with respect to firms with credit, which are normalized to one.

capital both in the model and the data (row 3). Their high productivity and low capital indicates that these firms have high MPK, which is consistent with their intensive use of cheap foreign loans to expand their investment.

Third, the model matches closely the investment rate of each group and shows that firms' issuing foreign denominated bonds have higher investment rates. More precisely, firms borrowing only in local currency have 10% and 9% investment rates in the model and the data; firms employing both types of financing have investment rates of 15% in the model and 18% the data; whilst firms only using foreign borrowing have 17% and 19% investment rates in the model and the data, respectively. Row 5 shows that the model predicts that firms borrowing in both currencies have a foreign currency share of 40%, while this share is 50% in the data.

Finally, the model follows closely the leverage of each group. Firms borrowing only in local currency have 21% and 17% of leverage in the model and data, respectively (row 6). Firms that borrow in both local and foreign currency have a leverage of 33% and 25% (row 6), a leverage in local currency of 20% and 14% (row 7), and a leverage in foreign currency of 13% and 9% (row 8) in the model and data, respectively. Firms that only borrow in foreign currency have a leverage of 21% and 18% in the model and the data (row 6). Importantly, neither in the model or in the Hungarian data, firms only borrowing in foreign currency have high levels of leverage or leverage in foreign currency. This is interesting because it indicates that firms do not use foreign currency loans to over-borrow. Instead, they borrow in foreign currency and exploit the UIP deviations to the level of risk that they can tolerate.

This section showed that the model matches well the main moments of the distribution of foreign loans. In the next section, we go one step further and assess whether the firm-level responses implied by the model are present in Hungary.

5 Model vs Data: Firm-Level Analysis

In this section, we test the model's predicted patterns of foreign currency borrowing and investment at the firm level. We conduct three exercises estimating in parallel regressions using the simulated and the Hungarian data. These exercises allow us to test econometrically the model's qualitative predictions in the data, to quantify its firm-level responses, and to compare the size of firms' responses of the model with those of the Hungarian data. In Section 5.1, we describe the deregulation of foreign currency loans in Hungary, assess selection into foreign currency borrowing and test whether firms choosing this financing have higher investment (Lemma 1). In Section 5.2, we test if UIP deviations promote foreign currency borrowing and investment (Lemma 2).

5.1 Access to Foreign Currency Loans: Firms' Characteristics and Investment

5.1.1 Deregulation of Foreign Currency Loans in Hungary

The model predicts that only highly productive firms borrow in foreign currency and that they employ this financing to expand their investment. In this section, we exploit the deregulation of foreign currency loans in Hungary in 2001 as an exogenous source of time variation to assess this prediction empirically. This reform allows identifying firms' pre-reform productivity and, in this way, address the causal relationship from productivity to foreign loans. Note that, since firms could use foreign loans to invest in technology and increase their productivity, a contemporaneous regression would absorb this relationship from foreign loans to productivity and bias the estimated coefficients. The use of this policy reform allows then identifying firms' productivity prior to the access of foreign loans and addressing this reverse causality concern.[22]

Prior to 2001, foreign currency loans were regulated by the Act XCV of 1995. As Varela (2018) shows, this law treated foreign and domestically-owned firms asymmetrically. Whilst foreign firms were legally allowed to hold foreign denominated loans, home firms were restricted to borrow locally in

[22]This exercise is an advance regarding the existing literature that only assesses the relationship between foreign loans and firms' characteristics contemporaneously and, thus, finds it difficult to identify the causal effect of firms' characteristics on foreign loans. Furthermore, data availability limits the analysis to small samples of already selected large firms –typically exporters and publicly listed– and, hence, to address selection into foreign currency borrowing.

national currency. In 2001, the ban on home firms' foreign currency loans was removed and home firms were thereafter allow to borrow in foreign currency. Our empirical strategy to identify the pre-reform characteristics and the investment behavior of firms borrowing in foreign currency focuses on those firms that gain access to foreign currency loans upon the reform, that is home firms. To address the above mentioned reverse causality concerns, we restrict our analysis to home firms.

The general context around the deregulation of foreign currency loans and its timing makes it likely to be exogenous with respect to the main outcome analyzed, i.e. home firms' decisions to borrow in foreign currency. The reform was driven by the accession of transition economies to the EU. The requirements to join the EU were predetermined by the Copenhagen Criteria in 1993 and have been equal for all accessing countries since then. In this sense, the content of the reform was exogenous to the country's political choice. As the agenda was jointly determined by the European Council and the candidate countries, it is unlikely to have been driven by political pressure from Hungarian firms. Furthermore, given the speed of the reform, it is unlikely that firms anticipated it and increased their productivity in advance.[23] Importantly, Hungary did not join the Euro zone and, hence, did not have to fulfill any monetary or fiscal criteria. Furthermore, the EU did not require any additional reform that could affect Hungarian firms' foreign currency borrowing decisions (see Varela 2018). Note as well that the Hungarian economy was already deeply integrated with the EU, as exports to the EU already accounted for 80% of total exports in 2001, and trade with the EU did not increase upon the reform (Figure B.10). Finally, FDI and trade remained constant during this period (Figures B.9 and B.11).[24]

5.1.2 Firms' Characteristics

We assess Lemma 1 and study whether home firms' pre-reform productivity correlates with foreign currency borrowing decisions using the following linear probability regression:

$$\text{FC Dummy}_i = \beta \log \text{Productivity}_i + \varepsilon_i, \tag{14}$$

where FC Dummy_i is a dummy indicating whether a firm had a foreign currency loan in 2005. Productivity_i denotes firm's productivity prior to the deregulation of foreign currency loans (in 2000), which is z_i in the model's simulated data and firm's RTFP in the Hungarian data.[25] The regressions estimated for Hungary add three features. First, we include four-digit NACE industries fixed effects that allow comparing firms within narrowly-defined industries and control for sectoral time-invariant characteristics.

[23] In December 2000, the European Council defined the timing for the accession vote and the last requirements to be met by each candidate. The reform had to take place before the accession vote in December 2002. Soon after the European Council meeting, in March 2001, Hungary deregulated foreign currency loans. Note that from the fourteen candidates only ten countries joined the EU in 2004 (Cyprus, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, and Slovenia).

[24] Varela (2018) shows that domestics exporters and non-exporters do not expand differentially during this period, and that there are no significant changes in firms ownership structure after 1996. Finally, foreign firms entering the market represented less than one percent of firms and this share remained constant over the period under analysis.

[25] The difference between physical and revenue TFP is –to a certain degree– second order in our analysis, since –as shown by Foster, Haltiwanger, and Syverson (2008)– these measures are highly correlated in the cross-section. In all our empirical exercises, we only employ RTFP in a given year to proxy firms' initial productivity and conduct robustness tests for different productivity measures.

Second, in our baseline specification, we exclude exporters (as they could be naturally hedged) and include them later in a robustness test. Finally, we cluster standard errors at four-digit industries to account for cross-sectional serial correlation within sectors. To assess whether more productive firms employ foreign currency loans more intensively, we re-estimate equation (14) using firms' log share of foreign currency loans in 2005. The coefficient of interest is β and captures whether firms that were more productive prior to deregulation have a higher probability of using this financing and share of foreign currency loans after it.

Columns 1-4 present in Table 4 present the results for the extensive margin of foreign borrowing where the foreign currency dummy is the independent variable. Both in the simulated and the Hungarian data, the regressions confirm that the probability of borrowing in foreign currency increases in firms' pre-reform productivity. The estimated coefficients are similar in magnitude implying that a one percent increase in a firm's productivity raises its probability of borrowing in foreign currency by 4.6 and 2 percentage points, in the model and Hungarian data respectively (columns 1 and 3). These results are robust to including capital as a control (columns 2 and 4).

The results for the intensive margin of foreign borrowing, using the share of foreign loans as independent variable, confirm these trends (columns 5-8). A one percent increase in a firm's pre-reform productivity raises its share of foreign loans by 0.015 and 0.005 percent, in the simulated and the Hungarian data (columns 5 and 7). As above, these results hold true when controlling for capital.[26]

Table 4: Decision into Foreign Currency Borrowing

	Foreign Currency Loan Dummy				Log Share of Foreign Currency Loans			
	Model		Data		Model		Data	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Log productivity	0.046***	0.045***	0.020***	0.012***	0.015***	0.016***	0.005***	0.003**
	(0.002)	(0.001)	(0.002)	(0.002)	(0.001)	(0.001)	(0.002)	(0.001)
Log capital		0.020***		0.032***		0.010***		0.009***
		(0.002)		(0.002)		(0.001)		(0.001)
Sector FE			Yes	Yes			Yes	Yes
R^2	0.006	0.012	0.028	0.053	0.003	0.009	0.028	0.035
N	152,706	152,706	33,327	33,327	152,706	152,706	33,327	33,327

Notes: *, **, *** significant at the 10, 5, and 1 percent level. Standard errors in parentheses. Source: APEH and Credit Register.

Table B.2 in Appendix B presents a full set of robustness tests. Column 1 includes exporters and shows that the estimated coefficients remain stable and highly statistically significant when including them into the analysis. Column 2 controls for firms' local currency leverage prior to the deregulation, as firms with better initial access to bank credit might find it easier to access to foreign loans. The coefficients remain highly significant and similar in size than those in the baseline specifications. Column 3 shows that results are robust to controlling for firms' age. Column 4 shows that results hold true when estimating firms' RTFP using the methodology of Olley and Pakes (1996) to estimate the coefficients of the production function, and column 5 when using labor productivity as a proxy for firms' productivity.

[26] As discussed in Appendix B.3, the R^2 in the simulated data is low by construction since productivity has persistence and firm's choices are simultaneous. When using Hungarian data, the low R^2 is additionally explained by the presence of unobserved heterogeneity, which is common in cross-sectional analysis (see for example Alfaro, Antras, Chor, and Conconi 2019, Amiti, Itskhoki, and Konings 2014, Bustos 2011 and Bertrand, Duflo, and Mullainathan 2004).

Column 6 illustrates that results are robust to using averages between 1998 and 2000 as pre-reform firms' characteristics. Lastly, Appendix B.5 breaks down loans by their currency denomination and shows that all the model's implications hold true.

5.1.3 Firms' Investment

The model predicts that firms borrowing in foreign currency have higher investment rates as they face lower financing costs. To assess this, we exploit the deregulation of foreign loans to study if firms using these loans have higher investment rates within the five years before and after the reform. We estimate:

$$\log Y_{it} = \beta\,(\mathrm{R}_t \,\mathrm{x}\, \mathrm{FC\,Dummy}_i) + \iota_t + \phi_i + (T_t \,\mathrm{x}\, \mathrm{FC\,Dummy}_i) + \varepsilon_{it}. \tag{15}$$

where $\log Y_{it}$ denotes log investment rate between 1996-2005, R_t is a dummy for the post-reform period ($\mathrm{R}_t > 1$ if year$\geq$ 2001, and 0 otherwise), ι_t are year-fixed effects and ϕ_i are firm-fixed effects. Since firms borrowing in foreign currency have higher levels of capital and are more productive, they could be in different trend. To account for pre-existing trends, we follow Gruber (1994) and Chinn (2005) and add a time trend interacted with the foreign currency debt dummy, i.e $T_t \,\mathrm{x}\, \mathrm{FC\,Dummy}_i$. The coefficient of interest β captures if firms borrowing in foreign currency have higher investment rates after the reform. Standard errors are clustered at year and four-digit sector when employing the Hungarian data.

Table 5 confirms that firms borrowing in foreign currency have higher investment rates. After the inclusion of all controls, the estimated coefficients imply that these firms have 13 and 7 percent higher investment rates in the simulated and Hungarian data (columns 2 and 4). Table B.3 shows that results are robust to including exporters and to considering sales as dependent variable.

Table 5: Foreign Currency Borrowing and Investment

	Log Investment Rate			
	Model		Data	
	(1)	(2)	(3)	(4)
R*FC dummy	0.200***	0.131***	0.207***	0.071***
	(0.002)	(0.004)	(0.020)	(0.027)
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
FC d.*time trend		Yes		Yes
R^2	0.274	0.274	0.511	0.512
N	1,527,060	1,527,060	393,149	393,149

Notes: *, **, *** significant at the 10, 5, and 1 percent level. Standard errors in parentheses. R is a dummy for the period 2001-2005. Period 1996-2005. Source: APEH and Credit Register.

5.2 *UIP Deviations: Firms' FC Borrowing and Growth*

Lemma 2 predicts that higher UIP deviations promote foreign currency borrowing. Figure 1 presented first evidence that, in Hungary, these deviations correlate with increases in the aggregate share of foreign currency loans. In this section, we study this relationship at the firm-level and assess whether UIP deviations correlate with higher investment.

We assess the relationship between UIP deviations and foreign currency borrowing in three steps. First, we check whether these deviations associate with increases in foreign currency borrowing at the firm-level. Second, we evaluate whether these responses are heterogenous across firms and correlate with firms' productivity. Finally, we add a second source of heterogeneity and assess whether firms' responses also vary in terms their capital stock. This second layer allows evaluating more precisely the mechanism proposed in the paper, namely foreign currency borrowing allowing productive firms to accumulate more capital. Hence, we study whether –conditional on productivity– firms with lower capital stock exploit UIP deviations relatively more to reach faster their optimal scale of production. In this way, we exploit three sources of variation: UIP deviations over time and cross-sectional variations in terms of firms' productivity and capital stock.

To test if UIP deviations associate with firms' foreign currency borrowing, we consider:

$$Y_{it} = \beta \, \log \text{UIP}_t + \phi_i + \varepsilon_{it}, \tag{16}$$

where Y_{it} is either the foreign currency debt dummy or the log foreign currency share between 2005 and 2010, i.e. FC Dummy$_{it}$ or Log FC Share$_{it}$. To control for valuation effects that could arise from the foreign currency share moving contemporaneously with the exchange rate, we construct the share in each year by employing the exchange rate in the previous year. Additionally, we conduct robustness tests, in which we fix the exchange rate to initial year (2005) and use its current level to build the foreign currency share. Log UIP$_t$ is the log of the UIP deviation during this period (the log of θ in the model). When using the Hungarian data, we create this variable by computing the one-year UIP deviation for each foreign currency in which Hungarian firms borrow –Euro, Swiss Franc and U.S. Dollar–, weighted by the aggregate share of loans in each currency.[27] Since foreign currency borrowing of exporters and foreign firms might be driving by other considerations, we exclude them in our baseline regressions and add them in robustness tests. The coefficient β captures if higher UIP deviations associate with increases in firms' probability of borrowing in foreign currency and foreign currency share.

To study whether UIP deviations affect more productive firms differentially, we estimate

$$Y_{it} = \beta \, \log(\text{UIP}_t \text{ x Productivity}_i) + \phi_i + \iota_t + \varepsilon_{it}, \tag{17}$$

where Productivity$_i$ is firm's initial productivity (z_i or RTFP$_i$) in 2005 and ϕ_i are firm-fixed effects that capture all time invariant firm characteristics.[28] To control for demand shocks that could affect sectors differently over time, we include four-digit sectors and year fixed effects interacted when using the Hungarian data. We cluster the standard errors at year and four-digit sectors. The coefficient β in equation (17) captures if more productive firms increase foreign borrowing more upon UIP deviations.

To evaluate whether more productive firms with lower capital stock differentially exploit UIP deviations, we break down firms by quartiles of productivity and capital in the initial year. In particular,

[27] More precisely, Log UIP$_t$ = $\log(\sum_{st} w_{st}\text{UIP}_{st})$, where s and t are currency and year, and w is the share of foreign loans. In 2015, 75% of corporate loans were denominated in Euros, 19% in Swiss Francs and 6% in U.S. Dollars.

[28] Note that we do not include firms' current productivity or capital because this would create endogeneity concerns.

we create four bins according with whether firms have "high" or "low" productivity and capital stock in 2005. We create the following four bins of firms: high productivity and low capital (Q_{HL}), high productivity and high capital (Q_{HH}), low productivity and low capital (Q_{LL}), and low productivity and high capital (Q_{LH}). This strategy allows comparing the responses of firms with similar productivity level, but different level of capital. When using the Hungarian data, we create bins within four-digit NACE industries to compare firms within narrowly defined sectors. We estimate the following regression:

$$Y_{it} = \beta_1 \log \text{UIP}_t \text{ x } Q_{HLi} + \beta_2 \log \text{UIP}_t \text{ x } Q_{HHi} + \beta_3 \log \text{UIP}_t \text{ x } Q_{LLi} + \beta_4 \log \text{UIP}_t \text{ x } Q_{LHi} + \phi_i + \iota_t + \varepsilon_{it}. \quad (18)$$

The estimated coefficients $\beta_1, \beta_2, \beta_3$ and β_4 capture the differential response of each group to changes in the UIP deviation. We expect high MPK firms (β_1) to have the largest response to UIP deviations.

Columns 1-3 in Table 6 present the results of regressions (16)-(18) using the model simulated data. The coefficient in column 1 (Panel A) indicates that UIP deviations increase firms' probability of borrowing in foreign currency. As expected, this increase is higher for more productive firms (column 2) and, among them, firms with low capital (high MPK in column 3). The regressions for the Hungarian data confirm these trends (column 4-6). Importantly, the model's implied firm-level responses are similar in magnitude than those of the Hungarian data. A one percent increase in the UIP deviation raises firms' probability of borrowing in foreign currency by 9.2 and 15 percentage points, in the simulated and Hungarian data respectively. Similarly, this expansion reaches 22 and 19.6 percentage points for high MPK firms, in the simulated and Hungarian data.[29]

Panel B, reporting the results for the share of foreign currency debt, confirm these trends. Both in the simulated and the Hungarian data, the share of foreign loans increases in UIP deviations, and firms' productivity and MPK. The size of the firm-level responses is similar in the model and the data. In particular, a one percent increase in the UIP deviation leads to a 0.053 and 0.084 percent increase in firms' foreign currency share, in the model and data (columns 1 and 4). High MPK firms have the largest response to UIP deviations and increase their foreign currency share by 0.15 and 0.09 percent, in the simulated and Hungarian data (columns 3 and 6).

Firms' investment responses are in line with the increase in foreign borrowing, as shown in Panel C. UIP deviations associates with high investment, specially of productive firms and, among them, those with low initial capital stock. In particular, the simulated and Hungarian data imply that a one percent increase in the UIP deviation leads to an expansion of 0.114 and 0.136 percent in firms' investment rate (columns 1 and 4). This expansion is larger for high MPK firms, whose elasticities are 0.126 and 0.15 percent, in the model and data (columns 3 and 6).

These results confirm the model's mechanism by showing that UIP deviations associate with expansions of foreign currency borrowing and investment, specially of productive firms with low capital stock. Notably, the model not only reproduces the sign of the firm-level responses observed in data (*qualitatively*), but the size of the implied elasticities (*quantitatively*). A key feature of the model is that firms using foreign loans enjoy lower costs of funds. Table B.17 in Appendix B documents suggestive evidence by showing that, both in the simulated and Hungarian data, firms borrowing in foreign currency pay

[29]Since equation (18) includes firm-fixed effects, the dummies Q_{HLi}, Q_{HHi}, Q_{LHi} and Q_{LLi} automatically drop from the regression as they are absorbed by the firm-fixed effects. Table B.4 confirms our results when replacing the firm fixed effects with these dummies.

Table 6: UIP Deviations: FC Borrowing Decisions

	Model			Data		
	Panel A. FC Dummy					
	(1)	(2)	(3)	(4)	(5)	(6)
Log UIP Dev.	0.092***			0.150***		
	(0.002)			(0.017)		
Log (UIP Dev. x Productivity)		0.098***			0.047***	
		(0.029)			(0.008)	
Log UIP Dev. x Q_{HL}			0.222***			0.196***
			(0.003)			(0.031)
Log UIP Dev. x Q_{HH}			0.046***			0.142***
			(0.002)			(0.042)
Log UIP Dev. x Q_{LL}			0.141***			0.088***
			(0.003)			(0.029)
Log UIP Dev. x Q_{LH}			0.102***			0.163***
			(0.003)			(0.040)
R^2	0.475	0.4809	0.4847	0.742	0.688	0.743
N	1,039,875	1,039,875	1,039,875	892,584	892,584	892,584
	Panel B. Log Share of Foreign Currency Loans					
	(1)	(2)	(3)	(4)	(5)	(6)
Log UIP Dev.	0.053***			0.084***		
	(0.001)			(0.010)		
Log (UIP Dev. x Productivity)		0.034***			0.025***	
		(0.014)			(0.019)	
Log UIP Dev. x Q_{HL}			0.154***			0.092***
			(0.001)			(0.017)
Log UIP Dev. x Q_{HH}			0.121***			0.076***
			(0.001)			(0.024)
Log UIP Dev. x Q_{LL}			0.103***			0.033*
			(0.001)			(0.017)
Log UIP Dev. x Q_{LH}			0.102***			-0.018
			(0.001)			(0.023)
R^2	0.4810	0.4818	0.4904	0.716	0.655	0.712
N	1,039,875	1,039,875	1,039,875	892,584	892,584	892,584
	Panel C. Log Investment Rate					
	(1)	(2)	(3)	(4)	(5)	(6)
Log UIP Dev.	0.114***			0.136***		
	(0.012)			(0.026)		
Log (UIP Dev. x Productivity)		0.303***			0.315***	
		(0.001)			(0.020)	
Log UIP Dev. x Q_{HL}			0.126***			0.150**
			(0.050)			(0.071)
Log UIP Dev. x Q_{HH}			-0.058			0.116
			(0.055)			(0.079)
Log UIP Dev. x Q_{LL}			-0.239***			0.064
			(0.050)			(0.062)
Log UIP Dev. x Q_{LH}			0.033			-0.097
			(0.051)			(0.083)
R^2	0.283	0.283	0.352	0.575	0.525	0.670
N	1,039,875	1,039,875	1,039,875	436,455	436,455	436,455
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE		Yes	Yes		Yes	Yes
Sector* Year FE					Yes	Yes

Notes: *, **, *** significant at the 10, 5, and 1 percent level. Standard errors in parentheses. Period 2005-2010. Source: APEH and Credit Register.

–on average– one percentage point lower interest rates.[30]

We conduct eight robustness tests. First, we compute UIP deviations without adjusting the sovereign

[30]Unfortunately, there is not coverage on firms' individual interest rates as the Hungarian credit registry data does not report this information. Instead, we employ interest rate data coming from the Business Environment and Enterprise Performance Surveys (BEEPS) of the World Bank and the European Bank for Reconstruction and Development on Hungary, which surveys firms and asks them the interest rate paid for the most recent loan and whether this loan was in local or foreign currency.

risk premium and show in Table B.5 in Appendix B that the estimated coefficients are robust. Second, we estimate the UIP deviation using realized exchange rates (instead of expected exchange rates) and confirm our results (Table B.6). Third, we show that results hold true when including exporters and foreign firms (Table B.7). Fourth, results on the foreign currency share are robust to accounting for valuations effects, as shown in Table B.8 that computes this share with the current exchange rate and the exchange rate in 2005. Fifth, we compute firms' MPK and regress equation (17) using this measure (Table B.9).[31] Sixth, we conduct two different exercises to assess whether for industry's exchange rare pass-through could affect our results. In our first exercise, we replace the four-digit sector-year fixed effects by the log of the producer price index at four-digit industry level and year fixed effects. Results –presented in Table B.11– show that the estimated coefficients remain highly statistically significant and similar in magnitude. In our second exercise, we estimate the exchange rate pass-through for each four digit industry in Hungary over period 1992 to 2008 and then include this variable as a control. Table B.13 presents the results and shows that industry exchange rate pass-through does not affect the size or significance of the firm-level responses.[32] Seven, we test if these decisions correlate with firms' age. Since young firms are farer away from their optimal scale of production, one would expect that young and productive firms take greater advantage of UIP deviations. We create bins by productivity and age and show that young and productive firms have the largest response to UIP deviations (Table B.14).[33] Finally, we show that results are consistent with expansions in firms' sales (Table B.16).

6 Aggregate Implications

In this section, we build on from firm-level decisions to quantify the aggregate impact of foreign currency borrowing and to conduct several policy experiments. Section 6.1 assesses the consequences of foreign loans and how their allocation across firms affects aggregate outcomes. Section 6.2 studies the impact of moderate and extreme depreciations on firms using these loans. Section 6.3 evaluates whether exchange rate market interventions can affect firms' currency debt composition and the allocation of foreign loans across firms. Lastly, Section 6.4 extends our analysis to countries in different stages of economic development and analyzes exchange rate pass-through. To understand the implications of foreign borrowing in a long term, we evaluate the period 2001 to 2015 using the same simulation strategy described in Section 4.

[31] For comparison, we estimate a triple interaction between UIP deviations, productivity and capital and present the results in Table B.10. These results confirm that the double interaction of UIP deviations and productivity, and UIP deviations and capital have a positive sign, but the triple interaction term is negative. This result, together with our non-parametric specification (Table 6), the MPK estimates (Table B.9) and the non-targeted moments (Table 3), confirm that high productive firms with low capital increase more their foreign loans following UIP deviations.

[32] In particular, we regress for each four digit industry $\log PPI_{jt} = \eta_j \log S_t + \varepsilon_{jt}$, where j is the industry and η_j captures the elasticity of the producer price index to the exchange rate for each industry. Note that, since the industry pass-through are estimated at four-digits industries, we cannot longer include four-digit fixed effects. Instead, we include two digit and year fixed effects, and present the results with and without the pass-through for comparison (Panels A and B).

[33] Additionally, to test whether the productivity threshold to borrow in foreign currency drops following UIP deviations (Lemma 2), we estimate a regression on the productivity of firms borrowing in foreign currency on UIP deviations, and show that the average productivity of these firms decreases following UIP deviations (Table B.15).

6.1 The Aggregate Impact of Foreign Loans and their Allocation across Firms

6.1.1 Impact of Foreign Currency Borrowing: Growth and Balance Sheet Effects

In this exercise, we quantify the firm-level and aggregate implications of foreign currency borrowing by comparing an economy with and without this financing. In particular, we compare our benchmark model with an economy in which firms are banned from borrowing in foreign currency and can only issue local denominated debt. In this setting, firms can choose their capital and local currency debt for the next period (k' and b'), given the states (ω, z, k, b).

In the economy with access to foreign currency borrowing, lower financing costs allow firms to achieve higher investment rates. As shown in columns 1 and 2 of Table 7, firms have 2 percentage points higher investment rates per year (13.7% vs 11.7%). This larger investment translates into an increase in firms' size and a lower default rate. This lower default rate (0.5 percentage points lower) is interesting because it indicates that, despite that foreign loans potentially expose firms to balance sheet effects, they also allow firms to accumulate more capital and become more resilient to productivity and interest rate shocks. Higher investment at the firm-level also leads to higher aggregate capital. Between 2001 and 2015, the economy with foreign loans has 8.4% higher capital growth and 7.8% higher sales growth. Remarkably, foreign loans reduce the MPK dispersion, as productive and small firms can accumulate more capital. In an economy without foreign loans, MPK dispersion is more than two times larger than when firms can use this financing.

This exercise shows that, even in presence of balance sheet effects, an economy with foreign borrowing has higher capital growth, and lower default and MPK dispersion. In the next section, we show that these results strongly depend on how foreign loans are allocated across firms.

Table 7: Aggregate Impact of Foreign Loans and their Allocation across Firms

	Benchmark	No FC Borrowing	No Heterogeneity in Prod. and Capital
	(1)	(2)	(3)
Firm-level results			
FC Debt Share	8.8	-	48.8
Investment rate	13.7	11.7	9.1
E(K)	43.2	42.3	49.3
Default rate	2.6	3.1	3.7
Aggregate results (wrt column 1)			
Capital Growth	100.0	91.6	82.1
Sales Growth	100.0	92.2	82.7
MPK Dispersion	100.0	319.8	318.3

Notes: Rows 1, 2 and 3 are in percentage. Rows 5-7 are with respect to column 1. Rows 5 and 6 is the growth between 2001 and 2015. Columns 1-3 show the moments for an economy with and without foreign currency borrowing, and with no heterogeneity in productivity and capital. Period: 2001-2015.

6.1.2 The Importance of the Allocation of FC Loans across Firms

In this section, we show that the aggregate implications of foreign borrowing depend on how these loans are allocated across firms by conducting two counterfactual exercises. In our first exercise, we make all firms use foreign loans independently of their level of productivity and capital. In our second exercise, we shut down heterogeneity in productivity and capital sequentially to analyze the implications of each dimension of separately. For comparison, in all exercises, we set firms' foreign currency leverage to imply the same aggregate share of foreign currency debt than in the benchmark. We match the aggregate foreign currency share to assess the importance of the distribution of foreign currency loans across firms on aggregate outcomes. We show that economies with the same share of foreign loans and different allocation of them can have different aggregate outcomes.[34]

Column 3 in Table 7 presents the results of our first exercise, in which all firms use foreign loans and have the same leverage in foreign currency. The comparison with our benchmark economy (column 1) reveals that, when firms can not choose their exposure to the currency risk, their investment rate is lower. This lower investment arises from the higher default rate and bigger size of surviving firms. Since in this economy foreign loans are also taken by less productive and/or smaller firms that cannot tolerate the currency risk, more firms default. Furthermore, surviving firms are larger and closer to their optimal scale and, thus, invest less. On the aggregate, lower investment rate translate into less 18% capital and 17% sales growth, and more than three-times MPK dispersion. This decrease in capital accumulation and increase in balance sheet effects can be such that the economy can experience 10% lower capital growth and 20% higher default than an economy without foreign loans (column 2).

To understand the forces driving these results, in our second exercise we shut down heterogeneity in capital and productivity sequentially. We keep a similar proportion of firms borrowing in foreign currency than in the benchmark economy (10%), and allocate foreign loans to the 10% firms with higher capital and the 10% most productive firms. That is, in the first exercise, we force firms with 10% higher capital to borrow in foreign currency regardless of their productivity. To fix ideas, we can think of this exercise as big and politically connected firms getting the foreign loans. In the second exercise, we force the 10% most productive firms to get foreign loans, independently of their capital. Since, in both economies, firms that do not borrow in foreign currency behave similarly to the non foreign borrowing exercise, we focus our analysis on firms that use this financing ($b'^* > 0$). Column 2 in Table 8 shows that, when only high capital firms borrow in foreign currency, the investment rate is much lower than in the benchmark economy (1.6% vs 14.7%) and the default rate drops to zero. Large firms are closer to their optimal scale and, thus, naturally have lower investment rate. Furthermore, their large size makes them more resilient to shocks and less likely to default. These results flip when instead only

[34]In our first exercise, we re-optimize firms choices, fixing the foreign currency leverage (b'^*/k') to be the same across firms but allowing them to decide their local currency debt (b') and capital (k'). Moreover, the firm foreign currency share is heterogeneous and pinned down by the firm's choice of local currency leverage. We calibrate the foreign currency leverage to 7%, which makes aggregate FC share match the one in the benchmark economy. In the exercise without heterogeneity in productivity, we force firms with capital in the top 10 percentile of the capital distribution in the benchmark simulation to have a FC leverage of 18% to match the aggregate FC share of the benchmark. Hence, capital and local currency debt are still a choice, but the level of FC leverage is fixed to zero for small firms and to 18% for the top largest firms. Similarly, in the exercise without heterogeneity in capital, we force the 10% most productive firms in the benchmark to have a leverage of 15% to match the aggregate FC share of the benchmark.

high productivity firms borrow in foreign currency (column 3). Since foreign currency borrowing is now held by productive but small capital firms, investment increases and defaults surges because these firms have higher needs of capital but are less resilient to shocks.

On the aggregate, economies in which firms borrow in foreign currency independently of their productivity or capital have about 8% lower capital growth and higher MPK dispersion. In the economy without heterogeneity in capital, there is more MPK dispersion because small firms can not borrow in foreign currency, which undermines their investment. Instead, in the economy without heterogeneity in productivity, highly productivity and capital scarce firms use foreign loans to invest, which lowers MPK dispersion. These exercises show that, even if only 10% of firms borrow in foreign currency, different allocations can entail non-trivial aggregate implications

Table 8: The Importance of the Allocation of FC Loans across Firms

	Benchmark	No selection	
		in productivity	in capital
	(1)	(2)	(3)
Firms borrowing in FC			
FC share	48.1	46.7	51.4
Investment rate	14.7	1.6	8.1
Default rate (wrt to column 1)	100.0	0.0	248.3
Aggregate (wrt column 1)			
Capital Growth	100.0	91.6	92.4
Sales Growth	100.0	92.2	93.0
MPK dispersion	100.0	321.3	225.6

Notes: Rows 1 and 2 are in percentage. Rows 3 and 4 are with respect to column 1. Columns 1-3 show the moments for an economy with foreign currency borrowing, with no heterogeneity in productivity and capital, respectively. Period: 2001-2015.

Results presented in this section show that assessing the allocation of foreign loans across firms is critical to understand its aggregate consequences. If firms would borrow in foreign currency regardless of their productivity and capital, the economy would see low growth and high balance sheet effects. Remarkably, these effects come from two different forces. Allocating foreign loans to high productivity firms maximizes capital accumulation, but increases default. Allocating foreign loans to high capital firms reduces investment, but also minimizes default. It is the allocation to high MPK firms what allows maximizing the growth benefits and minimizing the balance sheet effects of foreign borrowing.

This exercise also sheds light on the current debate about the sequence of reforms in developing economies. It indicates that, prior to the deregulation of foreign currency loans, countries should have an outstanding banking sector able to screen firms and allocate these loans to firms with low risk and high growth opportunities. To illustrate this, in Appendix A.8, we present an additional exercise in which creditors screen imperfectly the productivity of firms using foreign loans. This friction allows firms to take extra risk and use foreign loans to levels they cannot tolerate. On the aggregate, the foreign currency share almost doubles and default rates increases six-fold. A good screening mechanism is then crucial to minimize the balance sheets costs implied in foreign loans.

6.2 *Currency Crises*

Foreign currency borrowing allows firms increasing investment, but it also exposes them to currency mismatch. In this section, we conduct two exercises to study the impact of moderate and large depreciations on firms' balance sheet and exit. In the first exercise, we exploit the 10% depreciation of the Hungarian Forint during the Financial Crisis (2008-10) to evaluate whether the model is able to replicate the behavior of Hungarian firms upon the crisis. In the second exercise, we use the model to assess the possibility of rare but extreme depreciations during currency crashes.

-Hungary During the Financial Crisis

Following the bankruptcy of Lehman Brothers in 2008, the Hungarian currency abruptly depreciated against the Euro and declined by more 10% by 2010. We employ this exogenous depreciation in a difference-in-difference estimator to assess empirically whether it led to balance sheets effects. Additionally, we evaluate whether the model is able to reproduce Hungarian firms' responses by estimating the same regressions using the simulated data. Importantly, the model is able to mimic the currency depreciation as the calibration uses the realization of foreign interest rate shocks in those years. Note that the model also reproduces the cyclicality of firms' payoff, as aggregate productivity negatively correlates with the exchange rate, reducing firms' sales during depreciations.

To study balance sheet effects, we assess whether firms had their investment plans altered, changed the currency composition of their loans and their leverage and experienced higher exit. We estimate the following OLS regression:

$$Y_{it} = \beta \left(C_t \,\text{x}\, \text{FC Leverage}_i \right) + \phi_i + X_{jt} + \varepsilon_{ijt}, \tag{19}$$

where i, j, t index firm, four-digit NACE industries and time. Y_{it} is a vector of $\{\log \text{FC Share}_{it}, \log \text{Leverage}_{it}, \log \text{Investment Rate}_{it}, \text{Exit}_{it}\}$. C_t is a dummy for the crisis years ($C_t = 0$ if t $<$ 2008, and $C_t = 1$ if $t \geq 2008$). FC Leverage$_i$ is the firm's foreign debt-to-assets ratio in the initial year (2005). ϕ_i are firm fixed-effects, and X_{jt} are sector-year fixed effects interacted that absorb any year-sectoral shock that could affect firms differently across activities (as for example demand-industry specific shocks). β captures the differential impact of the depreciation according with firms' initial foreign debt leverage.

We present the Hungarian data results in columns 2, 4, 6 and 8 of Table 9. The estimated coefficients indicate that firms borrowing in foreign currency experienced negative balance sheet effects, as they lowered their investment rate (55%) and leverage (13%), and changed the composition of debt towards local currency denominated loans (34%). Notably, these firms did not experience higher exit after the depreciation. Instead, the negative and statistically significant coefficient indicates that these firms had lower exit rates.[35] While this lower exit might appear counter-intuitive at a first view, it is not surprising in light with the model's implications and the lower exit rate reported in Table 7. UIP deviations offer lower financing costs that allow firms to expand their investment and scale of operation. As firms

[35] These results are also in line with Gyongyosi and Verner (2019) who find that Hungarian firms borrowing in foreign currency did not experience large drops in sales or employment in the years following the currency depreciation of 2008-2010.

grow faster in "good times", they become more resilient to shocks. Hence, for relatively moderate depreciations, firms might experience negative balance sheet effects, but previous investment can allow them to survive the shock. Our results indicate that this was the case for Hungarian firms during the Financial crisis, but these result could change for larger depreciations as we show in the next section. Columns 1, 3, 5 and 7 show that our model is able to replicate –both in sign and size– these results.[36]

Table 9: Depreciation during the Financial Crisis

	Log Share of FC Loans		Log Leverage		Log Investment Rate		Exit	
	Model (1)	Data (2)	Model (3)	Data (4)	Model (5)	Data (6)	Model (7)	Data (8)
Crisis x Log FC Leverage	-0.384***	-0.341***	-0.197***	-0.130***	-0.554***	-0.554***	-0.012**	-0.047***
	(0.002)	(0.018)	(0.003)	(0.014)	(0.066)	(0.089)	(0.005)	(0.010)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector* Year FE		Yes		Yes		Yes		Yes
R^2	0.413	0.685	0.342	0.510	0.338	0.805	0.296	0.492
N	1,039,875	764,784	1,039,875	764,784	1,039,875	405,842	1,039,875	764,784

Notes: *, **, *** significant at 10, 5, and 1 percent. Standard errors in parenthesis. FC leverage is the firm's foreign currency debt over total assets in the initial year (2005). Source: APEH and Credit Registry.

-Extreme (and Rare) Depreciations

To evaluate the model's implications in extreme depreciations, we follow the literature of disaster risk in currency markets (Farhi, Fraiberger, Gabaix, Ranciere, and Verdelhan 2015 and Farhi and Gabaix 2016) and include the possibility of a rare but a large depreciation of 100%. For comparison, we estimate the same regression as in equation (19) with an extreme depreciation in 2008 and present the results in Table 10. This exercise shows that firms using foreign loans have much larger drops in leverage (61%), share of foreign loans (103%) and investment rate (69%) relative to a moderate depreciation (columns 1, 3 and 5 in Table 9). In contrast to moderate depreciations, firms borrowing in foreign currency have positive and higher exit rate (4.4%).

-Discussion of Results and Related Literature

The literature on currency crises has documented empirically balance sheet effects following large depreciations. Among others, Aguiar (2005) reports that Mexican firms indebted in foreign currency reduced investment rates during the Tequila crisis in 1994-95, and Kim, Tesar, and Zhang (2015) show that Korean firms using this financing had larger likelihood of exiting during Asian crisis in 1997-98. Besides confirming these results, this section provides novel evidence showing that, upon depreciations, firms deleverage and switch the currency composition of their debt towards local currency loans.

Additionally, and in contrast with the common belief that currency depreciations lead imminently to higher exit, we show that the relationship between currency depreciations and exit is non-monotonic.

[36] We present a full set of robustness tests in Appendix B. Table B.18 shows that results are robust to: i) replacing the year fixed effects by a crisis dummy, ii) control for the differential pre-growth trends of firms borrowing in foreign currency; and iii) to control for the differential effect of the depreciation on importers and smaller firms. Table B.19 shows that results are robust to including exporters and foreign firms.

Table 10: Extreme Depreciations

	Log Share of FC Loans	Log Leverage	Log Investment Rate	Exit
	Model			
	(1)	(2)	(3)	(4)
Crisis x Log FC Leverage	-1.031***	-0.615***	-0.694***	0.044***
	(0.006)	(0.004)	(0.062)	(0.006)
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
R^2	0.341	0.513	0.295	0.266
N	1,039,875	1,039,875	1,039,875	1,039,875

Notes: *, **, *** significant at 10, 5, and 1 percent. Standard errors in parenthesis. FC leverage is the firm's foreign currency debt over total assets in the initial year (2005).

For small and moderate depreciations, firms indebted in foreign currency might be able to survive currency shocks better, as higher capital accumulation during good times makes them more resilient to shocks. For sufficiently large depreciations, the increase in debt repayment can be high enough that firms cannot fulfil their commitments and exit market. This non-monotonic relationship provides additional support for the mechanism proposed in this paper by showing that, in a dynamic setting with capital accumulation, firms might choose to borrow in foreign currency and be exposed to the currency risk in order to increase investment and reach faster their optimal scale of production.

Note, finally, that our mechanism does not imply implicit bailout guarantees and, without them, firms might still find it optimal to use foreign loans. The next section advances this analysis and studies how exchange rate market interventions and bailout guarantees affect foreign borrowing decisions.

6.3 Exchange Rate Market Interventions and Systemic Risk

We have so far let the currency move freely without limiting depreciations or appreciations. In this section, we extend our analysis and study how exchange rate market interventions can affect firms' foreign currency borrowing decisions. That is, by affecting the volatility of the currency and, thus, foreign loans' implicit risk, these policies might not only affect the currency composition of firms' debt (intensive margin), but also the allocation of foreign loans across firms (extensive margin) and, consequently, entail different aggregate consequences. We conduct three numerical exercises: i) a regime in which the exchange rate is held constant (fixed peg), ii) a regime limiting depreciations (implicit bailout) and iii) a regime in which the exchange rate fluctuations are bounded below and above (managed float).[37]

i) Fixed Peg. In our first exercise, reported in column 2 in Table 11, we let the domestic currency be pegged to the foreign currency, such that there is no currency risk (i.e. $s'/s = 1$). As such, UIP deviations only arise from interest rate differentials. In the absence of currency risk and in presence of interest rate differentials, all firms that borrow do so in foreign currency and their foreign currency

[37] It is worth mentioning that these exercises do not intent to estimate the welfare gains from each regime or select the best of them. Instead, they aim to uncover how each regime would affect firms' foreign currency borrowing decisions and their aggregate implications.

share is 100%. There is also a large expansion in the extensive margin of firms borrowing: the share of borrowing firms reaches 90% of all firms in the economy, a 150% increase with respect to the benchmark. This increase in the extensive margin stems from two sources. First, firms that –in the benchmark– could not tolerate the currency risk and only borrowed in local currency can now switch their liabilities to foreign debt. Second, firms that –with a flexible currency– could not afford to borrow, they can now borrow at a cheaper (foreign) rate at zero currency risk. As a result, the composition of firms using foreign loans changes and the productivity threshold to use foreign loans drops. Hence, a fixed peg not only makes firms tilt all their liabilities towards foreign currency (intensive margin), but it also allows riskier firms to start using these loans (extensive margin). Remarkably, since more firms can accumulate more capital, the aggregate economy has lower MPK dispersion and higher capital growth.

These results are very interesting because they suggest that risk-taking governments could have incentives to implement pegs in order to expand cheap credit among more firms and accelerate capital accumulation. Yet this choice can create systemic risk, as unproductive firms start using –and do it– intensively foreign loans. A small change in external or internal conditions putting at risk the continuation of the peg can lead to massive balance sheet effects and default. Overall, these governments would be promoting growth to the expense of creating systemic risk.

Table 11: Exchange Rate Regimes

	Benchmark	Full Peg	Limit to Depreciations	Managed Float
	Model			
	(1)	(2)	(3)	(4)
Share of firms borrowing	36.3	89.4	73.7	36.4
Firms borrowing in FC				
Share of firms on firms with credit	48.6	100.0	85.1	36.1
FC share	47.3	100.0	76.4	42.0
Leverage	34.4	49.4	35.3	37.3
Productivity threshold	1.43	1.26	1.39	1.32
Default rate (wrt to column 1)	100.0	81.0	82.4	132.3
Aggregate (wrt column 1)				
MPK Dispersion	100.0	89.9	94.7	100.6
Capital Growth	100.0	126.5	98.8	96.7
Sales Growth	100.0	142.1	93.4	96.9

Notes: Rows 1-4 and 6 are in percentage terms. Rows 7-9 are with respect to column 1. Column 2 presents the moments of an economy in which the exchange rate is fixed. In column 3, the exchange rate is not allowed to depreciate more than 10%. In column 4, the economy precludes the exchange rate to appreciate or depreciate more than 10%. Period: 2001-2015.

ii) Limit to Depreciations. One way in which governments might intervene the exchange rate market is by limiting the extend in which the currency depreciates. By doing so, they implicitly create bailout guarantees that can affect firms' foreign currency borrowing decisions. In this exercise, we evaluate this by re-optimizing the model and restricting the currency to depreciate more than 10%. More formally, we set $s'/s = min(m'^{*}/m', 1.1)$. Column 3 in Table 11 shows that the presence of implicit bailout guarantees strongly encourages firms to borrow in foreign currency, as firms can borrow at a low rate without the downside of a negative currency shock. At the extensive margin, the share of firms borrowing in the economy doubles with respect to the benchmark (reaching 74% of firms), and 85% of these firms use foreign currency loans. The expansion on the extensive margin can also be seen through the decrease in the productivity threshold to use these loans. At the intensive margin, firms hold large shares of foreign currency debt, reaching on average 77%.[38] Hence, implicit bailout guarantees not only creates incentives for firms to switch the currency composition of their debt towards foreign loans, but they also allow riskier firms to borrow in foreign currency. On the aggregate, the economy has the same level of capital growth that the benchmark, but MPK dispersion decreases by 5%.

These results are in line with Schneider and Tornell (2004) and Ranciere, Tornell, and Vamvakidis (2010) who argue that implicit bailout guarantees encourage firms to borrow in foreign currency and can create systemic risk. Our results differ from theirs in three ways. First, while in their model bailout guarantees are the only source leading firms to use foreign loans; in our model these loans arise from UIP deviations and bailout guarantees only magnify their use. Second, in their model, bailout guarantees take the form of government lump-sum transfers that allow creditors and firms to not internalize the default cost and over- borrow. Instead, in our model, there is no excessive leverage as the currency risk is priced correctly, and firms and creditors fully absorb the default cost. This is shown in column 3 that indicates that leverage is close to the benchmark and its level is still moderate (35%). This level of leverage is consistent with the empirical evidence presented in Table 3 that shows that Hungarian firms only borrowing in foreign currency had a leverage of 18% and those borrowing in both local and foreign currency had a leverage of 25%. Finally, while in their model systemic risk arises from the use of foreign loans by firms without foreign income and their excessive leverage; in our model, systemic risk arises from the composition of firms using these loans. As discussed through the paper, in a dynamic setting, firms without foreign income could still find it optimal to borrow in foreign currency. What creates systemic risk is that exchange rate market interventions encourage the least productive firms to use foreign loans. This creates lock-in effects, as these firms are not resilient to moderate exchange rate movement and depreciations can lead to massive default.

iii) Managed Float. In our last exercise, we assess the effect of a manage float in which the currency is not allowed to depreciate or appreciate more than 10%. In particular, we set the change in the exchange rate as $s'/s = max(min(m'^{*}/m', 1.1), 0.9)$. The difference with our previous exercises is that, since appreciations are also limited, firms using foreign loans do not benefit from large revaluation effects that can reduce their debt repayment. The lower extend of these positive revaluation reduces firms' incentive to borrow in foreign currency. As shown in Column 4, the share of firms borrowing in foreign currency lowers and their foreign currency share drops with respect to the benchmark. Yet, in spite of the lower foreign currency borrowing usage, there is a 33% increase in the default rate. Why is there lower foreign currency borrowing and more default? The reason is that there is a change in the composition of firms using these loans. The decrease in the volatility of the exchange rate allows less productive firms to start borrowing in foreign currency and take the currency risk, which is shown by the decrease in the productivity threshold. Hence, while managed floats lower the intensive margin of

[38] Note that these shares are lower than in the fixed peg because exchange rate fluctuations discourage the least productive firms to borrow in foreign currency.

foreign loans, they increase balance sheet effects, as they affect the composition of firms using foreign loans towards risky firms.

The results above indicate that exchange rate market interventions affect not only firms along the intensive margin - by changing incentives to use this financing - but they also induce non-trivial extensive margin effects, altering the composition of firms resorting foreign loans. This, in turn, suggests that a dynamic setting that allows for heterogeneous agents is necessary to fully capture the causes and consequences of foreign borrowing.

6.4 Additional Exercises: Economic Development and Exchange Rate Pass-Through

We conclude the analysis of the determinants of foreign currency borrowing by assessing how countries in different stages of their economic development –thought as the level of capital in the economy– can experience different patterns of foreign borrowing, and how exchange rate pass-through might affect firms' foreign currency borrowing decisions.

-*Economic Development.* To assess whether the level of a country's economic development affects foreign borrowing patterns, we compare two economies with low and high level of capital. In particular, we let all the features of economy be equal to the benchmark, except for the firm size distribution. That is, we simulate an economy with the same optimization as in the benchmark, but we truncate the initial firm size distribution to the bottom 25 percentile for a capital-scarce economy, and the top 75 percentile for a capital-abundant economy. We then re-scale them such that we have the number of firms is the same as benchmark. Considering the worlds' capital distribution in 2005, this exercise would be comparing the use of foreign loans in Cameroon (in p25) and New Zealand (p75), as if they would only differ in their capital stock. Columns 2 and 3 in Table 12 show that, in a capital scarce economy, firms are more prone to borrow in foreign currency and take the currency risk, as lower financing terms allow them to increase investment and grow faster. A larger share of firms using foreign loans and larger foreign currency share illustrate this. However, since firms are smaller in size, they are less resilient to shocks and the default rate is 40% higher than in a capital abundant economy. On the aggregate, a capital-scarce economy has 40% higher levels of capital and sales growth over the same period.

This exercise shows that countries in their early stages of economy development could have incentives to deregulate foreign borrowing in order to grow faster, but this growth would be at the expense of higher firms' default and an economy more prone to currency crisis.[39]

-*Exchange Rate Pass-Through.* Although the bulk of firms using foreign loans are service firms (where pass-through is rather low) and that –as shown above– industry exchange rate pass-through does not seem to significantly affect firms' foreign currency borrowing decisions (Tables B.11 and B.9), it is worth assessing how exchange rate pass-through could affect firms' currency debt composition. The reason is that, following a depreciation, pass-through increases firms' prices and, thus, revenues mitigating or cancelling out negative balance sheet effects.[40] To assess the effect of pass-through, we

[39]This result is in line with Ranciere, Tornell, and Westermann (2008) who document that financially liberalized economies growth faster in the long-term, but they experience more frequent and deeper financial crises than non-liberalized economies.

[40]This exercise also helps illustrating how exporters could be naturally hedged, as their export prices can increase upon

set the exchange rate pass-through, η ($p = s^{\eta}$), to be 0.2, which is the value estimated for Hungary of regression of log consumer prices on the log exchange rate between 1992 and 2015. Column 4 in Table 12 shows that exchange rate pass-through has a large impact on the extensive margin, as the share of firms borrowing in foreign currency increases by more than two-fold with respect to the benchmark and the productivity threshold drops. There is also an expansion in the intensive margin, shown by the two-fold increase in aggregate share of foreign loans. Importantly, there is a 40% decrease in the default rate, as firms can accumulate more capital and pass-through mitigates the currency risk. The higher capital accumulation at firm-level results in high capital growth at the aggregate level and a reduction in MPK dispersion.

Table 12: Additional Exercises: Economic Development and Pass-Through

	Benchmark	Capital Distribution		Exchange Rate
		Percentile 25	Percentile 75	Pass-Through
	Model			
	(1)	(2)	(3)	(4)
Firm-Level Results				
Share of firms borrowing in FC	17.3	20.8	15.7	41.3
FC Share	8.76	9.96	8.18	28.4
E(K)	48.2	47.8	48.9	54.6
Default Rate (wrt column 1)	100.0	124.5	86.9	61.5
Productivity threshold	1.43	1.43	1.49	1.36
Aggregate Results (wrt column 1)				
Capital Growth	100.0	126.3	86.1	102.3
Sales Growth	100.0	118.1	88.0	107.4
MPK Dispersion	100.0	101.8	99.0	95.0

Notes: Rows 1 and 2 are in percentage terms. Rows 4 and 6-8 are with respect to column 1. Columns 2 and 3 present the moments of an economy in different levels of economy development, in which the initial size distribution of firms is in the percentiles 25 and 75 of the benchmark distribution. Column 4 shows the results for an economy with imperfect pass-through. Period: 2001-2015.

7 Conclusion

This paper shows that firms' foreign currency borrowing decisions arise from a dynamic trade-off between exposure to the currency risk and potential growth. We develop a firm dynamics model with endogenous debt composition to jointly study firms' financing and investment decisions. In our model, highly productive firms with low capital choose to borrow in foreign currency and be expose to the currency risk in order to reach faster their optimal scale of production.

We test the model's implications using a unique dataset reporting information on firms' balance sheets and debt by currency denomination in Hungary over 1996-2010. We confirm that there is selection into foreign currency borrowing, as only highly productive firms find it optimal to employ this financing, and that the share of foreign borrowing increases in firms' marginal product of capital. On the aggregate, we show that economies allowing for foreign currency borrowing have higher sales and more capital,

depreciations (depending on whether they set local or producer prices). The extreme case is dollar pricing in which export revenues increase one-to-one with the foreign debt repayment and there is no balance sheet effect.

at the expense of higher volatility. Our analysis points that selection of productive firms into foreign currency borrowing is crucial to generate gains from this financing, as a weak screening mechanism could lead to lower sales and capital than a closed economy.

This paper offers a novel framework to study the aggregate impact of risk factors building from firm-level decisions. In our model, exchange rate risk affects firms' risk taking decisions heterogeneously, which in turn shapes the aggregate impact of the currency shock. This approach can be extended to other questions beyond foreign currency borrowing, as for example firms' choice of interest rate exposure (floating vs fixed rates) or maturity decisions (short vs long term loans). From a policy perspective, this paper sheds lights on the importance of a well functioning financial sector in the process of international financial integration. We showed that the ability of banks to properly screen firms is crucial to reap benefit from international capital flows. Viewed through the lens of the paper, the sequence of reforms matters to profit from the financial globalization.

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