Financial Frictions, Foreign Currency Borrowing, and Systemic Risk*

Giovanni Dell'Ariccia
IMF and *CEPR*

Luc Laeven
ECB and *CEPR*

Robert Marquez
University of California, Davis

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Abstract

Fixed exchange rate regimes that are not fully credible are typically fraught with a peso problem (the low probability expectation of a large currency devaluation). Under these conditions, foreign currency borrowing can ameliorate financial frictions in the economy, while at the same time increasing systemic risk. The lower interest rate on foreign-currency-denominated liabilities improves borrowers' incentives and reduces the agency problem associated with limited liability and the unobservability of borrowers' action. In doing so, it reduces borrower idiosyncratic risk, but exposes the system to the risk of correlated defaults through exchange rate devaluation. The resulting trade-off between average performance and systemic stability provides a rationale for measures aimed at limiting currency mismatches. This becomes stronger when widespread bankruptcies increase the risk of failure as a result of the failure of a counterparty.

Keywords: liability dollarization, systemic risk, banking crises
JEL Classification Numbers: E44, E58, G21

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Abstract

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1 Introduction

In this paper we explore how foreign currency borrowing can ameliorate financial frictions in emerging economies while at the same time increasing systemic risk. Under certain conditions (that we interpret as typical of fixed exchange rate regimes), foreign-currency-denominated liabilities improve firms' incentives and reduce the agency problem associated with limited liability and the unobservability of a firm's actions. In doing so, it reduces idiosyncratic risk for firms. However, it exposes the system to the risk of correlated defaults through exchange rate devaluation.

Foreign currency borrowing (or liability dollarization) has been a common feature in several emerging market economies. Typically, this liability dollarization reduces the interest borrowers pay on their loans (these countries generally pay a currency premium) and has been associated with faster credit and economic growth. For instance, in the run-up to the recent global financial crises, among a sample of Eastern European countries, credit growth was the fastest in countries that had a larger share of credit denominated in foreign currency.

Liability dollarization, however, also increases systemic risk. Should the country experience a sharp currency depreciation, firms with unhedged foreign-currency denominated debt would find it difficult to honor their liabilities, resulting in widespread bankruptcies.[1] Indeed, there is a clear link between liability dollarization and the frequency of banking crises. Liability dollarization also appears to be associated with more rigid exchange rate regimes. For example, again in Eastern Europe, countries with currency boards or rigid pegs (such as Bulgaria, Estonia, or Latvia) had a much larger share of credit to the private sector denominated in foreign currency than exchange rate floaters (such as the Czech Republic, Poland, and Slovakia).[2] There is also some evidence that the share of foreign currency lending in domestic credit gradually declined in countries that abandoned a fixed exchange rate regime.[3]

In our model, entrepreneurs borrow in order to invest in productive projects. A project's probability of success depends on the entrepreneur's costly effort. We introduce two basic financial frictions. First, entrepreneurs/firms are protected by limited liability. Second, an entrepreneur's effort is unobservable to lenders and cannot be contracted upon. These two frictions generate an

[1] See Schneider and Tornell (2004).
[2] See Rosenberg and Tirpak (2008).
[3] See Martinez and Werner (2002) for a study on Mexico in the aftermath of the Tequila crisis.

inefficiency in the economy as they entail a backward bending credit supply curve (à la Stiglitz and Weiss, 1981). Higher interest rates reduce the entrepreneur's payoff in case of success and thus also reduce her effort. Then, when the cost of effort is sufficiently high, there does not exist an interest rate at which the lender can break even given the expected probability of repayment. Put differently, projects that could be funded under perfect information are rationed out of credit markets when the entrepreneur cannot commit to a particular level of effort.

We assume that the domestic currency is expected to depreciate, so that the risk free domestic interest rate is higher than the foreign rate. Further, we assume that this spread is due to the expectation of a large devaluation to which markets attach a relatively low probability. We interpret these "peso problem" conditions as typical of exchange rate pegs and currency boards. Under these conditions, we show that foreign currency borrowing reduces the moral hazard associated with limited liability. The reason is that borrowing in foreign currency acts as a bonding mechanism for the firm: since the risk free rate abroad is lower, the firm is able to obtain a lower interest rate loan as foreign lenders have a lower threshold for lending. This creates a higher return for the firm whenever its project is successful, and provides the firm with a greater incentive to ensure that its return actually materializes, i.e., to put in more effort. The trade-off, however, is that borrowing in the foreign currency exposes the firm to more risk since it exposes it to devaluation risk. This depends critically, however, on the distribution of possible exchange rate movements: when the probability of an exchange rate movement is instead high, foreign currency lending worsens, rather than ameliorates, the agency problem. Note as well that in our framework the firm does not borrow in order to hedge foreign currency risk and does not have income in foreign currency, unlike part of the literature on dollarization focusing on large firms, and that borrowing in foreign currency could be from abroad or directly from local banks.

From a policy perspective, the paper supports the view that government intervention, in the form of (macro) prudential regulation and/or capital controls, to curb foreign currency borrowing and the systemic risks associated with it may be socially optimal. The paper points to a trade-off between superior productivity and greater systemic risk (defined as the risk of widespread failures, i.e., a crisis). In the model, we assume risk neutrality. Hence, average performance is all that matters. However, the model lends itself to the analysis of the risk/performance trade-off once one

introduces a risk-averse regulator. Alternatively, the analysis can be readily augmented to include a non-linear social cost of failure: if a few borrowers fail the costs are relatively low, but become very large if there are widespread failures and defaults. Under either one of these minor extensions, situations where a large mass of firms default, which constitute systemic crises, have a significant negative effect on social welfare. This means that the social planner may be willing to trade average performance for a reduced probability of a systemic crisis.

We extend the model to consider the possibility the the failure of a counterparty negatively affects firms with successful projects and causes them to fail as well. This issue becomes more important the more firms fail at the same time, and we show that this adds an additional important wrinkle to the problem. In particular, the risk of devaluation acts as an externality if widespread failures may affect a firm's counterparties, thus having a detrimental effect on that firm's ability to repay even if it would be otherwise sound. If a sufficiently large fraction of firms borrows in foreign currency, others (who would have otherwise borrowed in local currency) may find it optimal to do the same as they are exposed to the risk of devaluation through its effects via the real economy. The possibility of counterparty failure thus affects firms' choice of whether to borrow in the domestic or the foreign currency - there is a complementarity in the choice of borrowing denomination - and may further exacerbate the likelihood and the severity of a systemic crisis. Under these conditions, regulation aimed at limiting or eliminating foreign currency borrowing may be welfare improving.

The paper relates to a broad literature on how financial imperfections contribute to shaping international capital flows. Our analysis is closest to Ranciere, Tornell, and Westermann (2008) and Schneider and Tornell (2004). As in those papers, foreign currency borrowing can help address an agency problem and increases output in tranquil times at the cost of greater risk of systemic crises. In those papers, however, credit rationing helps to resolve the asymmetric information problem between borrowers and lenders so that, in the absence of bailout guarantees, risk is correctly priced at the margin. Here, while risk is correctly priced in equilibrium, lenders cannot condition their pricing on an entrepreneur's effort. As a result, systemic risk associated with foreign currency borrowing can emerge even in the absence of bailout guarantees. From this point of view, our paper identifies an additional mechanism linking systemic risk and economic performance.

Several papers focus on the interaction between liability dollarization and government behavior.

In Jeanne (2009), a sovereign's inability to protect foreign creditors' rights results in a system dominated by short-term loans. This short maturity structure provides governments with incentives to enforce foreign contracts. However, it comes at the cost of risking liquidation (i.e., a "run") triggered by negative productivity shocks (a similar theme is in Tirole, 2003). In Velasco and Chang (2004), foreign currency borrowing emerges as a reaction to the expectation that the central bank will choose a fixed exchange-rate regime. Then, the financial instability that a devaluation would cause through balance-sheet effects induces the central bank to fight exchange rate flexibility, validating expectations. Under these conditions, committing to exchange-rate flexibility, if feasible, is welfare improving. A similar analysis is in Chamon and Hausmann (2005). In Jeanne (2005), foreign currency borrowing is an outcome of domestic monetary policy. If monetary policy mitigates default risk in the private sector, firms will tend to borrow in domestic currency. If, on the other hand, the monetary environment does not protect firms against low realizations of their domestic currency income, firms will borrow in foreign currency because borrowing in domestic currency can result in unbearably high real debt burdens if the expected domestic monetary policy does not materialize ex post. In Korinek (2011), foreign currency debt emerges from an optimal portfolio choice problem with a risk premium on local currency debt. The advantage of local currency debt is that it mitigates economic volatility. Local currency debt emerges at low levels of volatility of consumption and the exchange rate, as well as when risk premia on local currency debt are low.

While we cast the analysis in the context of domestic- versus foreign-currency borrowing, we believe that several insights from our framework apply more broadly. In particular, the central finding that a reduction in idiosyncratic risk, and the related efficiency gains, may come at the cost of greater systemic risk applies to other contexts. For instance, consider the trade-off between fixed- and variable-rate debt contracts. Under normal conditions, short-term rates will be lower than long-term ones, allowing for better borrower incentives, much the way that foreign currency borrowing does in our model. However, such short term contracts will leave firms exposed to potentially sharp increases in their debt burden, in a similar fashion to how devaluation affects firms in our model. While interest rate changes will typically be small and gradual, unlike devaluation in our model, there are cases in which even marginal changes will imply payment difficulties for certain borrowers. For example, this kind of effect was observed for a large fraction of subprime borrowers when their

contracts reset, suggesting that the basic ideas here may be applied to a broader context such as the maturity composition of debt rather than its currency denomination. A related argument has also been made in the context of the use of short term, or even demandable, debt by banks, where a risky financing choice can help alleviate a moral hazard problem that otherwise would lead to excessive risk taking or, equivalently, too little effort in monitoring (see Calomiris and Kahn, 1991, and Diamond and Rajan, 2001).

The paper proceeds as follows: Section 2 examines a series of stylized facts and the empirical literature on foreign currency borrowing and financial crises. Section 3 presents and analyzes the main model. Section 4 examines the effects of changes in interest rates. Section 5 extends the model to the case of contagious defaults. Section 6 discusses the trade-off between performance and stability. Section 7 concludes and briefly discusses the policy implications of the model.

2 Stylized facts and empirical evidence

In this section, we review the empirical literature on foreign currency borrowing and financial crises, and present some stylized facts that are consistent with the predictions of our model.

Much of the micro-level empirical literature on the determinants of foreign currency borrowing and the balance sheets effects that arise as a result of currency depreciations when firms borrow in foreign currency has focused, due to data limitations, on large and publicly traded firms. Allayanis, Brown, and Klapper (2003) investigate the capital structure of 327 large, publicly traded firms in East Asia around the time of the East Asian financial crisis and collect data on their local, unhedged foreign, and hedged foreign currency debt. They find that interest rate differentials are a key determinant of the use of foreign currency debt, and that the market value of firms that used financial hedges to synthetically convert foreign currency debt into local debt were hit particularly hard during the 1997-98 East Asian financial crisis. Bleakley and Cowan (2008) study the currency composition of the debt of 500 publicly traded firms in Latin America during the period 1990 to 1999, a period of substantial exchange rate volatility in this region of the world, and find that the sensitivity of firms' investments does not depend on the currency composition of their debt because firms tend to match the currency composition of their debt with the elasticity of their income to the exchange rate. For a sample of large US firms, Kedia and Mozumdar (2003) find that firms issue

foreign currency debt mainly to hedge their exposure to foreign currencies. Similarly, Keloharju and Niskanen (2001) find for a sample of large Finnish firms that hedging features prominently in the decision to borrow in foreign currency, with firms for which exports represent a larger fraction of sales more likely to raise foreign currency debt. At the same time, they also find that firms tend to borrow in foreign currency when the foreign interest rate is relatively low, consistent with carry trade explanations.

Many of these results may be skewed by the focus on large and stock-exchange listed firms that are often in a better position to use financial hedges compared to small firms (either because of know-how or economies of scale). In fact, Gelos (2003), using data on 500 Mexican firms, shows that firm size is a key determinant of foreign currency borrowing in addition to imports and exports. Moreover, a large fraction of these firms has natural hedges against exchange rate risks because they operate in the tradable sector and have significant foreign currency revenues. Not surprisingly, much of this literature finds relatively small balance sheet effects associated with foreign currency borrowing during currency crises (for reviews, see Galindo, Panizza, and Schiantarelli, 2003, and Kamil, 2008).

Brown, Ongena and Yesin (2009) are the first to study the determinants of foreign currency borrowing for a representative sample of firms that includes small firms using survey data on firms in Eastern Europe. They find that firms that naturally generate a larger fraction of income in foreign currency, such as exporting firms, are more likely to borrow in foreign currency, while interest rate differentials and exchange rate volatility do not explain the use of foreign currency borrowing. Brown, Kirschenmann, and Ongena (2009) study a representative sample of Bulgarian firms and find that foreign currency borrowing is not only driven by demand factors but is partly supply-driven by banks that prefer to lend in foreign currency to minimize currency mismatches in their balance sheets, even when borrowers request loans in domestic currency. Obviously, this still exposes the banks to credit risks arising from balance sheet effects of their borrowers in case of currency depreciation.

Ranciere, Tornell, and Vamvakadis (2010) also study a representative sample of firms in Eastern Europe and focus on foreign currency borrowing by firms with no foreign currency income. They find that currency mismatches reduce interest rates and enhance growth of small firms in non-tradable

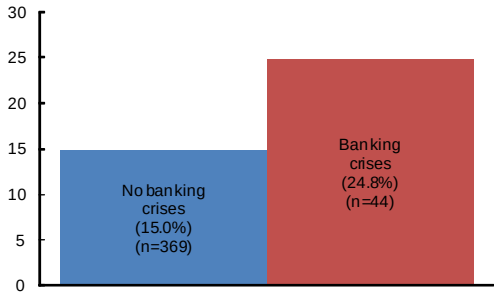
sectors, thereby contributing to growth in tranquil times, while at the same time increasing the probability of crises. They argue that the expectation of government bailouts in the event of a currency crisis is one of the mechanisms that fosters the use of foreign currency borrowing by firms that face borrowing constraints.

The empirical link between foreign currency borrowing and boom-bust cycles has led countries to implement regulatory policies to slow foreign currency borrowing during credit booms, although these policies have typically met with only limited success, mainly because these policies are generally easy to circumvent, for instance, through direct borrowing from abroad (Rosenberg and Tirpak, 2008). At the macro-level, a large empirical literature links banking and currency crises to credit booms accompanied by an overvalued currency, although most of this literature does not distinguish between local and foreign currency borrowing (see, for example, Kaminsky and Reinhart, 1999). In an exception, Ize and Levy-Yeyati (2003) show that the use of foreign-currency debt can be linked to macroeconomic uncertainty, including the relative volatility of domestic inflation and the real exchange rate.

Using data on foreign currency borrowing from the IMF's Vulnerability Exercise Database (not publicly available), Figure 1 shows a clear link between the degree of foreign currency borrowing in the country and the occurrence of banking crises, as defined in Laeven and Valencia (2008), in a sample of 114 countries. Foreign currency borrowing from banks in countries that experienced banking crises over the period 1970 to 2010 stood at 24.8 percent on average compared to only 15.0 percent in countries that did not experience a banking crisis over this period. These empirical findings are consistent with the prediction from our model that foreign currency borrowing exposes borrowers to exchange rate risk and exposes lenders to default risk from devaluation-driven balance sheet effects.

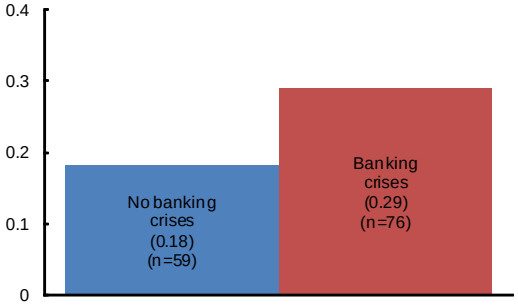
On the deposit-taking side of banks, De Nicolo, Honohan, and Ize (2003) show that dollarization is associated with deeper financial development, especially in high inflation environments. This is consistent with the model in Caballero and Krishnamurthy (2003) who argue that limited financial development reduces the incentives for foreign lenders to enter emerging markets.

Using data from Levy-Yeyati (2006) on the degree of dollarization of deposits in the country, Figure 2 shows a clear link between dollarization and the occurrence of banking crises, in line with



Notes: The red (blue) bar denotes the average percentage of foreign currency lending to nominal GDP across country-year observations for those years over the period 1970-2010 during which the country did (not) experience a systemic banking crisis, as defined in Laeven and Valencia (2010). Data on banking crises from Laeven and Valencia (2010), "Resolution of Banking Crises: The Good, the Bad, and the Ugly," IMF working paper 10/146, and data on percentage of foreign currency lending to nominal GDP from the IMF's Vulnerability Exercise Database. Number of country-year observations (n) between brackets. Sample of 114 countries.

Figure 1: Foreign currency lending to GDP and occurrence of banking crises, 1970-2010

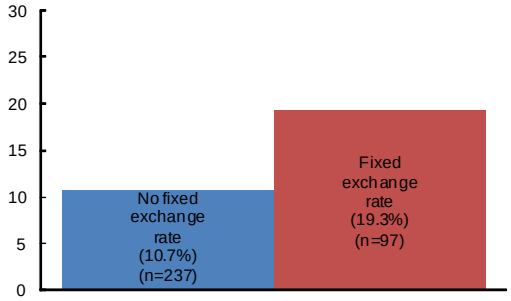


Notes: Bars denote the average degree of dollarization over the period 1970-2004 across countries depending on whether or not they experienced a systemic banking crisis during the period 1970-2004, as defined in Laeven and Valencia (2008). Degree of dollarization is the ratio of foreign currency deposits in total deposits. Data on the occurrence of banking crises are from Laeven and Valencia (2008), "Systemic Banking Crises: A New Database", IMF Working Paper 08/224, and data on the degree of dollarization are from Levy-Yeyati (2006), "Financial Dollarization: Evaluating the Consequences," Economic Policy, January, pp. 61-118. Number of country observations (n) between brackets.

Figure 2: Degree of dollarization and occurrence of banking crises, 1970-2004

the findings on the link between foreign currency lending and banking crises shown in Figure 1. The ratio of foreign currency deposits in total deposits is about 24 percent on average for countries that experienced a banking crisis over the period 1970 to 2004 compared to only 18 percent for countries that did not experience a banking crisis over this period.

A related literature studies the link between exchange rate regimes and banking crisis. Burnside, Eichenbaum, and Rebelo (2001) argue that banks in countries with a fixed exchange rate regime do not completely hedge the exchange risk that arises from the currency mismatch between their assets and liabilities in anticipation of government bailouts, and that such open foreign exchange positions makes banks prone to banking crises associated with currency crises. Empirical studies



Notes: The red (blue) bar denotes the average percentage of foreign currency lending to nominal GDP across country-year observations over the period 1970-2010 during which the country did (not) have a fixed exchange rate regime. Data on classification of exchange rate regimes from Reinhart, Carmen and Kenneth Rogoff, 2004, "The Modern History of Exchange Rate Arrangements: A Reinterpretation," Quarterly Journal of Economics 119(1): 1-48, and data on percentage of foreign currency lending to nominal GDP from the IMF's Vulnerability Exercise Database. We define fixed exchange rate regimes as exchange rate regimes with preannounced or de facto pegs (classification codes 2, 3 or 4 in Reinhart and Rogoff). Data on exchange rate regimes are averaged over the period 1970-2007. Number of country-year observations (n) between brackets.

Figure 3: Exchange Rate Regimes and Foreign Currency Lending, 1970-2010

generally find that fixed exchange rate regimes, and especially those with hard pegs, are more prone to banking crises than flexible exchange rate regimes or those with adjustable pegs, and that banking crises in fixed exchange rate regimes are more costly in terms of severity of crisis and output losses (Eichengreen, 2002, Demac and Martinez Peria, 2003, and Husain et al., 2005).

Figure 3 shows that foreign currency borrowing is more pervasive in countries with fixed exchange rate regimes, which together with Figure 1 suggests that the currency composition of borrowing may be a key driver linking fixed exchange rate regimes to crises. In the context of our model this association can be interpreted as fixed exchange rates being associated with higher expected devaluations despite higher probabilities (α) of the exchange rate remaining constant.

3 Model

Consider an economy populated by entrepreneurs/firms that invest \$1 in risky assets that return y when successful and 0 otherwise. A firm's effort determines the probability of success, q, at a cost $\frac{c}{2}q^2$. The cost c reflects country level institutional considerations that make it difficult for firms to establish good governance structures, such as because of the poor enforcement of investor rights. Firms have no initial funds and need to borrow in order to invest. The loan contract specifies the *gross* interest rate (i.e., one plus the net interest rate) r_L to be repaid by the borrower.

This is an open economy and firms can borrow in the domestic or a foreign currency. The two currencies are linked by a standard (simplified) interest parity condition: $r^* = r^{*f}\frac{\overline{e}}{e}$, where r^* is

the gross (credit) risk-free interest rate in domestic currency, r^{*f} its equivalent in foreign currency, $\overline{e}$ the expected future exchange rate change, and e the current exchange rate. For simplicity, we assume that exchange rate movements are governed by a binomial distribution: the exchange rate stays constant with probability α, and depreciates (or appreciates) by Δe with probability $1-\alpha$. Thus, we can rewrite the interest parity condition as

$$r^* = r^{*f}\left(1 + (1-\alpha)\frac{\Delta e}{e}\right). \tag{1}$$

3.1 Domestic currency borrowing

When a firm borrows in the local currency, it's expected profits can be written as

$$\Pi = q(y - r_L) - \frac{c}{2}q^2,$$

which reflects the fact that the firm's project will only pay off with a probability that is increasing in its level of effort q. When the project does pay off, the cash flow from the project is y, and the firm repays the lender the promised amount r_L. It's profit is then $q(y - r_L)$ minus the cost of its effort, $\frac{c}{2}q^2$. Maximizing this with respect to the level of effort gives

$$\widehat{q} = \frac{y - r_L}{c}.$$

The interest rate offered on the loan has to reflect the level of risk associated with the project. Suppose that investors or lenders conjecture a level of effort q^C. This then means that

$$q^C \widehat{r}_L = r^* \Rightarrow \widehat{r}_L = \frac{r^*}{q^C}.$$

In equilibrium, investors' or lenders' beliefs about the amount of effort that will be supplied must be correct, which means that $q^C = \widehat{q}$. We can substitute this into the expression for optimal effort $\widehat{q}$ to obtain $\widehat{q} = \frac{y - \frac{r^*}{\widehat{q}}}{c}$, and then solve for $\widehat{q}$ as

$$\widehat{q} = \min\left\{\frac{y + \sqrt{y^2 - 4cr^*}}{2c}, 1\right\}, \tag{2}$$

where (2) reflects the fact that the positive root that solves for the equilibrium value of effort is Pareto optimal (this can be easily shown). While in principle the negative root may also be part of a Nash equilibrium, we assume going forward that the Pareto dominant solution will be chosen.

The constraint that $\widehat{q} \leq 1$ reflects the fact that $\widehat{q}$ is the probability of project success and hence cannot exceed 1. Throughout, we focus on the case where there is an interior solution for the firm's effort, so that $\widehat{q} < 1$. It is straightforward to see that parameter values exist that guarantee $\widehat{q} < 1$ in equilibrium. We also assume that financing is viable, which amounts to assuming that $\widehat{q}$ is a real variable. A sufficient condition to guarantee this is that $y^2 - 4cr^* > 0$. We come back to this issue later when we explore the conditions under which investment, which entails financing, is feasible.

We can now invert the expression for optimal effort to obtain $\widehat{r}_L = y - \widehat{q}c$, which, after substituting for $\widehat{q}$ yields

$$\widehat{r}_L = y - c\frac{y + \sqrt{y^2 - 4cr^*}}{2c} = \frac{y}{2} - \frac{\sqrt{y^2 - 4cr^*}}{2}.$$

Using the optimal value $\widehat{q}$, we can write the equilibrium expected profits as

$$\begin{aligned}\Pi &= \widehat{q}(y - r_L) - \frac{1}{2c}(y - r_L)^2 = \frac{1}{c}(y - r_L)^2 - \frac{1}{2c}(y - r_L)^2 \\ &= \frac{1}{2c}(y - r_L)^2.\end{aligned}$$

Substitute now for the optimal $\widehat{r}_L$ to obtain

$$\widehat{\Pi} = \frac{1}{2c}\left(\frac{y + \sqrt{y^2 - 4cr^*}}{2}\right)^2.$$

Finally, we can use the interest rate parity condition, (1), to write the equilibrium profits $\widehat{\Pi}$ as a function of the foreign risk free rate, r^{*f}, and the expected expected exchange rate movement, $\frac{\Delta e}{e}$, and the probability of devaluation, $1 - \alpha$:

$$\widehat{\Pi} = \frac{1}{2c}\left(\frac{y + \sqrt{y^2 - 4cr^{*f}\left(1 + (1 - \alpha)\frac{\Delta e}{e}\right)}}{2}\right)^2. \tag{3}$$

3.2 Foreign currency borrowing

When firms borrow in the foreign currency, they become exposed to exchange rate risk. In particular, in case of a sharp depreciation of the domestic currency, firms may be unable to repay their loans even if their projects are successful (this is because the project is still run domestically, so the return y is denominated in the domestic currency, but the repayment r_L^f is in the foreign currency). Assume for simplicity that the possible depreciation Δe is large enough that, in the

even of a depreciation, the firm would go bust and default on its loan. A condition sufficient to guarantee this is that

$$y - r_L^f \left(1 + \frac{\Delta e}{e}\right) < 0.$$

Similar to above, we can write a firm's expected profit when it borrows in the foreign currency as

$$\Pi^f = q(y - r_L^f)\alpha - \frac{c}{2}q^2,$$

which reflects the fact that the project only pays off with probability q, but also the firm's return net of loan repayment is only positive if the domestic currency remains stable and does not depreciate. We can maximize these profits Π^f with respect to effort to obtain

$$\widehat{q}_f = \min\left\{\left(\frac{y - r_L^f}{c}\right)\alpha, 1\right\}. \tag{4}$$

As above, we will focus on the case where an interior solution exists, so that $\widehat{q}_f < 1$.

Now, since firms only repay when the currency remains stable, for banks/investors to be willing to lend in the foreign currency the interest rate needs to compensate them for both the borrower idiosyncratic risk, $1 - q$, and the devaluation risk, $1 - \alpha$. Assume for now the extreme (and unrealistic) case that under devaluation, the lender receives nothing back from the borrower. This would be consistent, for instance, with a very large devaluation that leaves little on the firm's balance sheet, and which subsequently gets lost as part of bankruptcy proceedings. As we show later, this extreme assumption in fact biases against borrowing in the foreign currency. Under this assumption, we have, given a conjectured level of effort q_f^C, that the promised repayment on the foreign loan, r_L^f, must satisfy

$$q_f^C \alpha r_L^f = r^{*f}.$$

From this we can solve for the equilibrium foreign denominated loan rate, $\widehat{r}_L^f$, as

$$\widehat{r}_L^f = \frac{r^{*f}}{q_f^C \alpha}.$$

As above, we can now substitute $\widehat{r}_L^f$ into the expression for the optimal effort $\widehat{q}_f$ given in (4) and solve for $\widehat{q}_f$ to obtain

$$\widehat{q}_f = \frac{1}{2c}\left(y\alpha + \sqrt{y^2\alpha^2 - 4cr^{*f}}\right).$$

Noting that $\widehat{r}_L^f = y - \frac{c\widehat{q}_f}{\alpha}$, we can substitute for $\widehat{q}_f$ and obtain

$$\widehat{r}_L^f = y - \frac{c\frac{1}{2c}\left(y\alpha + \sqrt{y^2\alpha^2 - 4cr^{*f}}\right)}{\alpha} = \frac{y}{2} - \frac{\sqrt{y^2\alpha^2 - 4cr^{*f}}}{2\alpha},$$

which gives us the equilibrium loan rate when the firm borrows in the foreign currency.

Given the optimal loan rate $\widehat{r}_L^f$ and effort level $\widehat{q}_f$, we can replace these in the expression for the firm's expected equilibrium profit as

$$\widehat{\Pi}^f = \widehat{q}_f(y - \widehat{r}_L^f)\alpha - \frac{c}{2}(\widehat{q}_f)^2 = \left(\frac{y - \widehat{r}_L^f}{c}\right)\alpha(y - \widehat{r}_L^f)\alpha - \frac{1}{2c}\alpha^2\left(y - \widehat{r}_L^f\right)^2.$$

Simplifying, $\widehat{\Pi}^f$ becomes

$$\widehat{\Pi}^f = \frac{1}{2c}\left(\frac{y\alpha + \sqrt{y^2\alpha^2 - 4cr^{*f}}}{2}\right)^2, \tag{5}$$

which again expresses the firm's equilibrium profit as a function of the foreign risk free rate.

3.3 Optimal borrowing

One important question of interest now is under what conditions, if any, firms prefer to borrow in foreign rather than domestic currency. We can now state the following result.

Proposition 1 *Keeping the size of the expected devaluation, $(1-\alpha)\frac{\Delta e}{e}$, constant, there exists a value $\underline{\alpha} < 1$ such that if the probability of no devaluation, α, is greater than $\underline{\alpha}$, firms prefer to borrow in the foreign currency rather than the domestic currency.*

Proof: A firm will prefer to borrow in the foreign currency if $\widehat{\Pi}^f > \widehat{\Pi}$. Using (3) and (5), we can write this inequality as

$$\frac{1}{2c}\left(\frac{y\alpha + \sqrt{y^2\alpha^2 - 4cr^{*f}}}{2}\right)^2 > \frac{1}{2c}\left(\frac{y + \sqrt{y^2 - 4cr^{*f}\left(1 + (1-\alpha)\frac{\Delta e}{e}\right)}}{2}\right)^2.$$

Rewriting yields

$$y\alpha + \sqrt{y^2\alpha^2 - 4cr^{*f}} > y + \sqrt{y^2 - 4cr^{*f}\left(1 + (1-\alpha)\frac{\Delta e}{e}\right)}. \tag{6}$$

If (6) is satisfied, then borrowing in the foreign currency will be optimal for the firm. From here, it is immediate that as α and $\frac{\Delta e}{e}$ increase so as to keep $(1-\alpha)\frac{\Delta e}{e}$ constant, hence keeping the domestic risk-free rate constant, $\widehat{\Pi}^f$ increases while $\widehat{\Pi}$ remains constant. As $\alpha \to 1$, the left hand

side converges to $y + \sqrt{y^2 - 4cr^{*f}}$, which is strictly greater than $y + \sqrt{y^2 - 4cr^*}$ since $r^{*f} > r^*$ whenever there is a positive risk of a devaluation. □

Proposition 1 establishes that an increase in the size of a (very large) devaluation that occurs with only a small probability - a "peso-problem" - favors foreign currency lending. One simple interpretation of this is as a fixed exchange rate regime where a change in the foreign risk free rate, r^{*f}, is immediately reflected onto an equal change in the domestic rate r^* because of the free flow of capital and the fact that with a (credible) fixed exchange rate regime expectations of a devaluation will not be affected by the change in the foreign interest rate.

By contrast, if α is low but the expected depreciation is also small (to maintain consistency with the interest rate parity condition), then profits are higher when borrowing in domestic currency. In other words, if there is a relatively high probability of a small devaluation, borrowing in the foreign currency is suboptimal because it exposes the firm to an additional large risk - the probability $1-\alpha$ of a devaluation - but little benefit since they only enjoy the reduced cost of borrowing $\widehat{r}_L^f$ when the project both succeeds and there is no devaluation. As above, this can be interpreted as a flexible exchange rate regime, where adjustments in the exchange rate are more frequent (i.e., lower α) but also typically smaller. We note, however, that (6) is written entirely in terms of the foreign rate r^{*f}, meaning that throughout we are assuming that parity is maintained by adjustments in the domestic rate r^*. In other words, the exercise conducted here cannot readily be interpreted as representing a flexible (i.e., fully floating) exchange rate regime. We discuss this case in more detail later.

As a final point, we show that the assumption that under devaluation the lender receives no repayment actually biases the firm against foreign borrowing. Suppose that instead under devaluation there is some residual amount less than what is promised to the lender, r_L^f, and which the lender can recover in case of default. The expression for the firm's profit will remain unchanged since under devaluation, which occurs with probability $1-\alpha$, there will still be nothing left for the firm. However, since the lender recovers something, the equilibrium loan rate r_L^f should be lower, ceteris paribus. Given that the optimal effort decision for the firm is given by $\widehat{q}_f = \left(\frac{y-r_L^f}{c}\right)\alpha$, this implies that $\widehat{q}_f$ will be higher, so that the firm's project is more likely to payoff. This has an additional feedback effect onto r_L^f, since the loan rate will also be lower when the probability of full

repayment, $\widehat{q}_f$, increases. Both of these effects together imply that the firm's equilibrium expected profit $\widehat{\Pi}^f$ will be higher when the lender obtains some recovery in case of devaluation. Therefore, the assumption we used above, that no such recovery exists, in fact biases our results against the optimality of foreign denominated borrowing.

4 Firm risk and capital flows

When capital can move across international boundaries with little frictions, the results above show that firms may sometimes find it optimal to obtain foreign currency denominated loans. The reason is that borrowing in the foreign currency acts as a bonding mechanism for the firm: since the risk free rate abroad is lower, the firm is able to obtain a lower interest rate loan as foreign lenders have a lower threshold for lending. This creates a higher return for the firm whenever its project is successful, and provides the firm with a greater incentive to ensure that its return actually materializes, i.e., to put in more effort. The trade-off, however, is that borrowing in the foreign currency exposes the firm to more risk since it introduces devaluation risk into the firm's expected profit function. Whether or not firms control risk to a greater extent is thus an open question. In this section we study how firm's choice of currency in which to borrow affects their optimal effort decisions and hence the risk of bankruptcy.

Proposition 2 *Whenever it is optimal to borrow in the foreign currency, so that* $\widehat{\Pi}^f > \widehat{\Pi}$*, then the firm also exerts more effort and reduces risk more when borrowing in the foreign currency than when borrowing in the domestic currency:* $\widehat{q}_f > \widehat{q}$.

Proof: When the firm borrows in the domestic currency, the optimal effort is given by

$$\widehat{q} = \frac{y + \sqrt{y^2 - 4cr^*}}{2c} = \frac{y + \sqrt{y^2 - 4cr^{*f}\left(1 + (1-\alpha)\frac{\Delta e}{e}\right)}}{2c}.$$

By contrast, when it borrows in the foreign currency, optimal effort is

$$\widehat{q}_f = \frac{y\alpha + \sqrt{y^2\alpha^2 - 4cr^{*f}}}{2c}.$$

From this, $\widehat{q}_f > \widehat{q} \Leftrightarrow$

$$y\alpha + \sqrt{y^2\alpha^2 - 4cr^{*f}} > y + \sqrt{y^2 - 4cr^{*f}\left(1 + (1-\alpha)\frac{\Delta e}{e}\right)},$$

which is the exact same condition that guarantees $\widehat{\Pi}^f > \widehat{\Pi}$. □

The proposition establishes an equivalence between a firm's effort or, equivalently, risk taking, and its optimal choice of financing arrangement. Specifically, it establishes that the preferred denomination of debt, in the sense of maximizing the firm's profit, is also the one that minimizes risk, implying that firms' decisions to maximize profits go hand in hand with risk reduction.

However, it may still be that firm risk may correlate to a greater extent with the choice of one currency versus the other. As we show in the previous section, changes in devaluation risk will shift a firm's choice between one type of debt and the other, e.g., switching from domestic to foreign borrowing or vice versa. To analyze this issue formally, it is useful to consider the marginal firm that is essentially indifferent between borrowing from a foreign lender versus obtaining a loan from a domestic lender. We first establish the following preliminary result.

Lemma 1 *For large α, there is always a value of c low enough such that $\widehat{\Pi}^f < \widehat{\Pi}$.*

Proof: Recall that $\widehat{\Pi}^f > \widehat{\Pi}$ if and only if

$$y\alpha + \sqrt{y^2\alpha^2 - 4cr^{*f}} > y + \sqrt{y^2 - 4cr^{*f}\left(1 + (1-\alpha)\frac{\Delta e}{e}\right)}.$$

Assuming an interior solution continues to hold in both cases, it is straightforward to see that a marginal reduction in c increases the right hand side more than the left hand side. Note, however, that as c decreases toward zero, $\widehat{q}, \widehat{q}_f \to 1$. Consider the firm's profit at the limit in both cases:

$$\widehat{\Pi} = (y - \widehat{r}_L) - \frac{c}{2}$$
$$\widehat{\Pi}^f = (y - \widehat{r}_L^f)\alpha - \frac{c}{2}.$$

Since $\widehat{r}_L = \frac{r^*}{\widehat{q}} = r^*$ and $\widehat{r}_L^f = \frac{r^{*f}}{\widehat{q}_f\alpha} = \frac{r^{*f}}{\alpha}$, we have that $\widehat{\Pi}^f = (y - \widehat{r}_L^f)\alpha - \frac{c}{2} = (y - \frac{r^{*f}}{\alpha})\alpha - \frac{c}{2} = \alpha y - r^{*f} - \frac{c}{2}$, while $\widehat{\Pi} = (y - \widehat{r}_L) - \frac{c}{2} = y - r^* - \frac{c}{2}$, so that $\widehat{\Pi} > \widehat{\Pi}^f \Leftrightarrow y - r^* - \frac{c}{2} > \alpha y - r^{*f} - \frac{c}{2} \Leftrightarrow y(1-\alpha) > r^* - r^{*f}$. This will be satisfied for large α, i.e., for α sufficiently close to 1. □

The opposite result may also be true as long as increases in c do not make lending in one market non viable. It is easy to see that parameter values exist so that for high effort costs c, foreign denominated debt is always preferred. The intuition for this stems from noting that, when

c is high, good governance is difficult for firms because, for instance, their country of incorporation lacks institutions that can enforce contracts efficiently or, more generally, investor rights are weak. In these situations, firms have a greater need for bonding themselves in order to commit to exert more effort, which is achieved by borrowing in the foreign "hard" currency, which is not subject to devaluation.

While we interpret c as a country-level variable reflecting the development of institutions that protect investors, we note that we can also interpret c as a cross-sectional, firm level variable measuring agency problems within the firm. In this case, Lemma 1 would stipulate that, for firms that have access to borrowing in either domestic or foreign currency, those who benefit the most from the bonding provided by foreign currency borrowing will choose to denominate their debt in foreign currency. Our result can thus be viewed as complementing findings in the literature on firms' listing choices, where a similar argument (with substantial evidence in favor) has been made: firms that choose to cross-list their equity in foreign exchanges are those who are likely to benefit the most from the positive signal provided by generally more stringent listing requirements abroad (see, e.g., Doidge et al., 2009, or Miller, 1999, among others).

Coupled with Proposition 2, these two results tell us that, rather than increasing the problem associated with limited liability, borrowing in the foreign currency attenuates the risk shifting problem and increases the likelihood that the lender is repaid. In other words, countries with weak institutions can actually increase investment through foreign currency borrowing. We note, however, that in our model the lender - whether domestic or foreign - plays no role other than to provide financing. We thus abstract from other solutions to limited pledgeability or poor enforcement that may be available, such as those emphasized in the literature on relationship banking (e.g., Rajan, 1992, Hauswald and Marquez, 2006) or monitored financing (e.g., Holmstrom and Tirole, 1997). To the extent that c reflects country level difficulties in committing to exert effort, it is likely that such alternatives would likewise not be present.

With this, we can now see that for a wide variety of instances, a value of c exists for which $\widehat{\Pi}^f = \widehat{\Pi}$, so that firms are indifferent between borrowing in the foreign or in the domestic currency. Call such a value $\widehat{c}$. We can now establish the following.

Proposition 3 *Under fixed exchange rates, so that any domestic interest rate changes, Δr^* , are*

equal to foreign interest rate changes, Δr^{*f}, the cutoff value $\widehat{c}$ is decreasing in the foreign risk free rate r^{*f}: $\frac{\partial \widehat{c}}{\partial r^{*f}} < 0$.

Proof: Start from the equality between the profits, and write:

$$Z = -y\left(1-\alpha\right) + \sqrt{y^2\alpha^2 - 4cr^{*f}} - \sqrt{y^2 - 4cr^{*f}\left(1 + \left(1-\alpha\right)\frac{\Delta e}{e}\right)} = 0$$

Taking the derivative with respect to c, we get:

$$\frac{\partial Z}{\partial c} = \frac{2r^{*f}\left(1 + \frac{\Delta e}{e}\left(1-\alpha\right)\right)}{\sqrt{y^2 - 4cr^{*f}\left(1 + \left(1-\alpha\right)\frac{\Delta e}{e}\right)}} - \frac{2r^{*f}}{\sqrt{y^2\alpha^2 - 4cr^{*f}}},$$

and substituting from Z, we get

$$\frac{\partial Z}{\partial c} = \frac{2r^{*f}\left(1 + \frac{\Delta e}{e}\left(1-\alpha\right)\right)}{-y\left(1-\alpha\right) + \sqrt{y^2\alpha^2 - 4cr^{*f}}} - \frac{2r^{*f}}{\sqrt{y^2\alpha^2 - 4cr^{*f}}} > 0,$$

which is positive since $\frac{\Delta e}{e} > 0$ and $y\left(1-\alpha\right) > 0$.

Taking the derivative with respect to r^{*f} we get:

$$\frac{\partial Z}{\partial r^{*f}} = \frac{2c\left(1 + \left(1-\alpha\right)\frac{\Delta e}{e}\right)}{\sqrt{y^2 - 4cr^{*f}\left(1 + \left(1-\alpha\right)\frac{\Delta e}{e}\right)}} - \frac{2c}{\sqrt{y^2\alpha^2 - 4cr^{*f}}},$$

which after substituting from Z is

$$\frac{\partial Z}{\partial r^{*f}} = \frac{2c\left(1 + \left(1-\alpha\right)\frac{\Delta e}{e}\right)}{-y\left(1-\alpha\right) + \sqrt{y^2\alpha^2 - 4cr^{*f}}} - \frac{2c}{\sqrt{y^2\alpha^2 - 4cr^{*f}}} > 0. \tag{7}$$

Using the implicit function theorem, we can then write

$$\frac{d\widehat{c}}{dr^{*f}} = -\frac{\frac{\partial Z}{\partial r^{*f}}}{\frac{\partial Z}{\partial c}} < 0,$$

as desired. □

The proposition establishes that increases in the foreign risk free rate r^{*f} make foreign denominated borrowing relatively more attractive, making it more attractive for borrowers in countries with ever weaker governance structures to obtain it. Put differently, if for each country c is assumed to be drawn from some fixed distribution, this would imply that the set of countries whose firms rely more heavily on foreign currency increases as r^{*f} increases.

At first sight, this result seems counterintuitive since it suggests that firms prefer to borrow in the currency whose loans are becoming relatively more expensive. Note, however, that here we

are assuming that changes in r^{*f} are fully and instantly reflected in domestic interest rates, r^*. Therefore, increases in r^{*f} reflect overall increases in the cost of borrowing no matter in which currency the firm borrows. However, as the risk free rate rises, the agency problem associated with limited liability increases since the loan rate r_L will also rise to reflect the increase in the risk free rate. Ceteris paribus, this reduces effort q, and leads to a yet higher loan rate since lenders need to be compensated for this increased risk.

The firm can, however, partially bond itself by borrowing from abroad. This bonding has the most value precisely when effort q is likely to be lowest, since the loan rate, for domestic debt, is $\widehat{r}_L = \frac{r^*}{\widehat{q}}$ and for foreign currency debt is $\widehat{r}_L^f = \frac{r^{*f}}{\widehat{q}_f \alpha}$. Therefore, a firm is more likely to find it optimal to borrow in the foreign currency when the risk free rates go up everywhere.

As a final point, it is useful to consider the opposite case where there is a floating exchange rate regime, which we define as a situation where the adjustment to a foreign interest rate shock occurs entirely through an adjustment in the expected exchange rate depreciation. We can rewrite Z as

$$Z = -y\left(1 - \alpha(r^{*f})\right) + \sqrt{y^2\left(\alpha(r^{*f})\right)^2 - 4cr^{*f}} - \sqrt{y^2 - 4cr^*} = 0$$

where the domestic interest rate r^* is assumed to remain constant under the assumption of fully flexible exchange rates. The derivative of Z with respect to c is the same as in the case with fixed rates, equation (7), and is positive. The derivative with respect to the foreign interest rate r becomes:

$$\frac{\partial Z}{\partial r^{*f}} = y\frac{\partial \alpha\left(r^{*f}\right)}{\partial r^{*f}} + \frac{y^2\alpha\left(r^{*f}\right)\frac{\partial \alpha\left(r^{*f}\right)}{\partial r^{*f}} - 2c}{\sqrt{y^2\alpha^2\left(r^{*f}\right) - 4cr^{*f}}}$$

where is α is function of r^{*f}. Now if $\frac{\partial \alpha\left(r^{*f}\right)}{\partial r^{*f}} \leq 0$, then $\frac{\partial Z}{\partial c} < 0$ and $\frac{d\widehat{c}}{dr^{*f}} > 0$. However, if $\frac{\partial \alpha\left(r^{*f}\right)}{\partial r^{*f}}$ is sufficiently positive, the opposite would happen. The second is economically irrelevant given the problem we want to study, allowing us to conclude that in this case $\frac{d\widehat{c}}{dr^{*f}} > 0$.

4.1 Quantity effects

Consider the marginal borrower that just breaks even at the prevailing interest rate conditions (the current level of the risk-free rate). In this economy there will be credit rationing (a la Stiglitz and Weiss, 1981) as borrowers cannot commit to a certain level of effort. Essentially, when the effort cost c is high, there is no interest rate at which the lender can break even once they take into

account the effect that the interest rate has on effort. Formally, in these economies (2) and/or (4) does not admit a real solution. If a solution exists, however, then financing is feasible and firms are able to obtain credit. An interesting question is whether credit is more likely to be available, or credit rationing is likely to be less severe, when borrowing in one type of currency versus the other.

To study this issue, we define $\overline{c}$ as the marginal effort cost such that firms can obtain credit domestically.[4] Likewise, we use $\overline{c}^f$ to denote the marginal effort cost such that borrowers can obtain foreign currency denominated debt.

Proposition 4 *Keeping the expected devaluation, $(1-\alpha)\frac{\Delta e}{e}$, constant, when the risk of devaluation is sufficiently low (i.e., α is large) but the size of the possible devaluation is large ($\frac{\Delta e}{e}$ is large), we have $\overline{c}^f > \overline{c}$.*

Proof: The marginal borrower in domestic currency is one for whom $y^2 - 4cr^* = 0$, which after some rearranging delivers the following threshold value of c:

$$\overline{c} = \frac{y^2}{4r^{*f}\left(1+(1-\alpha)\frac{\Delta e}{e}\right)}.$$

The equivalent threshold value for foreign currency borrowing is:

$$\overline{c}^f = \frac{\alpha^2 y^2}{4r^{*f}}.$$

Comparing the two cutoffs, it is immediate that

$$\overline{c}^f > \overline{c} \Leftrightarrow \frac{\alpha^2}{r^{*f}} > \frac{1}{r^{*f}\left(1+(1-\alpha)\frac{\Delta e}{e}\right)},$$

or, rearranging,

$$\overline{c}^f > \overline{c} \Leftrightarrow (1-\alpha)\frac{\Delta e}{e} > \frac{\left(1-\alpha^2\right)}{\alpha^2}. \tag{8}$$

As for the difference in profits, (**??**) can be always satisfied by increasing α and $\frac{\Delta e}{e}$ so that $(1-\alpha)\frac{\Delta e}{e}$ remains constant. □

Proposition 4 highlights again the effect of "peso-problem" conditions, this time on firms' access to credit. The proposition establishes that, under these conditions where severe devaluations are

[4] More precisely, given that the cost of effort q is $\frac{c}{2}q^2$, $\overline{c}$ is the threshold value of the parameter for the cost function above which (i.e., for $c > \overline{c}$) firms are unable to obtain credit.

possible but rare, firms in countries with weaker institutions will have access to foreign currency credit but not to domestic denominated credit. The reason is that, for firms in countries where the cost of effort c is relatively high, the only way to get financing is to use foreign denominated debt as a bonding mechanism, and take advantage of the lower cost of borrowing, r^{*f}, in the event of no devaluation. However, such a mechanism is only possible when the risk of devaluation is not too large, even if the trade-off is a larger devaluation when and if it occurs.

Consider the related question of who borrows in what currency. From (6) it is evident that, ceteris paribus, firms in relatively high c countries will favor foreign currency borrowing more than those in countries with relatively low c. As an extreme example, consider the case where $c = 0$ and, hence, $\widehat{q} = 1$ irrespective of the currency denomination of debt, and for which (6) is never satisfied, so that firms always find it preferable to borrow in the domestic currency. This means that if (6) does not hold for the firms in countries with the highest cost c in our distribution, then there will be no foreign currency lending. If it does, there may still be domestic currency lending in some economies if the range of c gets close enough to zero (i.e., if there are countries where firms can borrow close to the risk-free rate).

5 Complementarities

So far we have examined each borrower's risk of failure in isolation. Entrepreneurs borrowing in domestic currency are exposed exclusively to their own idiosyncratic risk. Those that borrow in foreign currency are also exposed to devaluation risk, but their failure and, hence, the fact that they borrow in foreign currency, does not have any impact on other firms. This is obviously a simplification as we can envisage several circumstances under which widespread bankruptcies (possibly associated with a currency depreciation) would have a negative effects on other firms' abilities to meet their own obligations. Consider, for instance, how the failure of a counterparty may affect a firm's cash flow and hence its ability to repay its own creditors. This is particularly problematic if the counterparty is an important customer who might be receiving items on credit (e.g., trade credit), such as in an upstream/downstream relationship, so that the counterparty's failure implies not just the loss of future business, but also losses in current revenue for the supplier. Another example can be drawn from the financial services industry, where lenders (i.e., banks) are

reliant for repayment on the success of the projects in which their borrowers invest: if borrowers' projects fail, the bank cannot be repaid and will itself face financial difficulties.

In this section, we modify our simple model to examine these issues. We assume that in the case of widespread bankruptcies, all entrepreneurs are at risk of failure even if their own projects would otherwise have turned out successful. Specifically, we assume that when a firm fails, there is a positive probability that its counterparties will also fail. This means that, from the perspective of a given firm i, the higher the fraction of *other* firms that fail, the more likely it is that firm i will be affected simply because as the fraction of failing firms increases, there is a greater likelihood that one of those failing firms may be a counterparty to firm i. We formalize this as follow: for any firm, there is a probability $G(\theta)$ that it will be unable to meet its own obligations when a fraction $0 \leq \theta \leq 1$ of other firms fail, irrespective of the success or failure of its own venture, with G increasing in θ. For simplicity, we will assume that $G(\theta) = 0$ for $\theta < \overline{\theta}$, and $G(\theta) = \overline{G}$ for $\theta \geq \overline{\theta}$. In order to consider the possibility that some firms borrow in the domestic currency and some in the foreign currency, we extend the model slightly by allowing c to vary across firms, so that firms are heterogeneous in their effort costs, as described below.[5]

We start with the extreme case where there is no foreign currency borrowing. First, note that with a continuum of firms, in a symmetric equilibrium where each firm chooses the same effort q, exactly a portion $\theta = 1 - q$ of firms will fail. Then, if $q < 1 - \overline{\theta}$ (so that $\theta > \overline{\theta}$) each firm will face a risk of counterparty default, meaning that with probability $G(\theta) = \overline{G}$ the firm fails irrespective of the realization of its project. We can now write the expected profits for firm i as

$$\Pi = \begin{cases} q_i(y - r_L) - \frac{c}{2}q_i^2, \text{ for } q_{-i} > 1 - \overline{\theta} \\ q_i\left(1 - \overline{G}\right)(y - r_L) - \frac{c}{2}q_i^2, \text{ for } q_{-i} < 1 - \overline{\theta} \end{cases}$$

where q_{-i} are the entrepreneur's beliefs about the level of effort to be exerted by other firms. Depending on its beliefs, firm i will choose

$$\widehat{q}_i = \begin{cases} \frac{y - r_L}{c}, \text{ for } q_{-i} > 1 - \overline{\theta} \\ \frac{(y - r_L)\left(1 - \overline{G}\right)}{c}, \text{ for } q_{-i} < 1 - \overline{\theta} \end{cases}$$

Now consider the case where $1 - \overline{\theta} < \widehat{q}_i = \frac{(y - r_L)\left(1 - \overline{G}\right)}{c}$. In the absence of foreign currency lending, there is never a symmetric equilibrium where firms suffer as a result of counterparty failure because

[5] This extension is consistent with the interpretation we suggested above of c as measuring the degree of firm-specific agency problems. For that case, we argued that for firms that have access to both domestic and international lending markets, it is those firms with larger agency problems and thus a larger need to bond themselves that borrow in the foreign currency. We exploit this structure further here.

the belief that $q_{-i} < 1 - \overline{\theta}$ cannot be correct. We focus here on this case since it means that in the absence of other aspects, such as the ability to borrow in another currency, counterparty failure is not a large concern because firms don't anticipate a high likelihood that they will be affected.

We now introduce foreign currency lending. Assume that a mass φ of firms has low effort costs c_1, and a mass $1 - \varphi$ has high effort costs c_2, with $c_2 > \widehat{c} > c_1$, where $\widehat{c}$ is the threshold value of the cost below which firms borrow in the domestic currency and above which they borrow in the foreign currency if they were not concerned about how the possibility of counterparty failure might affect them, as in Section 4. This means that, in the absence of other concerns, a mass φ of entrepreneurs would borrow in domestic currency and the rest in foreign currency. As above, assume that $1 - \overline{\theta} < \widehat{q}_i = \frac{(y - r_L)\left(1 - \overline{G}\right)}{c_2}$, which implies that in the absence of devaluation counterparty failure cannot cause the failure of a firm with a successful project. Under these assumptions, consider again the expressions for expected profits for borrowing in foreign and domestic currency. The former remains identical to what we studied before, since counterparty risk is only relevant conditional on devaluation, and conditional on devaluation firms that borrowed in the foreign currency fail anyway. As we show below, however, the firm's expected profit when borrowing in the domestic currency is not identical to that in case without counterparty risk.

By construction, there will be no equilibrium where firms adjust their borrowing behavior as a result of the counterparty risk associated with depreciation if φ, the fraction of firms with relatively low effort cost, is very high. However, when φ is relatively low, domestic currency borrowers become exposed to the risk that their counterparties may fail through the correlated default of foreign currency borrowers. In this case, the expected profit for borrowing in domestic currency becomes

$$\Pi_C = q\left(\overline{G}\alpha + 1 - \overline{G}\right)(y - r_L) - \frac{c_1}{2}q^2,$$

where the subscript C refers to the profits under the possibility that counterparty failure sinks the firm in question. We can write the first order condition for effort q when borrowing in domestic currency as

$$\left(1 - (1 - \alpha)\,\overline{G}\right)(y - r_L) - c_1 q = 0,$$

which yields

$$\widehat{q} = \min\left\{\frac{\left(1 - (1 - \alpha)\,\overline{G}\right)(y - r_L)}{c_1}, 1\right\}.$$

Lenders will price these loans according to their probability of repayment, so that, for a conjectured effort level q^C, the loan rate must satisfy

$$\widehat{r}_L = \frac{r^*}{q^C\left(1-(1-\alpha)\,\overline{G}\right)}. \tag{9}$$

We can immediately see that the risk of counterparty failure affects the foreign/domestic currency choice through three channels: 1) it directly affects the expected profits from borrowing in domestic currency; 2) it reduces the optimal level of effort when borrowing in domestic currency; and 3) it increases the interest rate for loans in domestic currency beyond the amount caused by the reduction in effort q (the probability of repayment drops from q to $\alpha q + (1-\alpha)\left(1-\overline{G}\right)q$).

For ease of exposition define $\xi = 1-(1-\alpha)\,\overline{G}$. Then, by substituting 9 into the expression for $\widehat{q}$ and solving we obtain

$$\widehat{q} = \min\left\{\frac{1}{2c_1}\left(y\xi + \sqrt{y^2\xi^2 - 4c_1 r^*}\right), 1\right\}.$$

Noting that, from this, $\widehat{r}_L = y - \frac{c_1\widehat{q}}{\xi}$, we can substitute for $\widehat{q}$ and obtain

$$\widehat{r}_L = \frac{y}{2} - \frac{\sqrt{y^2\xi^2 - 4c_1 r^*}}{2\xi},$$

which gives us the equilibrium loan rate when the firm borrows in the domestic currency under the risk that counterparty failure harms its own ability to meet its obligations and pushes it into bankruptcy.

As in the previous section, we can replace $\widehat{r}_L$ and $\widehat{q}$ in the expression for the firm's expected equilibrium profit and obtain

$$\widehat{\Pi}_C = \frac{1}{2c_1}\left(\frac{y\xi + \sqrt{y^2\xi^2 - 4c_1 r^*}}{2}\right)^2, \tag{10}$$

from which it is immediate that, since $\overline{G} > 0$ implies $\xi < 1$, we must have $\widehat{\Pi}_C < \widehat{\Pi}$. That is, the risk of counterparty failure associated with depreciation reduces the expected profits from borrowing in domestic currency. We can now derive a result related to firms' choices of borrowing in the domestic versus the foreign currency.

Lemma 2 *The threshold value of effort cost c below which borrowing in the domestic currency is optimal, denoted by $\widehat{c}$, is lower when $\overline{G} > 0$, so that counterparty risk is relevant, than when*

$\theta = 0$ *and a counterparty's failure has not significant impact on a firm's ability to meet its own obligations.*

Proof: The threshold value $\widehat{c}$ comes from comparing a firm's profit when it borrows domestically, $\widehat{\Pi}$, to what it obtains when borrowing in foreign currency, $\widehat{\Pi}^f$: $\widehat{c}$ is the value of c that satisfies $\widehat{\Pi} = \widehat{\Pi}^f$. As established in (10), however, $\widehat{\Pi}_C < \widehat{\Pi}$, while profits when borrowing in foreign currency are invariant to the possibility of contagion. Therefore, if at $c = \widehat{c}$ we have $\widehat{\Pi} = \widehat{\Pi}^f$, we must also then have $\widehat{\Pi}_C < \widehat{\Pi}^f$, so that foreign currency borrowing is strictly preferred. This implies that the threshold value must be lower in order for firms to be indifferent. □

The lemma describes a relatively straightforward implication of the analysis above, which is that the threshold value of the effort cost below which borrowing in the domestic currency is optimal decreases once counterparty risk is present. This implies a complementarity in firms' choices of currency in which to borrow because it means that once a sufficient number of firms borrow in the foreign currency, it may be optimal for the remaining firms to do so as well even if, absent counterparty risk, they would have preferred to borrow in domestic currency. One stark example of the possible effect associated with this shift in firms' preferences for domestic versus foreign currency borrowing can be obtained by considering the case when $c_1 = \widehat{c}$, where $\widehat{c}$ is as described above. For this case, low cost firms when counterparty risk is not an issue are exactly indifferent between foreign currency and domestic currency borrowing. However, for any counterparty risk $\overline{G} > 0$, these firms will strictly prefer to borrow in the foreign currency. By continuity, there will exist a $\overline{G}$ such that for firms with $c \in [\underline{c}, \widehat{c})$ we will have $\widehat{\Pi} > \widehat{\Pi}_f > \widehat{\Pi}_C$: once counterparty risk is possible, firms that would otherwise have borrowed in the domestic currency will instead choose to borrow in the foreign currency. In the context of our setting where there are only two types of firms, we get that the risk of counterparty failure causes all firms to borrow in foreign currency and as a result increases the degree of systemic risk to which all firms are exposed, increasing the likelihood that all firms fail at once in the event of a devaluation.

The implication of this result is that there are conditions under which measures aimed at preventing or limiting foreign currency borrowing can be welfare enhancing. Note, however, that these measures may not lead to Pareto improvements. Restrictions on foreign currency borrowing can prevent the risks associated with counterparty failure and, thus, improve the incentives and

profits of entrepreneurs that would otherwise switch to borrowing in the foreign currency. But they do so at the cost of worse incentives and lower profits for those that would otherwise prefer to borrow in foreign currency, and who may not be much afected by counterparty risk.

6 Average performance and systemic risk

The results in our model have a natural interpretation from the point of view of a trade-off between average performance and systemic risk. We assume risk neutrality throughout the model. Hence, average performance is all that matters. However, the model lends itself to the analysis of the risk/performance trade-off by introducing a risk-averse regulator. Alternatively, the model could be augmented with a non-linear social cost of failure: if a few borrowers fail the costs are relatively low, but become very large if there are widespread failures and defaults.

With either one of these modifications, realizations involving a large mass of borrowers in default (systemic crises) weight negatively on the social welfare functions. This means that the social planner will be willing to trade average performance for a reduced probability of systemic crisis.

For simplicity, consider an economy where borrowers' effort cost coefficient c is drawn from a uniform distribution. Also, assume that condition (6) holds, so that if allowed, all firms will borrow in foreign currency. It is easy to see that, under these conditions, a trade-off emerges. In the absence of foreign currency borrowing, the model delivers a predictable proportion of borrowers that default, $1-\widehat{q}$ (indeed, with a continuum of borrowers and no aggregate risk, the realized number of failures will be identical to the expected one). By contrast, when all entrepreneurs borrow in foreign currency, there will be a mass $1-\widehat{q}_f < 1-\widehat{q}$ of failures when the currency does not depreciate. But everybody will default (call this a systemic crisis) when it does depreciate. It follows that a social planner allowing foreign currency borrowing can obtain a reduction in "tranquil-times" failures of $\widehat{q}_f - \widehat{q}$ at the cost of a probability $1-\alpha$ of systemic crisis.

The rationale for government intervention and limits on foreign currency mismatches has an additional dimension when widespread defaults entail the possibility of contagion. As shown in the previous section, in cases where the threat of contagion induces a large fraction of borrowers to switch to foreign currency borrowing, limiting firms' abilities to borrow in foreign currency can

increase average performance (reduce defaults) while at the same time reducing systemic risk taking. The reason is that, through limiting currency mismatches, regulation can eliminate inefficiencies stemming from the externality associated with the risk of contagion. Doing so may be particularly important when contagion risk is high, since then the devaluation risk can trigger a larger systemic problem either directly through contagion, or through firm's increased desire to borrow in foreign rather than domestic currency.

7 Discussion and Conclusions

This paper presents a model where foreign currency borrowing, through a lower interest rate, may ameliorate agency problems between firms and lenders relative to borrowing in domestic currency. The reduction in idiosyncratic risk, however, comes at the cost of exposure to the risk of default should the currency devalue sharply. A trade-off emerges between average performance in tranquil times and systemic risk: foreign currency borrowing reduces the average number of failures in the economy, but will lead to widespread bankruptcies when the currency devalues. In addition, if widespread defaults can lead otherwise successful borrowers to default (by triggering a deep recession, for instance), then a sufficiently large fraction of firms borrowing in foreign currency may induce others to switch to foreign currency borrowing as well. In this case, foreign currency borrowing may actually be welfare reducing beyond its effect through systemic risk.

Our results support the view that government intervention to curb foreign currency borrowing and the contagion risks associated with it may be socially optimal in certain circumstances. Such government intervention could come in the form of capital controls or prudential regulation, or some combination of the two.[6]

The analysis of specific measures for intervention is beyond the reach of our stylized model. In practice, however, the optimal response depends on the type of risk and firms that are being targeted. When the problem is primarily with banks and other intermediaries funding themselves in hard currency on international markets and lending domestically in local currency, bank regulatory measures aimed at limiting foreign currency mismatches - such as tightening open position limits,

[6] See Ostry et al. (2011) for an overview of the considerations and tradeoffs involved in determining the optimal mix of macroeconomic policies, capital controls, and prudential regulation to manage foreign currency lending and capital inflows more generally.

in relation to bank capital, and stepping up of foreign currency-related liquidity requirements - may be effective.

When the ultimate borrower (a firm or household) takes on foreign currency debt from a bank but its income is in local currency, so that the borrower is therefore unhedged, banks are exposed to devaluations through credit risk. In this case, however, especially in small open economies, regulatory measures such as higher capital requirements on foreign currency loans or limits on loans to borrowers who cannot demonstrate a natural hedge may be only partially effective. They can reduce the direct exposure of the local banking system to currency risk, but to the extent that real sector borrowers switch to foreign lenders, which may be possible through cross-border flows, they will not protect the economy as a whole. Then, the rationale for broader-reaching capital controls would have to be evaluated.

As argued in the introduction, we have focused our analysis on the question of domestic- versus foreign-currency borrowing. However, several insights from our framework apply more broadly. In particular, the central finding that a reduction in idiosyncratic risk, and the related efficiency gains, may come at the cost of greater systemic risk applies to other contexts. For instance, consider the trade-off between fixed- and variable-rate debt contracts. Under normal conditions, short-term rates will be lower than long-term ones, allowing for better borrower incentives, much the way that foreign currency borrowing does in our model. However, such short term contracts will leave firms exposed to potentially sharp increases in their debt burden, in a similar fashion to how devaluation affects firms in our model. While interest rate changes will typically be small and gradual, unlike devaluation in our model, there are cases in which even marginal changes will imply payment difficulties for certain borrowers. For example, this kind of effect was observed for a large fraction of subprime borrowers when their contracts reset, suggesting that the basic ideas here may be applied to a broader context.

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