Working Paper
Series

FINRISK
National Centre of Competence in Research
Financial Valuation and Risk Management

National Centre of Competence in Research
Financial Valuation and Risk Management

Working Paper No. 767

Foreign Currency Debt and Expectations

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First version: February 2007
Current version: May 2012

This research has been carried out within the NCCR FINRISK project on
"Macro Risk, Systemic Risks and International Finance"

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Abstract

The paper explores the hypothesis that the dollarization of liabilities in emerging market economies results from the different expectations that domestic firms and international investors may have on the stability of the exchange rate. I show that in the presence of asymmetric information, dollarization can be interpreted-under certain conditions-as a signal of strong fundamentals, and that is influenced by the "type" of the Central Bank and the degree of transparency on the world market. Some policy implications are briefly discussed.

Keywords: International Finance, Dollarization, Expectations.

1 Introduction

Many emerging countries borrow in foreign currency. Currency mismatch was one important determinant of the '94 Mexican crisis and of the Asian crises in 1997-1998 and it is still an important issue, as shown by the rapid expansion of foreign denominated debt in Eastern Europe. The first empirical studies on the topic [1] have defined the large presence of foreign currency debt in emerging

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[1] Eichengreen Hausmann and Panizza (2003) and Hausmann and Panizza (2003).

countries as the "Original Sin of the International Finance". It has been described as the inability of developing countries to borrow in their own currency on the international markets. One of the most curious aspects of this phenomenon is that the "Original Sin" also affects emerging countries characterized by strong fundamentals and sound policies. Because of this, its main determinants have been identified in the way international markets operate, rather than in the specific features of each country.

As the debt crises of the 1990s show, the presence of foreign currency debt can be risky because not only it creates a mismatch in domestic firms' balance sheets, but it also constraints the traditional domestic policy instruments in dealing with home and foreign economic shocks. The reasons why such risky forms of international finance arise, especially in healthy countries, remain an open question. If foreign debt is so dangerous, it may be worth trying to give a micro-foundation to its emergence. Such a high share of foreign currency debt should be, at least in part, justified by the presence of some private benefits for the agents that choose this form of finance. If, in fact, it is reasonable to imagine that international markets are not willing to lend pesos to countries that are likely going to reduce their debt through devaluations, it becomes more difficult to explain the absence of supply of peso debt to those economies that display low exchange rate risk.

The goal of this paper is to rationalize the choice to borrow in dollars rather than in domestic currency on the international markets. In order to do so, I study how informational asymmetries and heterogeneous expectations can affect the choice of a borrower to expose herself to a currency risk. Furthermore I look at the policy implications of my findings to understand which policies could reduce the incentive of agents to dollarize.

My model is a portfolio choice model that analyzes how agents choose in which currency they

want to borrow. There are three types of agents: domestic borrowers, international investors and a central bank in the domestic country. I analyze two different settings of the model: In one case I assume that domestic agents receive private signals on the economic fundamentals, while international investors only observe a public signal that is common knowledge. The presence of private signals generates a coordination motive among domestic agents that therefore make their choices on the basis of their expectations and on their expectations on the expectations of the market (higher order beliefs). In the second setting, instead, I still assume that domestic agents have an informational advantage on the international investors, but among them have access to the same piece of information. Because of the absence of informational asymmetries among domestic agents, they can be considered as one unique player. The degree of dollarization is therefore the result of an interaction between two players: A domestic borrower and an international lender that observe different pieces of information.

The main findings of the model show that when domestic agents have an informational advantage and/or there is a low level of transparency on international markets, a certain degree of dollarization might be observed, if the fundamentals are relatively strong. This result implies that in this model dollarization is a signal of strong fundamentals: It is convenient for domestic agents to dollarize if the state of the economy is good and uninformed international investors are more pessimistic than informed domestic borrowers.

Another result is the way in which the exchange rate policy can affect borrowers' choices. If there is endogeneity between the exchange rate policy implemented by the monetary authority and domestic agents' decisions, a certain degree of complementarity in borrowers' choices may arise, thus creating a phenomenon of *moral hazard*. If domestic agents anticipate that a high share of dollar debt in

the economy makes the exchange rate more rigid, they may want to coordinate on the equilibrium where all the corporate debt in the economy is denominated in the foreign currency. It is therefore possible to observe foreign currency debt in the economy, even when its fundamentals are relatively weak.

These results have some policy implications. First of all the "type" of the central bank can create *moral hazard*. A benevolent central bank whose exchange rate policy depends on the degree of dollarization in the economy, can generate a coordination mechanism among the domestic borrowers that results in a risky degree of dollarization. A possible solution would be to *ex-ante* choose a central banker with a strong preference for a flexible exchange rate that only depends on the state of the fundamentals[2].

My findings also show the importance of transparency. Transparency does not necessarily coincides with public information. My model shows that the precision of the private sources of information actually determines the degree of dollarization. If international markets could have access to some sources of private information, they would be more willing to lend in pesos, when the fundamentals are relatively strong. As a consequence the economy would not experience high levels of dollarization and would be better protected against future negative shocks.

The logic of my model resembles the one used in the literature of Global Games, first introduced by Carlsson and van Damme (1993), and then applied by Morris and Shin (1998, 1999, 2002, 2004) to different economic contexts, like currency crises and debt rollovers, where the complementarity of agents' actions plays a crucial role. Through the introduction of private information in the economy, they show how it is possible to interpret certain phenomena as the result of a coordination game.

[2]Similarly to the solution proposed in the monetary literature to fight inflation bias, Rogoff (1985).

The theoretical literature on foreign currency debt in emerging economies has investigated this phenomenon often emphasizing more its consequences than its causes[3]. However the positive issue of why emerging market economies do in fact rely on foreign currency denominated debt has instead received limited attention so far. The papers that address this issue emphasize the role of the expectations and the interaction between domestic borrowers and the Central Bank. Chamon and Hausman (2004), Jeanne (2003), Cowan and Do (2003) and Chang and Velasco (2006) show how the interaction between domestic agents and their central bank can result in full dollarization of the economy. One common problem is the difficulty to determine the optimal degree of dollarization in the economy: All the mentioned papers, in fact, find either corner solutions or indeterminate solutions. In my paper, instead, I show that through the introduction of informational asymmetries, the resulting degree of dollarization is an interior solution and is proportional to the difference in agents expectations.

The reminder of this paper is organized as follows. Section 2 presents the basic model. Section 3 sketches two possible settings of the model: a coordination game among the borrowers, considering the international lenders as a unique player, and a simple game between domestic borrowers and international lenders, considered as two players. Section 4 briefly considers some policy implications. Section 5 concludes.

[3]Aghion, Bacchetta and Banerjee (2001), Jeanne and Zettelmeyer (2003), Gertler, Ghirchlist and Natalucci (2007), Cespedes, Chang and Velasco (2004), Faia and Monacelli (2002).

2 The Model

Consider a single-period small open economy populated by a continuum of domestic agents distributed over the unit interval. Agents are at the same time producers and consumers. There is a domestic currency, called *peso*, which is issued by the domestic Central Bank. There is also a foreign currency, called *dollar.* To finance their production domestic firms borrow on the international market at the beginning of the period. Each firm can borrow in pesos or in dollars. The firm's optimal borrowing policy determines the final degree of dollarization in the economy. At the beginning of the period the fundamentals of the economy are hit by a shock that cannot be fully observed by agents. The shock determines a change in the value of the exchange rate that agents try to anticipate. On the one hand, domestic agents formulate expectations on future depreciations of the peso and then decide the fraction of debt that they want to dollarize. On the other hand, also international investors formulate expectations on future exchange rate movements and then fix the interest rate at which they lend peso denominated funds. Domestic and international agents receive different pieces of information on the shock to the fundamentals and therefore formulate different expectations. The equilibrium share of foreign currency denominated debt results from the balance between these expectations. The final exchange rate depreciation (appreciation) is in turn determined by the Central Bank at the end of the period, after observing the true state of the economy and the realized degree of dollarization.

2.1 International Investors

International lenders are risk neutral. The interest rate required to lend funds denominated in pesos is:

$$(1+i) = (1+i^*)\, E_L\,(1+\Delta e) \tag{1}$$

where i is the domestic interest rate, i^* is the international interest rate and $E_L\,(1+\Delta e)$ is the international lender's expectation of future depreciation. The domestic interest rate equals the international one increased by lenders' expectation of future depreciations. The supply of funds is infinitely elastic and the international banks are willing to lend both in domestic and foreign currency to the domestic firms, if and only if the returns given by the combination of peso and dollar debt are at least equal to the international rate of return i^*. In other words, the *Uncovered Interest Parity* condition holds for the international lenders.

2.2 Domestic Borrowers

Each domestic firm produces a domestic good and borrows funds on the international markets to finance its production. Domestic agents maximize a CARA utility function whose argument is net output, i.e. their consumption. The choice of the currency denomination of agent i debt results from the maximization of her *ex-ante* utility function:

$$E_i U\left[\left(q - (1-m_i)\,(1+i^*)\,(1+\Delta e) - m_i\,(1+i)\right)|I_i\right], \tag{2}$$

where q is the constant quantity of good produced by the domestic firm, m_i is the share of debt denominated in domestic currency and $1-m_i$ is the share of debt denominated in foreign currency.

I_i is the information set available to agent i. It is possible to show[4] that each agent's optimization problem reduces to choosing the optimal share of peso-debt, m_i, to maximize Ξ_i, defined as follows:

$$\Xi_i = [(Aq - A(1-m_i)(1+i^*)E_i[(1+\Delta e)|I_i] +$$
$$-Am_iE_i[(1+i)|I_i]) - \frac{1}{2}A^2(1-m_i)^2(1+i^*)^2 VAR(1+\Delta e) \mid I_i],$$

where A is the coefficient of absolute risk aversion that is common to all domestic agents.

2.3 The Central Bank

In this economy there is a benevolent Central Bank whose policy instrument is the exchange rate. The Central Bank chooses the exchange rate policy in order to maximize an exogenous objective function, whose arguments are the *ex-post* utility function of the domestic economy (calculated by aggregating domestic agents' utility functions) and a term that measures the difference between the exchange rate depreciation and an adverse shock ($y > 0$) that hits the economy. A positive value of the shock y increases the shadow exchange rate. The inclusion in the utility function of this term can be interpreted as the attempt of the Central Bank to implement an exchange rate policy that also mirrors changes in the economic fundamentals: If the economy is hit by an adverse shock

[4]See Appendix A.

$y > 0$, the Central Bank should proportionally depreciate the exchange rate[5].

$$\max_{\Delta e} W_{CB} = \lambda[\int (Aq - A(1-m_i)(1+i^*)(1+\Delta e) - Am_i(1+i) - \frac{1}{2}A^2(1-m_i)^2(1+i)^2 VAR(\Delta e)])di] - \frac{1}{2}[\Delta e - y]^2 \quad (3)$$

that becomes when we integrate over i:

$$\max_{\Delta e} \lambda[Aq - A(1-M)(1+i^*)(1+\Delta e) - AM(1+i) - \frac{1}{2}A^2(1-M)^2(1+i)^2 VAR(\Delta e)]] - \frac{1}{2}[\Delta e - y]^2 \quad (4)$$

where $M = \int m_i di$ describes the degree of domestic currency debt in the economy. From the first order conditions the optimal policy rule followed by the Central Bank under discretion is:

$$\Delta e = -\lambda A\,(1-M)\,(1+i^*) + y \quad (5)$$

Proposition 1 *The contemporaneous presence of a high level of dollarization* $(1-M)$ *and an adverse shock* $(y > 0)$*, affects the exchange rate in opposite directions and results in the phenomenon usually known as "Fear of Floating".*

[5]The literature on balance of payment crises has identified several factors that can affect the shadow exchange rate. Krugman (1979) and Flood and Garber (1984) mostly focus on the importance of monetary and fiscal discipline. Goldberg (1988) also emphasizes the importance of other random shocks to the domestic money market, like shocks from external credit supplies and relative prices. Here I do not specify the exact nature of the shock, but I only assume that a positive shock y puts an upward pressure on the shadow exchange rate that would justify a depreciation of the exchange rate.

"Fear of floating" [6] is the expression commonly used to describe the exchange rate policy implemented in developing countries. It has been in fact observed that these countries had a tendency to keep their exchange rate fixed, even if they had formally adopted a flexible exchange rate regime. This behavior introduced many distortions in the financial markets that became evident during the crises in the late 90's. The monetary policy rule is linear in the degree of dollarization of the domestic economy $(1 - M)$ and in the shock to the fundamentals. For a given y, a higher share of dollar debt creates a bias towards an appreciation of the exchange rate. On the other hand, for a given degree of dollarization, a larger shock y leads to an exchange rate depreciation. In this model the central bank adopts at least *de facto* a fixed exchange rate regime, when liabilities are dollarized and shadow exchange rate shocks hit the economy.

2.4 Equilibrium Share of Peso Debt

The optimal share of peso debt for the borrower i is given by the constrained maximization of her ex-ante utility function, as follows:

$$\max_{m_i}[Aq - A(1 - m_i)(1 + i)(E_i(1 + \Delta e)|I_i) - Am_i(1 + i) \\ -\frac{1}{2}A^2(1 - m_i)^2(1 + i)^2 VAR(\Delta e)|I_i] \tag{6}$$

s.t.

$$(1 + i) = (1 + i^*)E_L((1 + \Delta e)|I_L), \tag{7}$$

[6] Calvo and Reinhart, (2000).

$$E_i(\Delta e|I_i) = -\lambda A E_i[(1-M)|I_i](1+i^*) + E_i(y|I_i), \tag{8}$$

$$E_L(\Delta e|I_L) = -\lambda A E_L[(1-M)|I_L](1+i^*) + E_L(y|I_L). \tag{9}$$

As equations (8) and (9) show, domestic and international investors use their expectations on the degree of dollarization and on the shock y in order to formulate their expectations of future devaluation, $E_i(\Delta e|I_i)$ and $E_L(\Delta e|I_L)$. When they take their decisions, agents not only are unable to perfectly observe the shock y, but they also cannot observe the degree of dollarization in the economy $(1-M)$ because it will be determined *ex-post* by the choices that they are making today. The resulting optimal share of peso-debt is

$$m_i = 1 + \chi[(E_i(1+\Delta e) \mid I_i) - (E_L(1+\Delta e) \mid I_L)], \tag{10}$$

where $\chi = \dfrac{1}{AVAR(\Delta e \mid I_i)(1+i^*)}$. Expectations are formulated on the basis of the policy rule (5) that is common knowledge in the economy. The difference in lenders' and borrowers' expectations is the main reason that justifies the decision to dollarize. Assuming that $i^* = 0$, the share of peso debt simply becomes a function of international lenders' and the borrowers' expectations about Δe. If $E_i(\Delta e \mid I_i) = E_L(\Delta e \mid I_L)$, the domestic borrower chooses to borrow only in domestic currency. This choice is the optimal one as it allows the agent to hedge herself against any shock to the exchange rate. The main reason that justifies the choice to borrow in dollars is that the expectations about the stability of the exchange rate are different for the international lenders and the borrowers, with international investors that are more pessimistic than domestic borrowers, i.e., $E_i(\Delta e) < E_L(\Delta e)$. If international lenders are more pessimistic than the generic domestic borrower i, the share of peso debt m_i is going to be smaller than 1. In this case pessimistic investors ask a

risk premium for lending in *pesos*, that is not justified by agent i expectations of devaluation. The domestic borrower therefore is not willing to pay an extra cost and prefers to borrow in dollars and run an exchange rate risk that she does not expect to be high.

The last possible case that can be realized is the one in which domestic agent i is more pessimistic than the international investor. In this case the domestic agent is willing to borrow in pesos a share of debt that is even larger than her total debt, because her expectation on the exchange rate risk is higher than the one of the international investor.

In what follows, I will focus my attention on the first case where international investors have more pessimistic expectations that domestic borrowers. The assumption of pessimistic international investors is consistent with the case analyzed in this paper, where emerging markets borrow in dollars even if they have strong fundamentals and, according to some studies[7], is also the empirically relevant one.

3 Information Structure

The optimal share of peso debt in (10) depends upon the difference between lenders' and borrowers' expectations. The choice to borrow in foreign currency here signals a difference in the information available to the two sets of agents considered. If lenders expect a larger depreciation than borrowers, the domestic interest rate increases making the decision to borrow in pesos more expensive. As a consequence, domestic agents have to compare the currency risk associated with dollar debt with the cost of borrowing in domestic currency, given lenders' pessimism, and choose accordingly.

[7]Bhagwati, (1998), Stiglitz, (1998), Rodrik, (1998), Radelet and Schs, (1998), Kim and Wei (2002a), Cho, Kho and Stulz, (1999), Borensztein and Gelos (2003), Kaminsky, Lyons and Schmulker, (2004), and Andrade and Kohlscheen, (2010).

The expectations of depreciation are based on the policy rule (5) that is common knowledge in the economy. This policy rule depends on the shock that hits the economy and on the degree of dollarization. The goal of all the agents is therefore to use all their available information in order to anticipate as much as possible these two variables.

In what follows I show that different information structures produce results that are consistent with each other, but, at the same time, allow me to separately emphasize the demand and supply side factors that determine the final outcome.

A general assumption that is common to the two settings of the model is that domestic borrowers dispose of a larger information set on the fundamentals of the economy than international investors. As suggested by Calvo (1999), this is a reasonable assumption because from the perspective of an international investor, learning about an individual country involves fixed costs that are large relative to the size of investment projects. This is especially true for emerging economies that rapidly change and therefore require a more frequent monitoring than more stable developed countries. Domestic agents instead are likely to have better information without incurring in high monitoring costs, simply because they regularly operate in the emerging economy, read its newspapers, listen to its radios, and so on.

There are two settings that I analyze:

- In the first case I show that the individual decision to borrow in foreign currency can be the result of a coordination problem, when there is heterogeneity in information among domestic borrowers.

- In the second case I remove information heterogeneity among domestic agents and I describe the interaction between a representative domestic borrower and an international investor.

3.1 The Coordination Game

Domestic and international agents at time 0 have a common prior about the adverse shock (y) that hits the economy. The shock is normally distributed with mean μ and variance σ_y^2. At time 1 the shock is realized, but it is not directly observed. At time 2 domestic borrowers receive a private signal $x_i = y + \epsilon_i$ that describes the shock and that they use to update their prior. The error term ϵ_i is normally distributed over the population of borrowers with mean 0 and finite variance $\epsilon_i \sim N(0, \sigma_\epsilon^2)$. At time 3 borrowers and lenders formulate their expectations on Δe and M, and the final share of peso debt in the economy is determined. The last stage of the game takes place when the central bank, after observing the realized values of M and y, chooses how to move the exchange rate.

The information set of domestic borrowers includes the common prior plus the private signal that they receive. After receiving their signal they follow the policy rule (5) to update their expectations on Δe, as follows:

$$E_i(\Delta e \mid x_{i,}\mu) = -\lambda A E_i[(1 - M) \mid x_{i,}\mu] + E_i(y \mid x_{i,}\mu) \tag{11}$$

The updated expectation of y after observing the private signal is:

$$E_i(y \mid x_{i,}\mu) = \frac{\sigma_\epsilon^2}{\sigma_\epsilon^2 + \sigma_y^2}\mu + \frac{\sigma_y^2}{\sigma_\epsilon^2 + \sigma_y^2}x_i. \tag{12}$$

The precisions of the two signals are $\alpha = \dfrac{1}{\sigma_y^2}$ and $\beta = \dfrac{1}{\sigma_\epsilon^2}$, and the updated expectation of y can be written as:

$$E_i(y \mid x_{i,}\mu) = \frac{\alpha\mu + \beta x_i}{\alpha + \beta}. \tag{13}$$

The conditional expectation of the exchange rate devaluation is:

$$\begin{aligned} E_i\left(\Delta e \mid x_{i,}\mu\right) &= -\lambda A\left(E_i\left(1-M\right) \mid x_{i,}\mu\right) + E_i(y \mid x_{i,}\mu) \\ &= -\lambda A + \lambda A E_i\left(M\right) + \frac{\alpha\mu + \beta x_i}{\alpha+\beta}. \end{aligned}$$

The information available to international lenders is only represented by the common prior on y and therefore their expectation about the shock coincides with its prior. Plugging the expression for $E_i\left(\Delta e \mid x_{i,}\mu\right)$ into (10), m_i becomes:

$$m_i = 1 - \frac{E_L\left(\Delta e \mid \mu\right) + \lambda A}{A(VAR\left(\Delta e\right)|x_i,\mu)} + \frac{\lambda A E_i\left(M \mid x_{i,}\mu\right) + E_i\left(y \mid x_i,\mu\right)}{A(VAR\left(\Delta e\right)|x_i,\mu)}. \tag{14}$$

The optimal share of peso debt for borrower i depends on her own expectations on the fundamentals, $E_i\left(y \mid x_{i,}\mu\right)$, on her expectation on the total share of peso debt in the economy, $E_i\left(M \mid x_{i,}\mu\right)$, and on lenders' expectations on the future devaluation rate, $E_L\left(\Delta e|\mu\right)$. Equation (14) clearly shows the coordination motive behind the borrowing choice. The individual agent does not only choose on the basis of the fundamentals of the economy, but also on the basis of the degree of dollarization that she expects is going to be realized. The agent in fact knows that the behavior of the exchange rate depends on both these variables and, therefore, makes her choice formulating her own expectations not only on the fundamentals of the economy, but also on the expectations of the rest of the market.

To find the equilibrium value of m_i I use the method of the undetermined coefficients. To find $E_i\left(M \mid x_{i,}\mu\right)$ I guess the generic rule followed by the domestic borrower j in the economy. The strategy followed by the generic agent j depends on both the public (i.e. the common prior) and

the private signals she observes, plus a constant.

$$m_j = K_x x_j + K_\mu \mu + \gamma \tag{15}$$

The total share of peso debt in the economy is found by integrating the individual share over the continuum of domestic agents as follows:

$$M = K_x y + K_\mu \mu + \gamma \tag{16}$$

And finally the expectation of domestic agent i is formulated in the following way:

$$E_i\left(M \mid x_i, \mu\right) = E_i\left(K_x y + K_\mu \mu + \gamma\right) = K_x\left(\frac{\alpha\mu + \beta x_i}{\alpha + \beta}\right) + K_\mu \mu + \gamma. \tag{17}$$

Similarly, we can use (16) to calculate lenders' expectation of the total amount of peso debt in the economy, given their information set:

$$E_L\left(M|\mu\right) = E_L\left(K_x y + K_\mu \mu + \gamma\right) = K_x\left(\mu\right) + K_\mu \mu + \gamma. \tag{18}$$

The final expression for the optimal share of peso debt chosen by the domestic agent i depends exclusively on the precision of the private signal, on the coefficient of risk aversion A, on the parameter λ that characterizes the policy rule, and on the value of the two signals:

$$m_i = \frac{\beta}{A\left[\frac{1}{2}\left[(1 + 2\lambda\beta) + \sqrt{4\beta\lambda + 1}\right] - \lambda\beta\right]}\left(x_i - \mu\right) + 1. \tag{19}$$

The observation of a highly precise private signal describing strong fundamentals induces the agent to choose to borrow in dollars. If the borrower has more confidence on the state of the fundamentals than the international markets, she considers the domestic interest rate unreasonably high and therefore opts for dollar debt.

It is worth noting that the precision of the public signal does not enter the expression for the equilibrium share of peso debt. This result is quite different from the ones usually found in global game models, where the coordination motive results in a weight given to the public signal that is increasing in its precision. Here instead there is a positive term in β involving the private signal and a corresponding negative term involving the public signal. The share of peso debt overreacts to the private signal, while the information content of the public signal is suppressed. This confirms the intuition that the choice concerning the currency denomination of the debt mainly depends on the differences in the availability of information. Typically the public signal influences the final outcome not only because of the information it conveys, but also because of its ability to re-create a certain degree of common knowledge among agents. The role of public information here becomes secondary instead, because it is contemporaneously used by two different categories of agents whose actions go in opposite directions. A public signal that suggests a future devaluation has in fact two effects: On the one hand, it reduces domestic agent's incentives to borrow in dollars, because there is a higher risk to experience an increase in the value of the debt that has to be repaid; On the other hand, the same signal suggests to international investors that it is becoming riskier to lend in pesos and therefore they increase the interest rate associated to peso debt. These two effects cancel out in the determination of the optimal share of domestic currency denominated debt, and what

really matters is the difference in the information available to agents [8].

By integrating m_i over the continuum of domestic borrowers, the optimal share of peso debt M is :

$$M = \frac{2}{A\left[1+\sqrt{4\beta\lambda+1}\right]}\left[\beta\left(y-\mu\right)\right]+1. \tag{20}$$

The optimal share of peso debt resulting from the coordination game among the domestic borrowers and from the interaction between domestic and foreign agents, depends on the spread between the realized value of the fundamentals and their common prior, and on the parameters describing the precision of the private signal, the risk aversion and the weight given to the social utility in the objective function of the central bank. When the realization of the shock equals its prior domestic and international agents have exactly the same expectations and the share of dollar debt in the economy is zero ($M = 1$).

3.1.1 Comparative Statics

It is possible to infer the following propositions from equation (20):

Proposition 2 *When the fundamentals are strong, i.e. $y < \mu$, an increase in the precision of the private signal observed by domestic agents results in an increase of the degree of dollarization in the economy.*

The partial derivative of M with respect to β is:

[8] As shown in Appendix B, the usual role of the public signal as a coordination device is re-established also in this context if we imagine that only domestic agents observe, additionally to their private signal, also a public signal that is not observed by international investors. The necessity to coordinate with the rest of the market implies that part of the available information might be disregarded.

$$\frac{\partial M}{\partial \beta} = \frac{(y-\mu)}{A\left[1+\sqrt{4\beta\lambda+1}\right]^2} \frac{\left[\sqrt{4\beta\lambda+1}+2\lambda\beta+1\right]}{\sqrt{4\beta\lambda+1}}$$

If the precision of the private source of information available to the domestic borrowers increases, we observe an increase in the degree of dollarization. If the fundamentals are strong in fact it is less risky in the borrowers' eyes to borrow in foreign currency and, as a result, the average share of peso debt decreases. On the other hand, if the realization of the shock y is higher than its prior, an increase in β increases the degree of peso debt in the economy. In other terms, a high precision of the private signal leads the currency denomination choices in the direction that is more consistent with the actual state of the economy.

Proposition 3 *When the fundamentals are weak, i.e. $y > \mu$, an increase in the parameter λ increases the degree of dollarization in the economy.*

The partial derivative of M with respect to λ is:

$$\frac{\partial M}{\partial \lambda} = -\frac{4\beta^2 (y-\mu)}{A\left[1+\sqrt{4\beta\lambda+1}\right]^2} \frac{1}{\sqrt{4\beta\lambda+1}}$$

When the fundamentals are weak, $(y > \mu)$, a higher protection of the central bank towards those that borrow in dollars increases the degree of dollarization. Even though the fundamentals are not very strong, the stronger commitment of the monetary authority to keep the exchange rate appreciated increases the degree of dollarization observed. Agents expose themselves to a risk that otherwise they would not have run. This is what I define "dollarization due to moral hazard".

3.2 Two Players

The optimal share of peso debt for the atomistic domestic borrower is given as before by (10). In this section I study what happens to the share of domestic currency denominated debt when I abstract from the coordination problem among domestic agents. In order to do that I assume that there is common knowledge in the domestic economy, even though I still assume that international investors and domestic borrowers have access to different sources of information. The results that I find in this new environment are still in line with the previous ones, but allow me to emphasize the role of supply-side factors in the determination of the degree of dollarization of the economy. Both domestic and international investors have a common prior about the shock that is normally distributed with finite mean and variance: $y \sim N\left(\mu, \sigma_y^2\right)$. I assume that after the shock takes place, all the domestic borrowers observe the same private signal about the fundamentals $x_i = y + \epsilon_i$, where $\epsilon_i = \epsilon_j$ with $\epsilon \sim N\left(0, \sigma_\epsilon^2\right)$. In this case I totally disregard the coordination motive and x is a private signal in the sense that it can be observed only by the domestic agents and not by the international markets. The direct consequence of this assumption is that all the borrowers choose the same composition of debt, observing exactly the same information. In this case the problem of higher order beliefs is not taken into consideration anymore, and $m_i = m = M$. International investors do not precisely see the average share of peso debt in the economy. They observe a signal z, instead. The degree of dollarization in the economy is given by the combination of borrowers' and lenders' expectation about the movements in the exchange rate. The Central Bank in the last stage observes M and y and implements the optimal monetary policy, as before. Since all the borrowers observe the same "private" signal x I will not use the subscript i. The share of peso debt of the single borrower coincides with the degree of domestic currency debt in the economy. Equation (10)

becomes:

$$M = 1 + \frac{E\left(\Delta e \mid x, \mu\right)}{AVAR\left(\Delta e \mid x, \mu\right)} - \frac{E_L\left(\Delta e \mid z, \mu\right)}{AVAR\left(\Delta e \mid x, \mu\right)}. \tag{21}$$

The expectations about the exchange rate movements are:

$$E(\Delta e \mid x, \mu) = -\lambda A + \lambda A M + E(y \mid x, \mu) \tag{22}$$

The variance of the depreciation rate coincides now with the variance of the shock:

$$Var(\Delta e \mid x, \mu) = \frac{\sigma_y^2 \sigma_\epsilon^2}{\sigma_y^2 + \sigma_\epsilon^2} \tag{23}$$

If we call $\alpha = \dfrac{1}{\sigma_y^2}$ and $\beta = \dfrac{1}{\sigma_\epsilon^2}$

$$Var(\Delta e \mid x, \mu) = \frac{1}{\alpha + \beta}. \tag{24}$$

The international borrowers observe a public signal describing the share of peso debt in the economy $z = M + \eta$ where $\eta \sim N(0, \sigma_\eta^2)$. Their expectations are still formulated on the basis of the optimal policy rule (5) as follows:

$$E_L(\Delta e \mid \mu, z) = -\lambda A + \lambda A M + \lambda A \eta + \mu. \tag{25}$$

Observe that when η is positive, investors overestimate the degree of peso debt in the economy and expect larger devaluations of the exchange rate. Plugging the expectations into (21), the final expression for the total share of peso debt is a function of the precision of the public and the private

signals, the two signals themselves, the noise of the signal observed by the lenders and the parameter λ that appears in the utility function of the central bank.

$$M = 1 + \frac{(\alpha + \beta)}{A}\left(\frac{\beta(x - \mu)}{\alpha + \beta} - \lambda A \eta\right). \tag{26}$$

It is worth noting the main differences between the expression for M in (26) and the one in (20): When there is common knowledge among domestic agents and international investors observe and exogenous noisy signal about M, the precision α of the common prior affects the total degree of peso debt. This happens because now the expectations of international investors on M totally depend on an exogenous signal and therefore we do not observe the two offsetting effects of α that I discussed before. Now α contributes to determine the variance of the exchange rate. Second, the absence of heterogeneity in domestic agents' information sets implies that the final degree of peso debt in the economy depends on the difference between the common prior and the private signal, while in the previous setting the value of M was determined by the difference between the realized value of the shock y and the common prior.

The total share of domestic currency denominated debt in the economy is lower when the private signal observed within the domestic economy is smaller than the common prior shared by all the agents, and determines domestic agents' optimistic expectations about the state of the fundamentals. Another important element is the noise η. When the low level of transparency on the international markets induces international lenders to overestimate the share of peso debt in the economy ($\eta > 0$), they increase their expectations of devaluation and decrease the supply of domestic currency denominated funds. When η is positive, the increase in dollarization is even stronger if the precisions of the signals is larger: More precise signals reduce the volatility of the exchange

rate and increase the willingness of domestic borrowers to borrow in foreign currency. As before, optimistic expectations of the domestic agents associated to highly precise private signals increase dollar debt in the economy.

3.2.1 Comparative Statics

From equation (26) it is possible to infer the following propositions:

Proposition 4 *An increase in the size of the noise that affects the signal z observed by the international lenders reduces the share of peso debt.*

$$\frac{\partial M}{\partial \eta} = -\lambda (\alpha + \beta)$$

A low level of transparency on the international markets increases the level of dollarization. If international lenders overstate the share of peso debt in the economy, they will increase their expectations of depreciation and with them also the price of domestic currency denominated funds. Such an increase in the share of dollar debt is greater with high values of λ and highly precise signals about the fundamentals.

Proposition 5 *An increase in the value of the parameter λ reduces the share of peso debt.*

$$\frac{\partial M}{\partial \lambda} = -\eta (\alpha + \beta)$$

An increase in the parameter that weights the social welfare in the utility function of the central bank results in an increase in the degree of dollarization, when the low level of transparency on the

international markets induces the lenders to overestimate the share of peso debt in the domestic economy. A paternalist central bank increases agents' incentives to contract dollar debt. If international investors overestimate the presence of domestic currency denominated debt ($\eta > 0$), it will become more expensive to borrow in pesos and the degree of dollarization will increase.

Proposition 6 *An increase in the precision β of the private signal that domestic agents observe, decreases the share of peso debt, when international investors overestimate the amount of peso debt in the economy. This effect is even stronger when the domestic market has optimistic expectations about the fundamentals.*

$$\frac{\partial M}{\partial \beta} = \frac{(x-\mu)}{A} - \lambda\eta$$

A higher precision of the private signal that the domestic economy observes increases the level of dollarization, when the fundamentals described by the private signal are stronger than the ones implied by the public signal. The degree of dollarization is also influenced by the policy parameter λ and by the degree of transparency on the international markets. If international investors overestimate the share of peso debt in the economy ($\eta > 0$), their expectations of depreciation will be high and the supply of domestic currency denominated debt will be reduced.

Proposition 7 *An increase in the precision of the public signal increases the degree of dollarization, when the international markets overestimate the presence of peso debt in the economy.*

$$\frac{\partial M}{\partial \alpha} = -\lambda\eta$$

An increase in the precision of the public signal increases the degree of dollarization, when international markets have high expectations of devaluation. A larger α means that the exchange rate volatility is lower and therefore less risky to borrow in dollars. There is an interaction between supply (η) and demand-side factors that pushes to increase dollarization in the economy. The amount by which peso debt is reduced also depends on the parameter λ.

4 Policy Implications

The two expressions for the average peso debt M that result from different assumptions, react in a similar way to a change in some key parameters like λ, the weight of the social utility in the objective function of the central bank, and β, the precision of the private signal observed only by the domestic borrowers. If there is an increase in λ, people anticipate that the larger the degree of dollarization in the economy, the stronger the exchange rate is going to be. This generates a coordination motive among domestic agents that creates a *moral hazard* problem in the domestic economy: Agents are willing to borrow in foreign currency even when the economy is relatively weak. The policy rule found in the model is the optimal policy that the central bank follows under discretion, when it doesn't have to commit *ex-ante* to an exchange rate policy that is not related to the share of dollar debt. In appendix C I show the effect on the degree of dollarization of a central bank that acts under commitment. If the central bank *ex-ante* announces an exchange rate policy that only depends on the changes in the fundamentals, the resulting degree of dollarization is always lower than the one that would emerge under discretion, for any parameter value. That is to say that if there is agreement on the riskiness of foreign currency denominated debt, the presence of a central bank that acts under commitment can reduce agents' incentives to coordinate and borrow

in dollars. The resulting degree of dollarization that is realized in the economy is uniquely justified by changes in fundamentals and by the different expectations that agents have over them.

The precision of available information also affects agents' borrowing decisions. As already noted, in the version of the model with dispersed information among domestic agents, only the private signal matters in the determination of the economy share of peso debt. This happens because the signal that can be observed by all the agents in the economy generates actions that offset each other and ultimately do not affect the share of peso debt. An increase in the precision of the private signal about the fundamentals, β, lowers the peso debt in the economy, when the fundamentals are relatively strong. It is in fact reasonable to think that if the precision of the private signal increases, the weight given by domestic borrowers to their private information increases as well, and the choice to borrow in dollars ends up revealing this additional information they dispose of.

Finally, when common knowledge is assumed in the domestic economy, another important parameter that influences the degree of dollarization is the size of the noise with which international investors observe the total share of peso debt, η. A positive shock η implies that international investors expect the share of peso debt to be larger than it actually is. A marginal increase in η results always in an increase in the share of dollar debt. This is a parameter that appears also in all the other partial derivatives and always increases the share of dollar debt. In general, the two settings of the model tell us something about the way in which transparency affects dollarization. In the first setting, when there are informational asymmetries among domestic investors, only private information matters. Moreover the pieces of information that can be observed by all the agents, including domestic and international ones, have no effect on the degree of dollarization. Therefore here transparency can be interpreted as an increase in the availability of many sources of private

signals that enrich agents' information sets helping them formulate expectations that are closer to fundamentals, since public information is totally ineffective. In the second setting, instead, when we leave aside all the coordination problems and we introduce an additional signal observed by international investors, transparency means the ability of investors to anticipate the share of peso debt that is going to be realized. Higher transparency on international markets therefore can be achieved through the dissemination of more precise information on the fundamentals.

5 Conclusion

The paper analyzes the factors that determine the choice of emerging markets agents to borrow in foreign currency, even if their economy is characterized by strong fundamentals and sound policies. In this model I show how the combination of demand and supply side factors can contribute to explain the emergence of the phenomenon known as "Original Sin". The main result is that the different information sets available to the agents in the economy can justify the formation of different expectations about the soundness of the domestic market and, therefore, the choice to dollarize. The most important factors that help explain the share of dollar debt in the economy are the informational advantage about the state of the economy that domestic agents have over international markets, the exchange rate policy and the degree of transparency on the international markets. The relative incidence of supply and demand side factors on the determination of the final degree of dollarization in the economy can change depending on the time and on the markets considered. In general the message of the model is that a high dollar debt even in strong economies, can be due, on the one hand, to the awareness that such countries have of being characterized by strong

fundamentals, and, on the other hand, to the low ability of the international markets to catch this signal. It is worth noting that a crucial role here is played by the central bank that with its exchange rate policy can deeply influence agents' behavior and, eventually, create dangerous distortions in the economy.

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A Appendix A

In this appendix I simply show how to use the typical properties of the CARA utility function in order to reach the final expression that I used in the text. Each domestic firm produces a domestic good q, and to finance her production she borrows funds on the international markets. Domestic agents maximize a CARA utility function whose argument is net output, i.e. their consumption. The choice of the currency denomination of their debt results from the maximization of their *ex-ante* utility function:

$$E_i U\left[q-\left(1-m_i\right)\left(1+i^*\right)\left(1+\Delta e\right)-m_i\left(1+i\right)\right]$$

$$=E_i\left[-\exp[-A[q-\left(1-m_i\right)\left(1+i^*\right)\left(1+\Delta e\right)-m_i\left(1+i\right)]\right]$$

$$\begin{aligned}= & -E_i[\exp(-A[(q-\left(1-m_i\right)\left(1+i^*\right)\left(1+\Delta e\right)-m_i\left(1+i\right)\mid I_i)+\\ & -\frac{A}{2}Var\left(q-\left(1-m_i\right)\left(1+i^*\right)\left(1+\Delta e\right)-m_i\left(1+i\right)\right)\mid I_i)]\end{aligned}$$

Let

$$\begin{aligned}\Xi_i = & [(Aq-A\left(1-m_i\right)\left(1+i^*\right)E_i\left(1+\Delta e\right)+\\ -Am_i\left(1+i\right) & \mid I_i)-\frac{1}{2}A^2\left(1-m_i\right)^2\left(1+i^*\right)^2VAR\left(1+\Delta e\right)\mid I_i]\end{aligned}$$

where A is the coefficient of risk-aversion that is the same for all the domestic agents. Agent's optimization problem reduces to choosing the optimal share of peso-debt, m_i to maximize Ξ_i, given her information set I_i.

B Appendix B

In order to analyze how the optimal share of peso debt chosen by each agent in the economy depends on the nature of the information available (public or private), I slightly modify some assumptions on the signals observed by the agents in the economy. If a certain degree of public information is shared only by domestic agents, the usual result concerning the typical over-reaction to public information is reestablished, even though the private information goes on playing a crucial role. This exercise helps clarify the main intuition according to which the problem analyzed in the model displays important complementarities in domestic agents' actions.

There is a common prior about the adverse shock that will hit the domestic market shared by the whole economy. The shock y is normally distributed with mean ϕ and precision θ, $y \sim N\left(\phi, \frac{1}{\theta}\right)$. After the shock has taken place, domestic agents update their expectations by observing a public signal μ, such that $\mu = y + \eta$, with $\eta \sim N\left(0, \frac{1}{\alpha}\right)$ and a private signal x_i , such that $x_i = y + \epsilon_i$, with $\epsilon_i iid \sim N\left(0, \frac{1}{\beta}\right)$ and $\epsilon_i \neq \epsilon_j$.The difference in the availability of information is now given by the presence of a public and a private signal that only domestic agents can observe.

Moving from equation (10) that describes the optimal share of peso debt chosen, the guess concerning the generic domestic agent j's actions depends now on the prior, the public signal and the private signal:

$$m_j = k_x x_j + k_\phi \phi + k_\mu \mu + \gamma \tag{B1}$$

The total amount of peso debt can be found by integrating over the continuum of domestic agents

$$M = k_x y + k_\phi \phi + k_\mu \mu + \gamma \tag{B2}$$

$$E_i \left(M \mid \phi, \mu, x_i \right) = k_x E_i \left(y \mid \phi, \mu, x_i \right) + k_\phi \phi + k_\mu \mu + \gamma \tag{B3}$$

International investors' expectations about the exchange rate devaluation depend, as before, only on the common prior

$$E_L \left(\Delta e \mid \phi \right) = -\lambda A + \lambda A E_L \left(M \mid \phi \right) + E_L \left(y \mid \phi \right) \tag{B4}$$

$$E_L \left(M \mid \phi \right) = \left(k_x + k_\phi + k_\mu \right) \phi + \gamma \tag{B5}$$

$$E_L \left(\Delta e \mid \phi \right) = -\lambda A + \lambda A \left(\left(k_x + k_\phi + k_\mu \right) \phi + \gamma \right) + \phi \tag{B6}$$

Plugging $(B3)$ and $(B6)$ into (10) I get

$$m_i = 1 + \frac{-\lambda A\left(\left(k_x\left(\alpha+\beta\right)+k_\mu\left(\vartheta+\alpha+\beta\right)\right)\phi\right)-\phi\left(\alpha+\beta\right)}{AVAR\left(\Delta e\right)\left(\vartheta+\alpha+\beta\right)}+ \frac{\lambda A\left[k_x\alpha\mu+k_\mu\mu\left(\vartheta+\alpha+\beta\right)\right]+\alpha\mu}{AVAR\left(\Delta e\right)\left(\vartheta+\alpha+\beta\right)} + \frac{\lambda A k_x\beta x_i+\beta x_i}{AVAR\left(\Delta e\right)\left(\vartheta+\alpha+\beta\right)} \tag{B7}$$

The average degree of domestic currency denominated debt in the economy becomes:

$$M = 1 + \frac{2\beta}{A\left[\left(1+2\lambda\beta\right)+\sqrt{1+4\beta\lambda}\right]}\left(y-\phi\right)+ + \frac{\alpha}{A\left[\left(1+2\lambda\beta\right)+\sqrt{1+4\beta\lambda}\right]}\left(\mu-\phi\right)+ + \frac{\alpha\left(2\lambda\beta+\sqrt{1+4\beta\lambda}\right)}{A\left[\left(1+2\lambda\beta\right)+\sqrt{1+4\beta\lambda}\right]}\mu - \frac{\alpha\left(2\lambda+1\right)}{A\left[\left(1+2\lambda\beta\right)+\sqrt{1+4\beta\lambda}\right]}\phi \tag{B8}$$

The introduction of a public signal μ observable only by the domestic borrowers reestablishes, to a certain extent, the usual properties of the public information in the context of a coordination game. The final degree of peso debt in the economy depends (positively) on the public signal and on the realized value of the shock, while it depends negatively on the common prior. More precisely, the degree of peso debt depends on the difference between the actual realization of the shock and its prior (as before) and now, with the introduction of a public signal, also on the difference between the public signal itself and the common prior, weighted by the precision of the former. From the first two elements of (B8) we can infer that the share of peso debt "over-reacts" to the actual realization of the shock and to the public signal, while the information content of the common prior

is to some extent suppressed. In other terms, the final degree of dollarization depends crucially on the additional information domestic agents dispose of. The public signal enters the expression for M with a higher weight, but the private signal still matters for the final degree of peso debt.

C Appendix C

It has been shown that the monetary policy influences agents' borrowing decision. A large value of λ in the policy function means that agents' utility enters the welfare function with a high weight. A higher degree of "paternalism" of the monetary authority seems to increase the incentive of domestic agents to borrow in foreign currency. That is to say, we observe a phenomenon of moral hazard due to the strong protection from exchange rate depreciations given by the central bank to those that dollarize. In the paper I analyzed the role of monetary policy under discretion, but it is worth studying how things change under commitment. Under a credible commitment the monetary authority that wants to rule out any coordination motive among agents and reduce as much as possible the moral hazard, announces an exchange rate rule that does not depend on the average degree of dollarization in the economy. I assume that the central bank credibly commits to a rule such that the movements in the exchange rate are only justified by the occurrence of shocks denoted as before by y.

$$\Delta e = \gamma\left(y\right) \tag{C1}$$

The optimal share of domestic currency denominated debt, m_i depends now on the expectations formulated on the basis of the new rule C1. Foreign investors formulate their expectations on the

basis of their information set given simply by the common prior on y, while domestic agents use both the sources of information they have, given by the prior and the private signal they observe.

Equation (10) now becomes

$$m_i = 1 + \frac{\gamma\left(\frac{\alpha\mu + \beta x_i}{\alpha + \beta}\right) - \gamma\mu}{AVAR\left(\Delta e \mid x_{i,}\mu\right)}.$$

The conditional variance of Δe is

$$VAR\left(\Delta e \mid x_{i,}\mu\right) = \frac{\gamma^2}{\alpha + \beta},$$

and the expression for the optimal share of peso debt becomes

$$m_i = 1 + \frac{\beta\left(x_i - \mu\right)}{A\gamma}. \tag{C2}$$

The total share of peso debt in the economy therefore is

$$M = 1 + \frac{\beta\left(y - \mu\right)}{A\gamma} \tag{C3}$$

In order to find the parameters γ in the policy rule and, with them, the optimal degree of dollarization under commitment, it is necessary to maximize the social welfare function with respect to γ :

$$\max_{\gamma} W_{CB}^{C} = \lambda[Aq - A(1-M)(1+i^*)(1+\Delta e) - AM(1+i) \\ -\frac{1}{2}A^2(1-M)^2 VAR(\Delta e)] - \frac{1}{2}[\Delta e - y]^2$$

The optimal value of γ is:

$$\gamma = \frac{y^2 - \mu A\lambda}{y^2}.$$

It is now possible to compare the optimal share of peso debt in the economy under commitment (M^c) with the one that emerges under discretion (M^d) :

$$M^c = 1 + \frac{\beta\,(y-\mu)\,y^2}{A\,(y^2 - \mu A\lambda)} \tag{C5}$$

$$M^d = \frac{2}{A\left[1+\sqrt{4\beta\lambda+1}\right]}\left[\beta\,(y-\mu)\right] + 1 \tag{C6}$$

The result is that always, for any value of the parameters of the model, the degree of dollarization that is realized under commitment is smaller than the one that is realized under discretion.