Foreign Currency Debt and Expectations

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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 as a signal of strong fundamentals. Some policy implications are briefly discussed.

1 Introduction

Many emerging countries borrow in foreign currency. The presence of large shares of foreign currency debt in emerging markets has been object of many studies in the last years because currency mismatch was one important aspect of the East Asian and Latin American crises of the 1990s.

However data show that foreign currency debt was not an unknown phe-

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nomenon before these episodes and that historically countries with very different features denominated their foreign debt in a handful of key currencies[1]. The first empirical studies on the topic [2] have defined the large presence of foreign currency debt in emerging countries as the "Original Sin of the International Finance". The "Original Sin" has been described as the inability of developing countries to borrow in their own currency on the international markets. Several studies have shown the lack of any correlation between foreign currency denominated debt and countries' fundamentals [3] and, as a consequence, the main determinants of the phenomenon have been identified in the way international markets operate, rather than in the specific features of each country.

Nevertheless, part of the literature has emphasized the necessity to give a micro-foundation to the emergence of this phenomenon. Given the high costs associated with a massive presence of foreign currency denominated debt, there should be at least some private benefits for the agents that choose this form of finance.

In this paper I study the demand-side forces that can help 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

[1] Flandreau and Sussman (2005).

[2] Eichengreen and Hausmann (1999), Eichengreen Hausmann and Panizza (2005a, 2005b), Hausmann and Panizza (2003).

[3] Hausman and Panizza (2003), Bordo and Meissner, (2007).

and heterogeneous expectations can affect the choice of a borrower to expose herself to a currency risk. My main result is that when domestic agents have an informational advantage, a certain degree of debt dollarization might be observed, if the fundamentals of the economy are relatively strong. This result implies that in this model dollarization is a signal of strong fundamentals: It is rational for domestic agents to dollarize their debt if the state of the economy is good and uninformed international investors are more pessimistic than informed domestic borrowers. Furthermore, my model shows that the exchange rate stability observed in the presence of debt dollarization is compatible with a situation of financial soundness.

In the model there are three types of agents: domestic borrowers, international investors and a domestic central bank (CB). Domestic agents want to minimize their borrowing costs and, in order to do that, they choose the currency denomination of their debt. Agents can denominate their debt in domestic or in foreign currency. Foreign currency debt is cheaper only in the case of no devaluation of the exchange rate. If instead there is an exchange rate devaluation, domestic currency debt becomes cheaper. The exchange rate policy depends on two factors: the fundamentals of the economy and the share of dollar debt. The weaker the fundamentals are, the higher the probability of a devaluation is. The larger the share of foreign currency debt is, the smaller the probability of devaluation is. Domestic agents have to

formulate their expectations on the probability of devaluation and compare them with the probability of devaluation formulated by the international investors and reflected in the interest rate charged on domestic currency debt. Domestic borrowers and international markets can rely on different sources of information. Whenever there is agreement between domestic borrowers and international lenders, it is indifferent for domestic agents to borrow in one currency or in the other. When there is disagreement instead, domestic agents will have a clear preference for one currency over the other. The actions of the domestic agents are strategic complements in this model. Domestic agents are in fact aware that the CB is affected in its devaluation decision by the state of the fundamentals and by the share of dollar debt in the economy. A high share of dollar debt makes a devaluation more costly and reduces CB's incentives to implement it. Domestic agents therefore have an incentive to denominate their debt in foreign currency if they think that fundamentals are strong and if they expect the rest of the market to think that the state of the fundamentals is good. Similarly, they are going to denominate their debt in domestic currency if they think that the fundamentals are weak and if they think that all the other borrowers share the same belief. The result of the model is consistent with the empirical evidence that even countries with good fundamentals and strong institutions have been borrowing in foreign currency. Furthermore it confirms the empirical findings of

Bordo et al. (2010) that show that historically there has not been incompatibility between financial stability and high shares of dollar debt. A strong presence of foreign currency denominated debt can in fact be harmful for stability only if it is associated with other fundamental weaknesses.

The theoretical literature on foreign currency debt in emerging economies has mostly focused its attention on the subset of economies with bad fundamentals that have borrowed in foreign currency and then have been involved in a crisis. This literature has identified several factors that could explain the choice to borrow in foreign currency: Moral hazard created by bailout guarantees (McKinnon and Pill (1999), Burnside, Eichenbaum and Rebelo (2001), Schneider and Tornell (2001)), lack of domestic financial development (Caballero and Krishnamurthy (2003)), commitment/signaling problems at the level of domestic firms (Aghion, Bacchetta and Banerjee (2004)), and domestic monetary policy (Chamon and Hausman (2005), Jeanne (2003), Cowan and Do (2003) and Chang and Velasco (2006)). The explanation for debt dollarization that I propose here should be considered as complementary to the ones identified until now. I focus on the subset of stable countries that are nevertheless characterized by dollar debt and I show that it can result from uncertainty over the state of the fundamentals and does not need to be associated to financial instability. A simple explanation for why countries borrow in dollars and not in pesos is that borrowing in dollars is cheaper in

general. The reason why it is cheaper here is that investors' pessimism is such that the interest rate charged on peso debt is *unfairly* high and borrowers rationally dollarize their debt. It might well be instead that when the state of the fundamentals is very bad, as it happened in the case of Latin American crises in the late 1970s, the interest rate charged on domestic currency debt is *fairly* high because it accounts for the currency risk associated to the economy. In this case debt dollarization cannot be considered a signal of economic strength and the reasons for its emergence should be more related to phenomena of moral hazard and implicit guarantees.

The papers that are more closely related to mine are Chamon and Hausman (2005) and Chang and Velasco (2006): They also emphasize the endogeneity between the currency denomination of the debt and the exchange rate policy of the CB. They show how this endogeneity can give rise to multiple equilibria when fundamentals are common knowledge. As it happens in second-generation currency crisis models, when fundamentals are in an intermediate region agents can coordinate their actions that, in turn, become self-fullfilling. If all the agents in the economy decide to dollarize their debt, the CB will be forced to keep the exchange rate strong. If they all borrow in domestic currency, the CB will be free to let the exchange rate float. Their models differ from mine because they only have two sets of actors (CB and domestic borrowers) and they assume common knowledge. The logic of my

model instead 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 agents' actions are complemetary. 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. One important condition that needs to be satisfied in these models to guarantee equilibrium uniqueness is that the precision of public information has to be smaller than the precision of private information. In my model I show that through the introduction of an additional set of agents, the international investors, I relax the conditions that guarantee the existence of a unique equilibrium. In my model in fact I have always equilibrium uniqueness whenever common knowledge is ruled out [4].

The reminder of this paper is organized as follows. Section 2 describes some motivating evidence in support of the theoretical model. Section 3 describes the full model. Section 4 deals with equilibrium uniqueness, section 5 analyses the concept of transparency. Section 6 discusses some policy implications of the model. Section 7 concludes.

[4]Multiple equilibria can be generated in my model when there is a highly precise public signal that can only be observed by domestic borrowers. In such a case, it behaves as a sunspot and can coordinate the whole domestic economy on the equilibrium in which all agents borrow in domestic or in foreign currency.

2 Motivating Evidence

The stylized fact on which the model in this paper is based is that countries with very different features dollarize their debt. Debt dollarization has often been associated to financial fragility, and to currency and financial crises, but in fact empirical studies (Bordo (2010), (2007)) have shown that dollarized liability per se cannot be blamed as the cause of crises. In the 1990s, countries like India, Chile, Eastern European and North African countries have not been involved in the wave of financial crises that characterized those years, despite their high share of dollar denominated debt. Nowdays, the East Asian and Latin American countries that have been dramatically involved in the financial crises of the 1990s, still display high shares of dollarized debt, even if the state of their fundamentals is much stronger than before (Hausmann and Panizza (2010)). This evidence suggests that, for different reasons, both the weak economies and the more stable ones have an incentive to dollarize their liabilities. As already argued in the literature, economies with poor fundamentals dollarize their debt for reasons related to moral hazard and implicit guarantees. My argument here is that instead stronger economies dollarize their debt because of information asymmetries and pessimism on international markets. There are two main assumptions at the basis of the mechanism proposed by my model: The existence of informational frictions and, more precisely, of an informational advantage in

favor of domestic agents; The presence of a public signal on which international agents coordinate and that induces, under certain conditions, domestic agents to dollarize their debt in order to signal their disagreement with the conditions offered on the international markets. The goal of this section is to show that these two assumptions have been empirically observed and can support the validity of the model in reality.

An informational advantage in favor of domestic investors has been identified as one of the main determinants of home bias in asset holdings. As a consequence, the literature has tried to empirically verify the existence of such informational frictions on international capital markets. French and Poterba (1991) show that agents may choose to renounce to diversify their portfolio internationally because of what they describe as "familiarity effect." Once they include the extra risk to foreign investments due to informational asymmetries, investors end up believing that domestic returns are systematically higher than those that they would get from a diversified portfolio. Tesar and Werner (1995) show that transaction costs associated with trading foreign securities cannot be an explanation to home bias and they conclude that informational constraints can be a determinant of this phenomenon. Brennan and Cao (1997) argue through a model that they empirically test, that the observed positive correlation between asset price and foreign purchases is the effect of an informational disadvantage of international investors.

An alternative approach that has been used more recently consists in comparing the performance of domestic and international investors in terms of profits earned: Who knows more gets more. The evidence is mixed but still in favor of those that believe in the informational advantage of domestic agents. Grinblatt and Keloharju (2001) using Finnish data and Seasholes (2000) with Taiwanese data, make the case that foreigners do better than local investors. Hau (2001), Choe, Kho and Stulz (1999), Dvorak (2005) and Kalev et al.(2006), reach the opposite conclusion.

Finally Portes et al. (2001), (2005) and Coval et al. (1999) emphasize how geographic distance matters in the determination of international portfolio equity transactions. In particular, Portes et al. (2001) and (2005) show that the gravity model performs at least as well in explaining asset trade as goods trade. They find that distance has a negative impact on equity transactions and, controlling for several other variables, they reach the conclusion that the informational friction is the main factor shaping the geographical distribution of international equity trade.

Overall, the issue has been highly debated and, as it often happens, the literature has not reached a full agreement, but a good number of studies concludes that there is an informational advantage in favor of domestic investors, especially in less developed countries.

Another important aspect of my model is related to the coexistence of a

public signal that domestic and international markets can observe, and a certain degree of dollar denominated debt in emerging economies. The literature on the original sin was born as an empirical literature and the numerous studies (Eichengreen and Hausmann (1999), Eichengreen Hausmann and Panizza (2005a, 2005b) and Hausmann and Panizza (2003)) have reached the main conclusion that the original sin does not have any correlation with the macroeconomic features of the countries. Only country's size, proxied by its GDP, has proven significantly correlated with the presence of dollar debt. However, a couple of studies (Hausmann (2003)) and Eichengreen et al.(2005a)) highlighted the presence of a significant negative correlation between credit ratings and original sin. These studies show that credit ratings could vary across countries with similar debt to GDP ratios, and they identified the determinant of this heterogeneity in ratings with the presence of dollarized debt. The correlation has been interpreted as a causality relationship going from original sin to credit ratings: Original sin is an additional source of risk that determines lower ratings. I would here propose a different interpretation: Lower credit ratings could be interpreted as public signals that international markets observe and that reduce the willingness of international investors to lend to these countries in their own currencies. Empirical studies (Cantor and Packer (1995), (1996)) have in fact shown that it is difficult to clearly identify the determinants of credit ratings. Ratings are

presented as measures of creditworthiness and the methodologies used to determine them are not disclosed. Several empirical analyses have shown that ratings depend on a combination of quantitative and qualitative measure of risk. Cantor and Packer (2006) find that macroeconomic factors like GDP per capita, inflation, past sovereign defaults and economic development seem to be important factors in the determination of sovereign ratings. Also the external debt variable is a significant determinant of ratings, but its weight seems to be much smaller than the one on the other variables. Factors like the size of the country and its degree of development seem to matter a lot in the determination of both original sin and credit ratings.

It would be interesting to delve deeper into the causality relation between credit ratings and foreign currency denominated debt and, more in general, empirically study whether informational asymmetries have also an impact on the share of foreign currency denominated debt.

3 The Model

3.1 Agents, Actions and Payoffs

Consider a single-period small open economy populated by a measure-one continuum of domestic agents, a domestic central bank (CB), and a measure-one continuum of international investors. The economy here considered is a

developing economy and, as such, cannot rely on a domestic bond market. As a consequence, in order to finance their production, domestic firms have to borrow on the international market at the beginning of the period. Each firm can borrow in the domestic currency, called *peso*, or in the foreign currency, called *dollar*. The supply of funds on the international markets is infinitely elastic and therefore the cost of borrowing in pesos, i, is exogenously given and is solely determined by the expectations of devaluation formulated by the international investors. The cost of borrowing in dollars instead depends on the international interest rate i^* and on the final decision of the CB to devalue or not the domestic currency. For simplicity i^* is normalized to 0. The initial exchange rate between dollar and peso is one. In the absence of a devaluation, the agent that borrows in dollars has a cost of debt equal to 0. A devaluation, instead, implies that two pesos are exchanged for one dollar and the total borrowing cost in terms of pesos becomes 1. The agent that borrows in pesos instead has a cost of debt that is proportional to the probability of devaluation formulated by the international investors and is always equal to i, where $0 < i < 1$. The borrowing costs are summarized in the table:

	Devaluation	No devaluation
Dollar debt	1	0
Peso debt	i	i

3.2 The Central Bank

The decision of the CB to devalue depends on the state of the fundamentals, θ, amd on the share of peso debt in the economy, $M(\theta)$. The state of the fundamentals can be interpreted as the amount of foreign reserves available to the domestic economy. A larger stock of foreign reserves reduces the currency mismatch generated by debt dollarization and increases the sustainability of a strong exchange rate. There are two reasons that can induce the CB to devalue. First, the CB devalues when the state of the fundamentals, θ, is bad and it knows that a strong exchange rate is not sustainable. Second, the CB devalues when it knows that there is a relatively large share of peso debt $M(\theta)$[5] in the economy, and therefore that action cannot hurt a large proportion of borrowers. As a result, the rule followed by the CB is such that the devaluation occurs if and only if[6]:

$$\theta \leq M(\theta)^{7}. \tag{1}$$

[5]Note that the share of peso debt $M(\theta)$ is the complement to one of the share of dollar debt $D(\theta)$.

[6]As in Chamon and Hausman (2002), the CB here does not try to expropriate investors to the benefit of domestic residents. The exchange rate policy has the main goal to make dollar debt safer, given that it has already been issued.

[7]As shown in the previous version of the paper, when you assume continuous actions, it is possible to endogenously derive this policy function. The policy function describes the optimal behavior of the Central Banks whose welfare function depends on the aggregate utility of the economy and on the deviation of the exchange rate from its shadow value.

3.3 Complemetarity

The borrowing cost of each individual agent i, $C(a_i, \theta, M)$, depends on her individual action, a_i, on the state of the fundamental θ, and of the share of peso debt in the economy $M(\theta)$. Agents can choose between two actions: Either borrow in dollars $a_i = 1$, or borrow in pesos $a_i = 0$. Agents' actions are strategic complements: Debt dollarization minimizes the agent's borrowing cost if and only if the exchange rate is not devalued, and this happens only if a sufficiently large fraction of agents denominate their debt in dollars. For a given state of the fundamentals θ, the borrowing cost of foreign currency debt versus domestic currency debt, $C(1, \theta, M) - C(0, \theta, M)$, is increasing in the share of peso debt M and decreasing in the share of dollar debt D:

$$C(1, \theta, M) - C(0, \theta, M) = \begin{cases} -1 & \text{if } \theta > M \\ 1 - i & \text{if } \theta \leq M \end{cases}$$

As a consequence, the incentive to denominate the debt in foreign currency increases with the total share of dollar debt in the economy. As it has been extensively shown by second-generation models of currency crises, when the fundamentals are common knowledge, it is possible to identify three regions in the space of the fundamentals. When the fundamentals are below a certain cut-off point, $\underline{\theta} = 0$, the economy is so weak that the devaluation occurs for

sure. The dominant strategy is to denominate the debt in domestic currency. When the fundamentals are above a certain upper bound, $\overline{\theta} = 1$, the fundamentals are so strong that the devaluation never occurs, and it is optimal for agents to denominate their debt in dollars. In the intermediate region, the devaluation depends on the share of dollar debt in the economy. Therefore there are two equilibria: One equilibrium in which everyone dollarizes the debt and therefore devaluation does not occur. Another equilibrium where all the borrowers denominate their debt in pesos and the devaluation occurs. In this region we have multiple equilibria and self-fullfilling expectations.

3.4 Information

The state of the economy is assumed not to be common knowledge. At time 0 nature selects $\theta \in \mathbb{R}$ that is not directly observed on the markets. Domestic and international agents at time 1 observe a public signal about the state of the fundamental, denoted by $\mu \sim N(\theta, \frac{1}{\alpha})$. Domestic agents have access to a second source of information represented by a private signal $x_i = \theta + \epsilon_i$. The error term ϵ_i is normally distributed over the population of borrowers with mean 0 and finite variance, $\epsilon_i \sim N(0, \frac{1}{\beta})$. International investors formulate expectations on future exchange rate movements based on the public signal, and then fix the interest rate at which they lend peso denominated funds. Domestic agents, in turn, formulate their own expectations using all their

sources of information. They compare their expectations with the ones of international investors, reflected in the domestic interest rate, and then decide in which currency they want to denominate their debt. The equilibrium share of foreign currency denominated debt results from the balance between these expectations. The CB at the end of the period chooses whether to devalue, after observing the true state of the economy and the realized degree of debt dollarization.

3.5 Strategies and Equilibrium Analysis

A *strategy* for agent i is a decision rule that maps each realization of x_i to an action (i.e., to denominate her debt in dollars or in pesos). An *equilibrium* is a profile of strategies-one for each borrower- such that a borrower's strategy maximizes her expected payoff conditional on the information available, when all the other borrowers are following the strategies in the profile.

Throughout the paper, we look at monotone (or treshold) equilibria. That is, equilibria in which $a(x, \mu)$ is monotonic in x. A monotone equilibrium is such that, for any given realization μ of the public signal, an agent denominates her debt in pesos if and only if the realization x of the private signal is less than a treshold $x^*(\mu)$. By implication, the share of peso denominated debt is decreasing in θ, so that there is also a treshold $\theta^*(\mu)$ such that a devaluation occurs if and only if the state of the fundamentals is less than that treshold.

A monotone equilibrium is then identified by the treshold functions $x^*(\mu)$ and $\theta^*(\mu)$.

In such an equilibrium, the share of peso debt is given by the proportion of agents that observe a private signal x smaller than the treshold $x^*(\mu)$:

$$M(\theta, \mu) = Pr(x < x^*(\mu)|\theta) = \Phi(\sqrt{\beta}(x^*(\mu) - \theta)), \tag{2}$$

where Φ denotes the cumulative distribution function for the standard normal. Equivalently, agents borrow in dollars whenever their signal is larger than the treshold, $x^i > x^*(\mu)$, and the share of dollar debt in the economy is

$$D(\theta, \mu) = Pr(x > x^*(\mu)|\theta) = 1 - \Phi(\sqrt{\beta}(x^*(\mu) - \theta)) = \Phi(\sqrt{\beta}(\theta - x^*(\mu))). \tag{3}$$

A devaluation occurs if and only if the state of the fundamentals θ is smaller than the treshold $\theta^*(\mu)$. The probability of devaluation of the international investors and of the domestic agents can be respectively rewritten as $p^I(\mu) = Pr(\theta \leq \theta^*(\mu)|\mu)$ and $p^i(\mu, x^i) = Pr(\theta \leq \theta^*(\mu)|\mu, x^i)$. There exists a unique treshold $x^*(\mu)$ that makes the agent indifferent between borrowing in pesos or in dollars. Assuming that the CB has a binary choice, i.e., devalue $d = 1$ or not devalue, i.e., $d = 0$, the indifference condition of the domestic agent

on the borrowing costs is:

$$i = dPr(\theta \leq \theta^*(\mu)|\mu, x^*(\mu)) + dPr(\theta > \theta^*(\mu)|\mu, x^*(\mu)). \tag{4}$$

The *Uncovered Interest Parity* implies that the interest rate charged on peso debt is directly proportional to the probability of devaluation formulated by international investors:

$$i = i^* + p^I(\mu), \tag{5}$$

where $i^* = 0$ and $p^I(\mu)$ is the probability of devaluation of international investors, given their information set composed only by the public signal μ. The indifference condition (4) reduces to a comparison between the probability of devaluation of international investors and the one of the domestic borrower:

$$p^I(\mu) = p^i(\mu, x^*(\mu)). \tag{6}$$

In order to choose their strategy, borrowers compare the probability of devaluation given their information set, with the probability of devaluation determined by the international markets, given their information set. Equivalently, they compare their expectation of devaluation, $p^i(\mu, x^i)$ with the domestic interest rate $i = p^I(\mu)$. The optimal strategy can be summarized

as follows:

$$a(x^i, \mu) = \begin{cases} 1 & \text{if } p^i(\mu, x^i) < i \\ [0,1] & \text{if } p^i(\mu, x^i) = i \\ 0 & \text{if } p^i(\mu, x^i) > i \end{cases}$$

It is optimal for the agent to dollarize her debt when her expectations of devaluation are smaller than the domestic interest rate. In the opposite case, when the expectations of devaluation of the international markets are smaller than those of the agent, it is optimal to denominate the debt in pesos. When the expectations coincide, the agent is indifferent between dollarizing or not. Intuitively this treshold $x^*(\mu)$ describes the case in which the private signal of the domestic agent does not provide any additional information with respect to the public signal μ. Given the treshold $x^*(\mu)$ below which the agents borrow in pesos, the share of peso debt $M(\theta, \mu)$ is decreasing in θ. As a consequence, $\theta - M(\theta, \mu)$ is increasing in θ and there exists a unique $\theta^*(\mu)$ such that:

$$\theta^*(\mu) = M(\theta^*(\mu), \mu). \tag{7}$$

In order to constitute an equilibrium in monotone strategies, $\theta^*(\mu)$ and $x^*(\mu)$ must jointly solve (6) and (7). Substituting (3) in (7) we get:

$$x^*(\mu) = \theta^*(\mu) + \frac{1}{\sqrt{\beta}}\Phi^{-1}(\theta^*(\mu)). \tag{8}$$

The indifference cost equation (6) can be rewritten as:

$$\Phi(\sqrt{\alpha}(\theta^* - \mu)) = \Phi(\sqrt{\alpha+\beta}(\theta^*(\mu) - \frac{\alpha}{\alpha+\beta}\mu - \frac{\beta}{\alpha+\beta}x^*(\mu))). \quad (9)$$

Sunstituting (8) into (9), gives a single equation in $\theta^*(\mu)$

$$\mu - \sqrt{\frac{\alpha}{\alpha+\beta}}\mu = \theta^*(\mu) + \frac{\beta}{\sqrt{\alpha(\alpha+\beta)}}\theta^*(\mu) + \sqrt{\frac{\beta}{\alpha(\alpha+\beta)}}\Phi^{-1}(\theta^*(\mu)) - \sqrt{\frac{\alpha}{\alpha+\beta}}\theta^*(\mu). \quad (10)$$

Proposition 1. *A monotone equilibrium in this game is characterized by tresholds $\theta^*(\mu)$ and $x^*(\mu)$ such that:*

(i) $\theta^*(\mu)$ is given by

$$G(\theta^*(\mu)) = g(\mu),$$

where $g(\mu) = \mu - \sqrt{\frac{\alpha}{\alpha+\beta}}\mu$ and

$$G(\theta^*(\mu)) = \theta^*(\mu) + \frac{\beta}{\sqrt{\alpha(\alpha+\beta)}}\theta^*(\mu) + \sqrt{\frac{\beta}{\alpha(\alpha+\beta)}}\Phi^{-1}(\theta^*(\mu)) - \sqrt{\frac{\alpha}{\alpha+\beta}}\theta^*(\mu).$$

(ii) $x^*(\mu)$ is given by

$$x^*(\mu) = \theta^*(\mu) + \frac{1}{\sqrt{\beta}}\Phi^{-1}(\theta^*(\mu)).$$

The equilibrium value of the fundamentals, θ^* results from the intersec-

tion between the two functions $g(\mu)$ and $G(\theta^*(\mu))$. As shown in Figure 1, $g(\mu)$ is a constant that depends on the mean μ of the public signal and on the precisions of the signals, while $G(\theta^*(\mu))$ is an increasing function of θ. The equilibrium value of the fundamentals is a function of the parameters of the model. Larger values of μ increase the value of the cut-off θ^*. A larger mean of the public signal can be interpreted as a sign of optimism on the international markets. If international investors have optimistic expectations concerning the economy, they fix more favourable conditions on peso denominated debt and, as a consequence, agents are induced to dollarize their debt only when the state of the economy is excellent. Also the precisions of the two signals matter in the determination of the equilibrium value of the fundamentals. As I will discuss in more detail in the next section, equilibrium uniqueness is always guaranteed in this model, for any finite values of the precisions of the two signals. Since it is not necessary to impose any particular condition on the relative precisions of the signals, I analysed the effects of different precision ratios on the cut-off value of the fundamentals. A relatively larger precision of the public signal has a positive impact on the value of θ^*. When public information is highly precise, the informational advantage of domestic borrowers is reduced and they end up accepting international market conditions more easily. There is a lower degree of coordination on dollar denominated debt and the no devaluation region shrinks. When pri-

vate information is relatively more precise than public information instead, the value of the cut-off decreases. Agents use their informational advantage to coordinate more on debt dollarization and, through this action, they affect CB's devaluation decision. The cut-off point switches to the left and the region of the fundamentals in which there is no devaluation increases.

4 Uniqueness of Equilibrium

It is possible to show that equation (10) always admits a solution and that this solution is unique for every μ, without any condition on the relative precisions of public and private signals.

Proposition 2. *In this game equilibrium uniqueness is always guaranteed for finite values of the signals' precisions.*

Proof. See Appendix 1 □

As shown by Hellwig (2002) and Morris and Shin (2004), this kind of models require for equilibrium uniqueness a condition on the relative precisions of the signals to be satisfied. It is in fact necessary to have that the noise of the private signal is small relative to the noise of the public signal, in order to exclude multiplicity of equilibria. When in fact the public signal is highly precise, agents find it more convenient to totally ignore the private signal and use the public signal as a focal point on which all the economy

coordinates. In this case each agent is perfectly able to anticipate other agents' behaviors and we are back to a situation of indeterminacy. In this model, instead, uniqueness is always guaranteed, for finite values of the two precisions. If for large values of the public signal's precision agents discarded the private signal, automatically they would formulate the same expectations as the international investors and they would end up in a situation of indifference between peso and dollar debt. Domestic borrowers have always an incentive to exploit all the sources of information available in order to reduce their borrowing costs below the domestic interest rate i. By using all their information, only in the worst case scenario they end up paying what they would have paid anyways. Their optimal strategy is then to evaluate all the information available, formulate their expectations on the state of the economy and on the decisions of the rest of the market, and then decide their own strategy. It is important to note that the introduction in this model of a set of agents, the international investors, that are less informed but that nevertheless have a strong market power, plays an important role for the uniqueness result. In this setting, in fact, agents have two goals: They want to coordinate with the rest of the market, but they also want to exploit their information advantage with respect to the international investors, in order to reduce their borrowing costs. This means that, given the assumed information structure, common knowledge will never be recreated, at least for finite

values of signals' precisions. In more traditional settings, instead, where there are only two sets of agents, (for example, speculators and a central bank), agents' goal is uniquely represented by coordination and this same information structure can generate indeterminacy and multiple equilibria. Multiple equilibria can emerge in a version of the model presented in Appendix 2, where there are two public signals. One signal is observed by the whole economy (including international investors and domestic borrowers) and the other one can be observed only by the domestic agents ("domestic public signal"). In this case, a highly precise domestic public signal observed only by domestic agents can enable them to coordinate and make their belief self-fulfilling. In this case the piece of information that they observe is different from the one that international investors observe and there is space for disagreement, even if they only consider the domestic public signal. If the highly precise domestic public signal says that the fundamental is better than the one described by μ, they all coordinate on the equilibrium where all the debt is dollarized and they induce the CB not to devalue. If their signal is smaller than μ instead, they all coordinate on the equilibrium with no debt dollarization and they induce the CB to devalue.

5 Transparency

In this section I look at some limit cases in order to study how information affects the equilibrium. By transparency I mean the degree of accuracy with which information describes the fundamentals.

When the public signal is infinitely precise, $\alpha \to \infty$, we are back to the case of common knowledge and multiple equilibria. The state of the fundamentals is perfectly observed by all the agents and each domestic agent is perfectly able to predict others' behavior. The individual borrower has an incentive to borrow in dollars (pesos) whenever all the others are doing so. If the fundamentals lie in the intermediate region [0,1] and all domestic agents dollarize their debt, the exchange rate is not going to be devalued for sure and each individual agent has an incentive to follow the rest of the market. If instead all the economy is borrowing in pesos, the devaluation is sure and borrowing in dollars would imply a total cost equal to 2. As a result none borrows in dollars.

When only the private signal is infinitely precise, i.e., $\beta \to \infty$, using equation (10) it is possible to define the cut-off value of the fundamental θ^* as:

$$\Phi(\sqrt{\alpha}(\mu - \theta^*)) = \theta^*. \tag{11}$$

Differently from the traditional result found in previous papers, the equilibrium here displays non fundamental volatility, meaning that it still depends on the common prior μ. In the seminal papers on global games (Angeletos et al. (2006), Morris and Shin (1998), (2004)), they show that when private information becomes infinitely precise, individuals cease to use the public signal and the equilibrium does not depend on the common noise anymore. In that case, in equilibrium there is not fundamental uncertainty anymore (i.e., uncertainty over the state of the economy), but there is still strategic uncertainty (i.e., uncertainty over other agents' actions). This is why equilibrium uniqueness holds. However, they also show that when both the public and the private signals' precisions tend to infinity [8], $\alpha \to \infty$, $\beta \to \infty$, the equilibrium is affected by the ex-ante mean. Their argument is that in this case the public signal is used to solve the strategic uncertainty that still exists, even if there is no more fundamental uncertainty.

In my model the public signal affects the equilibrium even when its precision is finite and the precision of the private signal tends to infinity. The way in which the ex-ante mean affects the equilibrium is therefore much stronger than in the previous models of global games. This happens because the market conditions are determined by the public signal and agents' actions must always reflect them. Public information cannot be ignored because it

[8] A condition on the speed with which the two precisions tend to infinity needs to be respected in order not to generate common knowledge.

is a kind of reference point with respect to which agents act. More optimistic priors increase the value of the cut-off. Intuitively, when investors are more optimistic they set lower interest rates on peso borrowing and domestic agents are going to accept those conditions with higher probability. We observe debt dollarization only when the state of the fundamental is very good. When instead investors are more pessimistic, the cut-off point switches to the left and we observe dollar debt even when the fundamentals are weaker. In other terms, the common prior affects the region of debt dollarization. Pessimism on the international markets increases the region of debt dollarization (Figure 2).

When both precisions tend towards infinity at the same speed, i.e., $\alpha = \beta \to \infty$, a similar result holds. In fact equation (10) becomes:

$$\Phi((\mu - \theta^*)) = \theta^*. \tag{12}$$

This last result is consistent with the findings of the previous literature (Morris and Shin (2004)).

6 Policy Implications

The findings described in the previous paragraph show the importance of public information. Whenever the precision of the private signal alone or of

both the private and the public signals increases to infinity, the equilibrium is always affected by the mean of the public signal. The mean of the public signal can be interpreted as the degree of optimism (or pessimism) on the international markets. Investors' pessimism or optimism determine market conditions at which emerging economies can borrow and therefore the extent to which they have to dollarize their liabilities.

The literature has interpreted the concept of transparency in several ways: Heinemann and Illing (2002) and Bannier and Heinemann (2005), for example, interpreted transparency as an increase in the precision of the private signal, while Angeletos and Pavan (2004) mostly focus their attention on the transparency of the public signal. My model instead shows the importance of working also on the first moment of the public signal. As already mentioned, the degree of pessimism affects the region of debt dollarization. When the pessimism is high, the cut-off value of the fundamentals is very low and therefore also economies with relatively weak fundamentals are induced to denominate their liabilities in dollars. This means that in such an environment economies have a tendency to accumulate larger stocks of foreign currency denominated debt. The model presented in the paper is static, but we could imagine to extend it to a dynamic context. In a dynamic context there is a positive probability for the economy to jump to the crisis region, where the devaluation occurs for sure. In this sense, liability

dollarization can be harmless today, but can affect the intensity of a crisis in the future. A large accumulation of dollar debt in the past can generate an extremely powerful crisis, when fundamentals worsen and the devaluation cannot be avoided. Because of this, it is necessary for the policy maker to diffuse public signals that describe in the most accurate and realistic way the state of the fundamentals. As argued in the second paragraph, what I call public signal in the model could be interpreted as credit rating in the reality. In this case, the accuracy of the rating does not only depend on the policymaker of the country, but also, and probably mainly, on the activity of the rating agencies. In this sense, the proposals to introduce a regulation able to increase the degree of transparency of the rating process and improve the accuracy of the ratings could also have a positive impact on the ability of emerging markets to borrow abroad in their own currency.

7 Conclusion

The paper analyzes the factors that determine the choice of emerging markets to borrow in foreign currency, even if their economy is characterized by strong fundamentals and sound policies. In this model I show how demand-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 their debt. The most important factors that help explain the share of dollar debt in the economy are the informational advantage in favor of domestic agents about the state of the economy and the presence of a public signal that determines the market conditions at which agents can borrow. In general the message of the model is that a strong presence of dollar debt even in healthy 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 gives agents an incentive to coordinate and affect its devaluation decisions.

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References

Aghion, Philippe, Philippe Bacchetta, and Abhijit Banerjee (2004) "A Corporate Balance Sheet Approach to Currency Crises," *Journal of Economic Theory*, Vol. 119.

Angeletos, George Marios and Alessandro Pavan (2004) "Transparency of Information and Coordination in Economies with Investment Complementarities," *American Economic Review*, Vol. 94, No. 2, pp. 91–98.

Angeletos, George Marios and Ivan Werning (2006) "Crises and Prices: Information Aggregation, Multiplicity and Volatility," *American Economic Review*, Vol. 96, No. 5, pp. 1720–1736.

Bannier, Christina E. and Frank Heinemann (2005) "Optimal Transparency and Risk-Taking to Avoid Currency Crises," *Journal of Institutional and Theoretical Economics*, Vol. 161, No. 3, pp. 374–391.

Bordo, Michael D. and Christopher M. Meissner (2007) "Financial Crises, 1880–1913: The Role of Foreign Currency Debt," in *The Decline of Latin American Economies: Growth, Institutions, and Crises*: National Bureau of Economic Research, Inc.

Bordo, Michael D., Christopher M. Meissner, and David Stuckler (2010) "Foreign Currency Debt, Financial Crises and Economic Growth: A

Long-Run View," *Journal of International Money and Finance*, Vol. 29, pp. 642–665.

Brennan, Michael J. and Henry Cao (1997) "International Portfolio Investment Flows," *Journal of Finance*, Vol. 52, No. 5, pp. 1851–80.

Burnside, Craig, Martin Eichenbaum, and Sergio Rebelo (2001) "Hedging and financial fragility in fixed exchange rate regimes," *European Economic Review*, Vol. 45, No. 7, pp. 1151–1193.

Caballero, Ricardo and Ananth Khrishnamurthy (2003) "Excessive Dollar Debt: Financial Development and Underinsurance," *The Journal of Finance*, Vol. 58.

Calvo, Guillermo (1999) "Contagion in Emerging Markets: When Wall Street is a Carrier," mimeo.

——— (2001) "Capital Markets and the Exchange Rate," *Journal of Money, Credit and Banking*, Vol. 33.

Calvo, Guillermo and Carmen Reinhart (2000) "Fear of Floating," NBER Working Paper No. W7993.

Cantor, Richard and Frank Packer (1995) "Sovereign Credit Ratings," *Federal Reserve Bank of New York Current Issues in Economics and Finance*, Vol. 1, No. 3.

——— (1996) "Determinants and Impact of Sovereign Credit Ratings," *FRBNY Economic Policy Review*, pp. 37–54.

Carlsson, Hans and Eric Van Damme (1993) "Global Games and Equilibrium Selection," *Econometrica*, Vol. 61.

Céspedes, Luis Felipe, Roberto Chang, and Andrés Velasco (2004) "Balance Sheets and Exchange Rate Policy," *American Economic Review*, Vol. 94, pp. 1183–1193.

Chamon, Marcos and Ricardo Hausmann (2005) "Why do countries borrow the way they borrow?" in Barry Eichengreen and Ricardo Hausman (eds.) eds. *Other People's Money: Debt Denomination and Financial Instability in Emerging Market Economies*: Chicago: University of Chicago Press.

Chang, Roberto and Andrea Velasco (2006) "Monetary Policy and The currency denomination of Debt: A tale of two equilibria," *Journal of International Economics*, Vol. 69.

Choe, Hyuk, Bong-Chan Kho, and René M. Stulz (1999) "Do Foreign Investors Destabilize Stock Markets? The Korean Experience of 1997," *Journal of Financial Economics*, Vol. 54.

Coval, Joshua D. and Tobias J. Moskowitz (1999) "Home Bias at Home: Local Equity Preference in Domestic Portfolios," *Journal of Finance*, Vol. 54, No. 6, pp. 2045–2073.

Cowan, Kevin and Quy-Toan Do (2003) "Financial Dollarization and Central Bank Credibility," mimeo.

Dvorák, Tomás (2005) "Do Domestic Investors Have an Information Advantage? Evidence from Indonesia," *Journal of Finance*, Vol. 60, No. 2, pp. 817–839.

Eichengreen, Barry and Ricardo Hausmann (1999) "Exchange Rates and Financial Fragility," in *New Challenges for Monetary Policy*: Federal Reserve Bank of Kansas City, pp. 329–68.

Eichengreen, Barry, Ricardo Hausmann, and Ugo Panizza (2005a) "The Mystery of Original Sin," in Barry Eichengreen and Ricardo Hausman (eds.) eds. *Other People's Money: Debt Denomination and Financial Instability in Emerging Market Economies*: Chicago: University of Chicago Press.

Eichengreen, Berry, Ricardo Hausmann, and Ugo Panizza (2005b) "The Pain of Original Sin," in Barry Eichengreen and Ricardo Hausman (eds.) eds. *Other People's Money: Debt Denomination and Financial Insta-*

bility in Emerging Market Economies: Chicago: University of Chicago Press.

Faia, Ester and Tommaso Monacelli (2002) "Financial Exposure, Exchange Rate Regime and Fear of Floating," mimeo.

Flandreau, Marc and Nathan Sussman (2005) "Old Sins: Exchange Rate Clauses and European Foreign Lending in the 19th Century," in Barry Eichengreen and Ricardo Hausman (eds.) eds. *Other People's Money: Debt Denomination and Financial Instability in Emerging Market Economies*: Chicago: University of Chicago Press.

Flood, Robert and Peter Garber (1984) "Collapsing exchange-rate regimes : Some linear examples," *Journal of International Economics*, Vol. 17, pp. 1–13.

French, Kenneth R. and James M. Poterba (1991) "Investor Diversification and International Equity Markets," *American Economic Review*, Vol. 81, No. 2, pp. 222–26.

Gertler, Mark, Simon Gilchrist, and Fabio M. Natalucci (2007) "External Constraints on Monetary Policy and the Financial Accelerator," *Journal of Money, Credit and Banking*, Vol. 39, pp. 295–33.

Goldberg, Linda (1991) "Collapsing exchange rate regimes: shocks and biases," *Journal of International Money and Finance*, Vol. 10, pp. 252–263.

Graciela, Kaminsky, Lyons Richard, and Schmukler Sergio (2004) "Managers, Investors and Crises: Mutual Fund Strategies in Emerging Markets," *Journal of International Economics*, Vol. 64.

Grinblatt, Mark and Matti Keloharju (2001) "The Investment Behavior and Performance of Various Investor Types: A Study of Finland's Unique Data Set," *Journal of Financial Economics*, Vol. 52, pp. 43–67.

Hau, Harald (2001) "Geographic Patterns of Trading Profitability in Xetra," *European Economic Review Review*, Vol. 45, pp. 757–769.

Hausmann, Ricardo (2003) "Good Credit Ratios, Bad Credit Ratios: The Role of Debt Structure."

Hausmann, Ricardo and Ugo Panizza (2003) "On the Determinants of Original Sin: an Empirical Investigation," *Journal of International Money and Finance*, Vol. 22.

——— (2010) "Redemption or Abstinence? Original Sin, Currency Mismatches and Counter-Cyclical Policies in the New Millenium," CID Working Paper No. 194, February.

Hausmann, Ricardo, Ugo Panizza, and Ernesto H. Stein (2001) "Why do Countries Float the Way They Float?" *Journal of development economics*, Vol. 66.

Heinemann, Frank and Gerhard Illing (2002) "Speculative Attacks: Unique Equilibrium and Transparency," *Journal of International Economics*, Vol. 58, pp. 429–450.

Hellwig, Christian (2002) "Public Information, Private Information, and the Multiplicity of Equilibria in Coordination Games," *Journal of Economic Theory*, Vol. 107, No. 2, pp. 191–222.

Jeanne, Olivier (2003) "Why Do Emerging Economies Borrow in Foreign Currency?," CEPR No 4030.

Jeanne, Olivier and Jeromin Zettelmeyer (2003) "Original Sin, Balance Sheet Crises, and the Roles of International Lending," IMF Working Papers 02/234.

Kalev, Petko S., Anh H. Nguyen, and Natalie Y. Oh (2006) "Foreign versus Local Investors: Who Knows More? Who Makes More?," mimeo.

Krugman, Paul (1979) "A Model of Balance-of-Payments Crises," *Journal of Money, Credit and Banking*, Vol. 11, pp. 311–325.

Mckinnon, Ronald and Huw Pill (1999) "Exchange-Rate Regimes for Emerging Markets: Moral Hazard and International Overborrowing," *Oxford Review of Economic Policy*, Vol. 15, No. 3, pp. 19–38.

Morris, Stephen and Hyun Song Shin (1998) "Unique Equilibrium in a Model of Self-Fulfilling Currency Attacks," *American Economic Review*, Vol. 88.

——— (1999) *A Theory of the Onset of Currency Attacks*, Vol. The Asian Financial Crisis: Cambridge University Press.

——— (2002) "Social Value of Public Information," *American Economic Review*, Vol. 92.

——— (2004) "Coordination Risk and the Price of Debt," *European Economic Review*, Vol. 48.

Nadeem Ul Haque, Manmohan S. Kumar, Nelson C. Mark, and Donald J. Mathieson (1996) "The Economic Content of Indicators of Developing Country Creditworthiness," *IMF Staff Papers*, Vol. 43, No. 4, pp. 688–724.

Portes, Richard, Helen Ray, and Yonghyup Oh (2001) "Information and capital flows: The determinants of transactions in financial assets," *European Economic Review*, Vol. 45, No. 4-6, pp. 783–796.

Portes, Richard and Helene Rey (2005) "The determinants of cross-border equity flows," *Journal of International Economics*, Vol. 65, No. 2, pp. 269–296.

Rogoff, Kenneth (1985) "The Optimal Degree of Commitment to an Intermediate Target," *Quarterly Journal of Economics*, Vol. 100.

Schneider, Martin and Aaron Tornell (2001) "Balance Sheet Effect, Bailout Guarantees and Financial Crises."

Seasholes, Mark (2000) "Smart Foreign Traders in Emerging Markets."

Tesar, Linda L. and Ingrid M. Werner (1995) "Home bias and high turnover," *Journal of International Money and Finance*, Vol. 14, No. 4, pp. 467–492.

A Appendix 1: Proof of Proposition 1

Equation (10) in the text can be described as

$$G(\theta^*(\mu), \mu) = 0, \tag{13}$$

where

$$G(\theta, \mu) = \theta^*(\mu) + \sqrt{\frac{\beta}{\alpha(\alpha+\beta)}}\Phi^{-1}(\theta^*(\mu)) - \frac{\alpha}{\sqrt{\alpha(\alpha+\beta)}}\theta^*(\mu) - \mu + \sqrt{\frac{\alpha}{\alpha+\beta}}\mu. \tag{14}$$

In order to establish the existence and analyze the determinacy of the equilibrium, we need to look at the properties of the function G. For every $\mu \in \mathbb{R}$, $G(\theta, \mu)$ is continuous in θ.

$$G(\underline{\theta}, \mu) = \sqrt{\frac{\beta}{\alpha(\alpha+\beta)}}\Phi^{-1}(0) = -\infty, \tag{15}$$

$$G(\overline{\theta}, \mu) = \sqrt{\frac{\beta}{\alpha(\alpha+\beta)}}\Phi^{-1}(1) = \infty, \tag{16}$$

where I assumed that $\underline{\theta} = 0$ and $\overline{\theta} = 1$. Equations (15) and (16) show that there is a solution $\theta^*(\mu) \in (\underline{\theta}, \overline{\theta})$. In order to prove the uniqueness of the solution we need to look at the region in which the derivative of function G

with respect to θ is positive:

$$\frac{\partial G(\theta,\mu)}{\partial \theta} = 1 + \frac{\beta}{\sqrt{\alpha(\alpha+\beta)}} + \sqrt{\frac{\beta}{\alpha(\alpha+\beta)}}\frac{1}{\phi(\Phi^{-1}(\theta))} - \sqrt{\frac{\alpha+\beta}{\alpha}} \geq 0 \quad (17)$$

Since $\max_{\omega\in\mathbb{R}} \phi(\omega = \frac{1}{\sqrt{2\pi}})$, we can rewrite (17) as

$$\frac{\partial G(\theta,\mu)}{\partial \theta} = 1 + \frac{\beta}{\sqrt{\alpha(\alpha+\beta)}} + \sqrt{\frac{\beta}{\alpha(\alpha+\beta)}}\sqrt{2\pi} - \sqrt{\frac{\alpha+\beta}{\alpha}} \geq 0 \quad (18)$$

Equation (16) can be manipulated and rewritten as

$$-\frac{1}{\sigma_x + \sqrt{\sigma_x^2 + \sigma_\mu^2}} \leq \sqrt{2\pi}, \quad (19)$$

where σ_μ^2 and σ_x^2 are respectively the variances of the public and the private signals. As long as the standard deviations of the two shocks are positive, this inequality is always satisfied and multiple equilibria are excluded.

B Appendix 2

In this appendix I show how some of the traditional results concerning the relative precision of public and private signals can be reestabilished when we introduce an additional public signal that only the domestic economy can observe. As before, the information set of international investors includes

only the common prior $\mu \sim N(\theta, \frac{1}{\alpha})$, while domestic borrowers observe the common prior, a domestic public signal $\eta \sim N(\theta, \frac{1}{\gamma})$ and a private signal $x_i = \theta + \epsilon_i$. The error term ϵ_i is normally distributed over the population of borrowers with mean 0 and finite variance, $\epsilon_i \sim N(0, \frac{1}{\beta})$. Following the same procedure described in section 3 I find a new equilibrium condition that determines the equilibrium value of the fundamental:

$$F(\theta, \mu, \eta) = 0, \tag{20}$$

where

$$F(\theta, \mu, \eta) = \theta^*(\mu) + \sqrt{\frac{\beta}{\alpha(\alpha+\beta+\gamma)}}\Phi^{-1}(\theta^*(\mu))$$
$$-\frac{\alpha+\gamma}{\sqrt{\alpha(\alpha+\beta+\gamma)}}\theta^*(\mu) - \mu + \sqrt{\frac{\alpha}{\alpha+\beta}}\mu - \frac{\gamma}{\sqrt{\alpha(\alpha+\beta+\gamma)}}\eta.$$

The following condition needs to be satisfied for equilibrium uniqueness:

$$\frac{\alpha+\gamma-\sqrt{\alpha(\alpha+\beta+\gamma)}}{\sqrt{\beta}} < \sqrt{2\pi}. \tag{21}$$

Differently from before, this equation is not always satisfied. When the precision of the domestic public signal is large enough, we are back to the case of multiple equilibria. Multiple equilibria arise because with a highly precise domestic public signal agents can remove strategic uncertainty, i.e.,

the uncertainty over other agents' actions, and at the same time exploit all the possible arbitrage opportunities. When the precision of the domestic public signal is large enough agents can perfectly predict the action of the others and coordinate on different equilibria.

C Figures

Figure 1: Cut-off value of the fundamentals

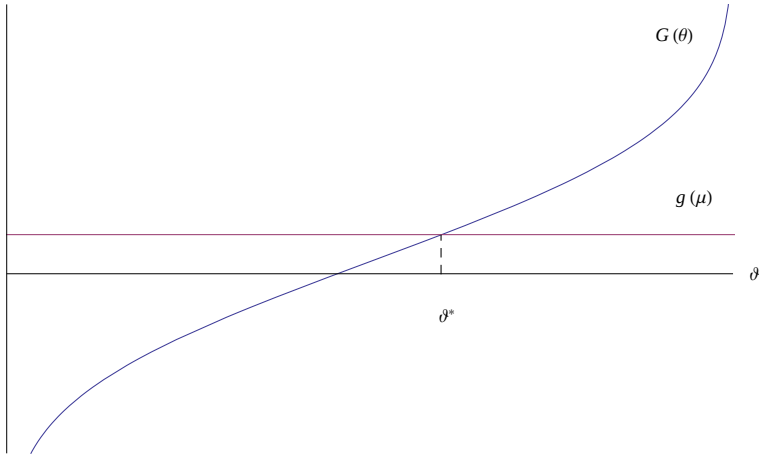

Figure 2: Effect of different priors on the cut-off value of the fundamentals, with $\mu_0 < \mu_1$