

Foreign Currency Debt and Expectations

Kenza Benhima* and Isabella Blengini[†] and Ouarda Merrouche[‡]

August 4, 2020

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. We show that a certain degree of debt dollarization might be observed, if the fundamentals are relatively strong and domestic agents have an informational advantage on the state of the economy. We provide empirical evidence of this phenomenon. Transparency on the international markets and policy implications of our findings are briefly discussed.

Keywords: International Lending and Debt Problems, Expectations.

JEL codes: F34, D84.

1 Introduction

Many emerging countries borrow in foreign currency. This “original sin” was one important aspect of the East Asian and Latin American crises of the 1990s, and is still a major source of vulnerability.¹ Surprisingly, while the theoretical literature has emphasized the role of poor fundamentals as the source of original sin, the empirical literature does not find a strong correlation between foreign currency denominated debt and countries’ fundamentals.² Only

*University of Lausanne and CEPR, email: kenza.benhima@unil.ch.

[†]Ecole hôtelière de Lausanne, HES-SO - University of Applied Sciences Western Switzerland, email: isabella.blengini@ehl.ch.

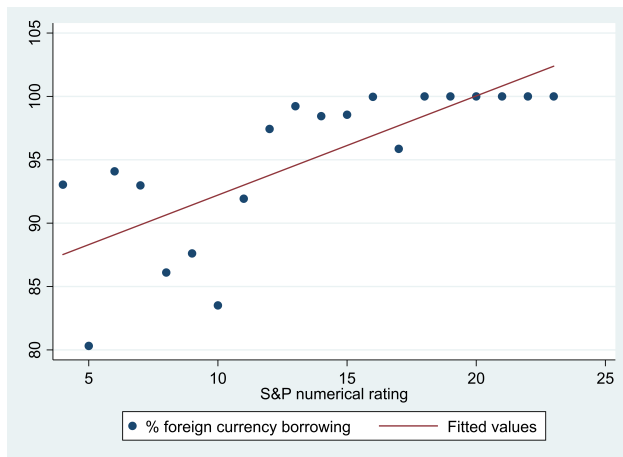
[‡]University Paris -Nanterre , email: Ouarda.Merrouche@EUI.eu

¹See Eichengreen and Hausmann (1999), Eichengreen Hausmann and Panizza (2005a, 2005b), Flandreau and Sussman (2015) and Hausmann and Panizza (2003).

²See Hausman and Panizza (2003), Bordo and Meissner (2007). In Niepmann and Schmidt-Eisenlohr (2017), it appears that domestic fundamental contribute very little to determine the currency denomination of individual loans, as regressions involving the country’s fundamentals have typically low R-squares.

country size, proxied by its GDP, has proven significantly correlated with the presence of dollar debt. The East Asian and Latin American countries that have been at the epicenter of the financial crises of the 1990s, still in 2008 displayed high shares of dollarized debt, even if the state of their fundamentals was at that point much stronger than before.³ This suggests that both the weak and the more stable economies have an incentive to dollarize their liabilities.

Figure 1: Foreign currency debt and credit rating



Note: This chart depicts the average percentage of foreign currency debt obligation issued for each sovereign numerical rating. A higher value indicates a lower credit quality.

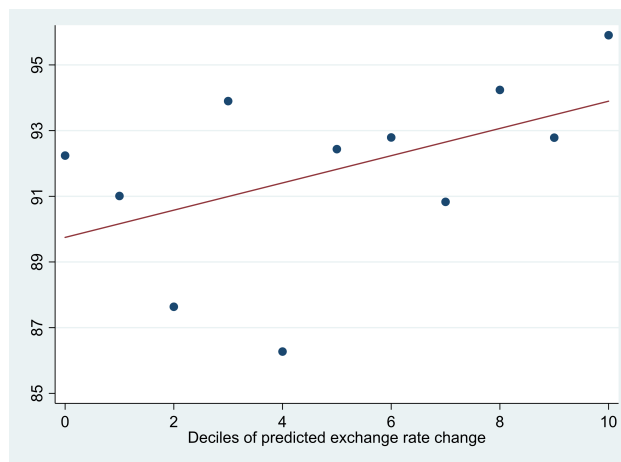
We provide even more intriguing evidence on the role of fundamentals. Using a panel 17 countries over the period Q1-1990 to Q4-2019, we compare the relation between the proportion of bonds in foreign currency by the private non-financial sector and two measures of predicted exchange rate appreciation: Standard and Poors' credit rating of sovereign dollar debt and our own measure of predicted appreciation, based on a set of contemporaneous macroeconomic fundamentals.⁴ The difference between the two measures is that credit ratings are public measures that are contemporaneously available to investors, while our measure is based on indicators that are made public only ex post (macroeconomic variables are typically published with a lag), so it is based on an updated information set. Figure 1 displays a chart showing the average share of foreign currency borrowing over the range of

³See Hausmann and Panizza (2010), Bordo and Meissner (2007), Bordo et al. (2010).

⁴See Section 4 for more details on this data.

credit ratings. The relationship is clearly linear and upward sloping: a weak sovereign rating is associated with a higher share of foreign currency indebtedness by the private sector. In Figure 2 the average share of foreign currency borrowing is higher at higher deciles of predicted exchange rate changes. Dollarization is therefore driven either by poor ratings (or poor public signals on the fundamentals) or by good fundamentals. This evidence explains the elusive empirical link between fundamentals and original sin: it depends on whether information on fundamentals is publicly available or not.

Figure 2: Foreign currency debt and predicted exchange rate change



Note: This chart depicts the average percentage of foreign currency debt obligation issued by decile of predicted exchange rate change.

Motivated by this evidence, this paper contributes to a better understanding of the sources of foreign currency borrowing by taking into account information asymmetries between foreign and domestic investors. In this context, foreign currency borrowing is only loosely related to fundamentals. Namely, foreign currency borrowing results from the comparison of the costs of foreign currency borrowing and the cost of domestic currency borrowing, along with the borrower's beliefs about the stability of the domestic currency. Since the cost of domestic currency borrowing reflects the international investors' beliefs about the stability of the domestic currency, then, disagreement between foreign creditors and domestic borrowers is crucial to determine the amount of foreign currency borrowing. As a result, debt dollarization does not derive from poor fundamentals per se but from the relative pessimism of international markets.

In particular, when domestic agents have an informational advantage, a certain degree of debt dollarization might be observed even if the fundamentals of the economy are relatively strong. More precisely, in our model, there is a public signal on the fundamentals, observed by both the domestic and foreign investors. Domestic investors observe another private signal on the fundamentals. This assumption is justified by an abundant literature documenting the informational advantage of domestic agents.⁵ Using this model, we show that for a given public signal, better fundamentals lead to more financial dollarization. On the opposite, for given fundamentals, a better public signal leads to less dollarization. This result explain the elusive empirical link between fundamentals and original sin and is consistent with Figures 1 and 2, where credit ratings are interpreted as public signals, and expected appreciation is interpreted as the fundamental. The model also predicts that the precision of the public signal makes financial dollarization more sensitive to the value of the public signal: Countries with a poorer public signal will be more dollarized while countries with better signals will be less dollarized. We test all these predictions more formally using our panel, and show that they are consistent with the data.

We then explore the welfare implications of this result. We show that a more precise public signal reduces the volatility of payoffs as all agents have better information. We next extend the model to take into account the fact that financial dollarization itself influences exchange rate policy in the spirit of the “global games” models. Our main results carry through. In terms of welfare implications, the results are less straightforward because there are strategic complementarities between domestic agents. In this context, they over-react to their public signal.

Borrowing in dollars and not in pesos is cheaper in general. The reason why it is cheaper

⁵The literature has identified the informational advantage in favor of domestic investors as one of the main determinants of home bias in asset holdings. French and Poterba (1991) show that agents may choose to renounce to diversify their portfolio internationally because of what they describe as “*familiarity effect*”. 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 that the observed positive correlation between asset price and foreign purchases is the effect of an informational disadvantage of international investors. A more recent approach consists in comparing the performance of domestic and international investors in terms of profits earned: Who knows more gets more. Hau (2001), Choe, Kho and Stulz (1999), Dvorak (2005) and Kalem et al.(2006), make the case that local investors do better than foreigners. Finally Portes et al. (2001), (2005) and Coval et al. (1999), using a gravity approach, emphasize how geographic distance matters in the determination of international portfolio equity transactions.

in our model, is that investors’ pessimism is such that the interest rate charged on peso debt is *unfairly* high and borrowers rationally dollarize their debt. In our model, the interest differential, and the domestic agents’s detection of deviations from the uncovered interest parity (henceforth UIP) are at the heart of the mechanism. This is consistent with the microeconomic empirical literature. In particular, firms are more likely to borrow in foreign currency with large cross-currency interest differentials and deviations from uncovered interest parity.⁶ In advanced economies, foreign currency borrowing typically responds to global funding conditions on the dollar (Bacchetta and Merrouche, 2017; Ivanisha et al., 2012).

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 et al., 2002; Schneider and Tornell, 2004), lack of domestic financial development (Caballero and Krishnamurthy, 2003), commitment problems at the level of domestic firms (Aghion et al., 2004), and domestic monetary policy (Chamon and Hausman, 2005; Jeanne, 2005; Cowan and Do, 2003; and Chang and Velasco, 2006).⁷ The explanation for debt dollarization that we propose here should be considered as complementary to the ones identified until now. The main difference between our approach and the approach adopted in the literature is that in our approach borrowers choose to expose herself to currency risk. To quote Tirole (2003), “...dangerous forms of debt cannot be presumed to be suboptimal for those who issue them”. In other words, while the literature has focused on the “supply side” of foreign currency borrowing (on the ability of domestic agents to borrow in foreign currency), the “demand side” (their willingness to) plays also a role in our model.

⁶See Keloharju and Niskanen (2001), McCauley et al., (2015), Brown, Kirschenman and Ongena (2013), Brown, Ongena, and Yesin (2011), Brauning and Ivashina (2017), Niepmann and Schmidt-Eisenlohr (2017), Bruno and Shin (2017) and Varela and Salomao (2020).

⁷Tirole (2003) analyses the problem in a context of uncoordinated borrowing where agents are not aware of the effect of their behavior on government policies. Differently from him, in our extended model we emphasise how agents’ decisions also result from their awareness of the effect that they have on the exchange rate policy. From this point of view our paper is close to Chamon and Hausman (2005) and Chang and Velasco (2006): They also emphasize the endogeneity between the currency denomination of the debt and the policy of the CB.

The logic of our extended 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 where agents' actions are complementary, like currency crises and debt rollovers. Through the introduction of private information in the economy, they show that it is possible to interpret certain phenomena as the result of a coordination game. In those models, equilibrium uniqueness is possible only under very precise conditions⁸. In our model instead, we show that through the introduction of an additional set of agents, the international investors, those conditions are relaxed. In our model we *always* have equilibrium uniqueness whenever common knowledge is ruled out.⁹

The remainder of this paper is organized as follows. Section 2 describes the model. Section 3 deals with the global games extension of the model. Section 4 tests the model's implications regarding the role of the signals' precision. Section 5 discusses some policy implications of the model. Section 6 concludes.

2 The Model

2.1 Agents, Actions and Payoffs

Consider a two-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. Domestic and foreign agents are risk-neutral. In period 1, in order to finance their production, domestic firms have to borrow on the international market. Firms can borrow either in the domestic currency, called *peso*, or in the foreign currency, called *dollar*. The supply of funds on the international markets is infinitely elastic. The cost of borrowing in pesos depends on r , the interest rate on peso debt. The cost of borrowing in dollars depends on the international interest rate r^* and on the decision of the CB to devalue or not the domestic currency in period 2. For simplicity r^* is normalized to 0. The initial exchange rate between dollar and peso is one in period 1. In the absence of a devaluation, the agent

⁸I.e., when the precision of public information is smaller than the precision of private information

⁹Multiple equilibria can be generated in our 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.

that borrows in dollars has a net cost of debt equal to 0 in period 2. A devaluation in period 2, instead, implies that two pesos are exchanged for one dollar and the net borrowing cost in terms of pesos becomes 1. The agent that borrows in pesos instead has a cost of debt equal to r , where $0 < r < 1$, that is proportional to the probability of devaluation formulated by the international investors. The borrowing costs are summarized in the table:

	Devaluation	No devaluation
Dollar debt	1	0
Peso debt	r	r

The Central Bank We assume in a first step that the decision of the CB to devalue in period 2 depends on the state of the fundamentals, θ . Later, we will consider the possibility that it also depends on the proportion of peso debt, M . 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. The CB devalues when the state of the fundamentals, θ , is bad and it knows that a strong exchange rate is not sustainable. The rule followed by the CB is such that the devaluation occurs if and only if:

$$\theta \leq \theta^*. \quad (1)$$

with θ^* a constant term.

Currency denomination of debt The borrowing cost of each individual agent i , $C(m_i, \theta)$, depends on her individual action, m_i , and on the state of the fundamental θ . Agents can choose between two actions: Either borrow in dollars $m_i = 0$, or borrow in pesos $m_i = 1$.¹⁰ Debt dollarization minimizes the agent's borrowing cost if and only if the exchange rate is not devalued. The borrowing cost of foreign currency debt versus domestic currency debt, $C(1, \theta) - C(0, \theta)$, is decreasing in the state of fundamentals θ :

¹⁰This binary choice is without loss of generality. Indeed, as we will see, since agents are risk-neutral, they endogenously choose to fully denominate their debt in one currency, depending on how their expectations differ with the foreigners'.

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

As a consequence, the incentive to denominate the debt in foreign currency decreases with the confidence agents have in their domestic fundamentals. But note that it also decreases with r , the cost of peso debt. This cost, as we will see, is lower when foreign investors are more confident about the country's fundamentals. To determine the equilibrium currency denomination of domestic debt, we therefore need to define the information structure first.

2.2 Information

The state of the economy is assumed not to be common knowledge. At time 1 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. At time 2, the CB observes the true state of the economy θ and chooses whether to devalue or not.

2.3 Strategies and Equilibrium Analysis

A *strategy* for agent i is a decision rule $m_i(x_i, \mu)$ that maps each realization of x_i and μ 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. A *symmetric equilibrium* is an equilibrium such that all individual strategies are identical: $m_i(x_i, \mu) = m(x_i, \mu)$. In a symmetric equilibrium, two distinct individuals receiving the same private signal will choose the same action.

Throughout the paper, we look at monotone (or threshold) symmetric equilibria. That is, equilibria in which $m(x, \mu)$ 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 threshold $x^*(\mu)$. A monotone equilibrium is then identified by the threshold function $x^*(\mu)$.

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 threshold $x^*(\mu)$:

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

where Φ denotes the cumulative distribution function for the standard normal. The share of dollar debt is therefore $D(\theta, \mu) = 1 - M(\theta, \mu)$.

The subjective probability of devaluation from the point of view of the international investors and of the domestic agents are respectively $Pr(\theta \leq \theta^* | \mu)$ and $Pr(\theta \leq \theta^* | \mu, x^i)$. Given that foreign investors are risk-neutral and that the supply of funds is infinitely elastic, the interest rates on peso and dollar debt must satisfy the *Uncovered Interest Parity* (UIP). Given that the CB has a binary choice, i.e., devalue or not devalue, and that the dollar interest rate r^* is normalized to zero, the UIP implies that the interest rate charged on peso debt is directly proportional to the probability of devaluation formulated by international investors:

$$r = Pr(\theta \leq \theta^* | \mu), \quad (3)$$

In order to choose their strategy, borrowers compare the probability of devaluation given their information set, with the domestic interest rate r . In other words, they compare their expectation of devaluation, with the probability of devaluation determined by the

international markets. The optimal strategy can be summarized as follows:

$$m(x^i, \mu) = \begin{cases} 0 & \text{if } Pr(\theta \leq \theta^* | \mu, x_i) < r \\ [0, 1] & \text{if } Pr(\theta \leq \theta^* | \mu, x_i) = r \\ 1 & \text{if } Pr(\theta \leq \theta^* | \mu, x_i) > r \end{cases}$$

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 they are larger, it is optimal to denominate the debt in pesos. When the expectations coincides with the domestic interest rate, the agent is indifferent between dollarizing or not. Note that, despite the fact that the UIP holds from the point of view of the foreigners, the domestic borrowers' choice reflect individual deviations from the UIP.

There exists a unique threshold $x^*(\mu)$ that makes a domestic agent indifferent between borrowing in pesos or in dollars:

$$r = Pr(\theta \leq \theta^* | \mu, x^*(\mu)). \quad (4)$$

Using the UIP condition (3), the indifference condition (4) reduces to a comparison between the probability of devaluation of international investors and the one of the marginal domestic borrower:

$$Pr(\theta \leq \theta^* | \mu) = Pr(\theta \leq \theta^* | \mu, x^*(\mu)). \quad (5)$$

Intuitively, $x^*(\mu)$ is the private signal that makes a domestic agent form the same expectations as foreigners.

In order to constitute an equilibrium in monotone strategies, $x^*(\mu)$ must solve for the indifference equation (5). It can be rewritten as:¹¹

$$\theta^* - \mu = \sqrt{\frac{\alpha + \beta}{\alpha}} \left(\theta^* - \frac{\alpha}{\alpha + \beta} \mu - \frac{\beta}{\alpha + \beta} x^*(\mu) \right) \quad (6)$$

¹¹We use $Pr(\theta \leq \theta^* | \mu) = \Phi(\sqrt{\alpha}(\theta^* - \mu))$ and $Pr(\theta \leq \theta^* | \mu, x^*(\mu)) = \Phi\left(\sqrt{\alpha + \beta}\left(\theta^* - \frac{\alpha}{\alpha + \beta} \mu - \frac{\beta}{\alpha + \beta} x^*(\mu)\right)\right)$.

The left-hand side is a monotonous transformation of foreigners' subjective devaluation probability, while the right-hand side is the same monotonous transformation of the marginal domestic agents' subjective devaluation probability. We can see that the public signal μ has a smaller effect on the domestic agents' expectations. This is explained by the fact that the domestic agent has an alternative source of information (her private signal). This determines the equilibrium effect of the public signal on the equilibrium marginal signal $x^*(\mu)$ that determines the proportion of dollarization in the economy.

It is useful to rewrite the indifference equation (6) as a function of $\epsilon^*(\theta, \mu)$, where $\epsilon^*(\theta, \mu) = x^*(\mu) - \theta$, so that $x_i < x^*(\mu)$ is equivalent to $\epsilon_i < \epsilon^*(\theta, \mu)$. We then obtain:

$$\theta^* - \mu = \sqrt{\frac{\alpha + \beta}{\alpha}} \left(\theta^* - \frac{\alpha}{\alpha + \beta} \mu - \frac{\beta}{\alpha + \beta} [\epsilon^*(\theta, \mu) + \theta] \right) \quad (7)$$

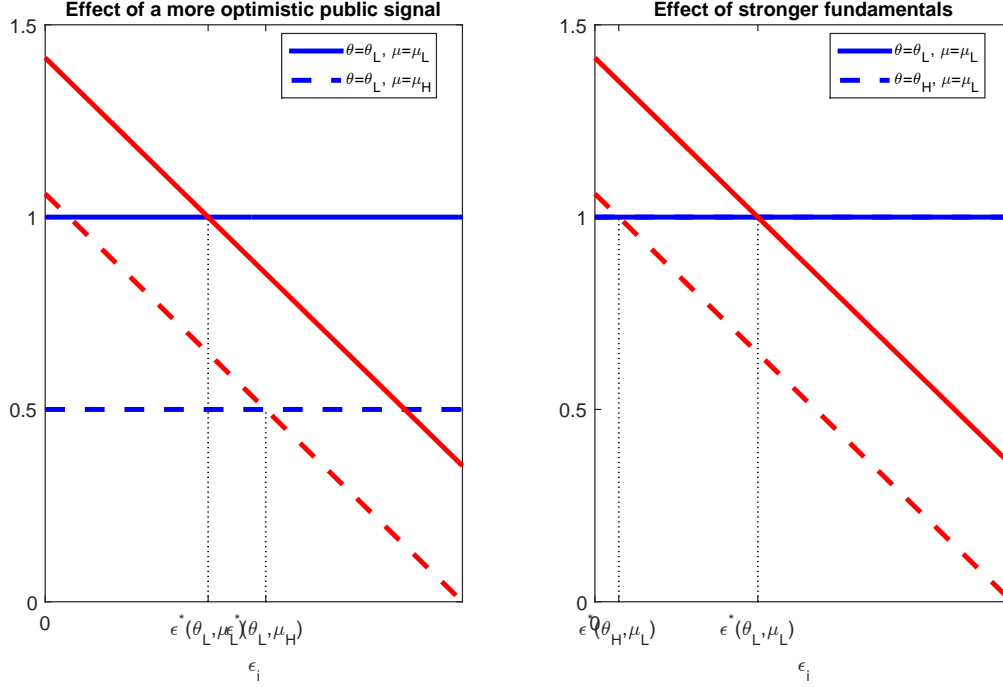
For a given public signal μ , the fundamental θ affects the investors's decisions through their private signals. Note the role played by the level of asymmetric information $\sqrt{\frac{\alpha + \beta}{\alpha}}$. When there is asymmetric information (when $\beta > 0$), the domestic expectations react not only to the public signal μ , but also to the fundamentals θ to some extent. This indifference equation then determines the threshold noise $\epsilon^*(\theta, \mu)$. Since ϵ_i is independent of θ and μ , the share of peso debt is monotonously related to $\epsilon^*(\theta, \mu)$:

$$M(\theta, \mu) = Pr(\epsilon_i \leq \epsilon^*(\theta, \mu)) = \Phi \left(\sqrt{\beta} \epsilon^*(\theta, \mu) \right)$$

A higher threshold $\epsilon^*(\theta, \mu)$ means that more agents choose to borrow in peso.

Consider Figure 3, which represents the foreign and domestic –transformed– devaluation expectations, for given θ and μ . The flat line represents the foreigner's devaluation expectation. The decreasing line represents the domestic agents' expectation as a function of ϵ_i , which measures the optimism of the private signal. These expectations are equal for $\epsilon_i = \epsilon^*(\theta, \mu)$. For lower values of ϵ_i , the domestic agents issue peso debt, and they issue dollar debt for larger values. Now consider that μ increases, so that agents receive a more optimistic public signal, while fundamentals remain the same. This decreases both the foreign and domestic devaluation expectations. However, since the foreign expectations react

Figure 3: Cut-off value for ϵ_i



This figure represents the left-hand side of equation (7) (blue line), which is a transformation of the foreign investors' expected probability of devaluation, against the right-hand side (red line), which is a transformation of the domestic investors' expected probability of devaluation, as a function of ϵ_i . The intersection between these two lines gives ϵ^* , the cutoff value for ϵ_i . If $\epsilon_i < \epsilon^*$, then investor i is relatively more pessimistic than the foreign investors and borrows in domestic currency. If $\epsilon_i > \epsilon^*$, then investor i is relatively more optimistic than the foreign investors and borrows in foreign currency. The figure is based on the following parametrization: $\theta^* = 1.5$, $\theta_L = 0.5$, $\theta_H = 1$, $\mu_L = 0.5$, $\mu_H = 1$, $\alpha = \beta = 1$.

relatively more to the public signal, then domestic investors face more favorable conditions on the peso, that are not compensated by lower depreciation expectations. More domestic agents then borrow in peso. This is translated in the Figure through an increase in the threshold $\epsilon^*(\theta, \lambda)$, thus decreasing the amount of dollarization.

Now consider that θ increases, for a given public signal μ . Domestic agents then receive more optimistic private signals, while foreign expectations do not change. More domestic agents then borrow in dollars. This means that the threshold $\epsilon^*(\theta, \lambda)$ declines, thus increasing the amount of dollarization.

We establish the following proposition that summarizes these effects and further explores the role of information asymmetries:

Proposition 1. *From the indifference equation, we can determine the equilibrium cut-off for ϵ_i :*

$$\epsilon^*(\theta, \lambda) = A(\mu - \theta^*) - (\theta - \theta^*)$$

with $A = \sqrt{\alpha}(\sqrt{\alpha + \beta} - \sqrt{\alpha})/\beta > 0$.

We can additionally show that

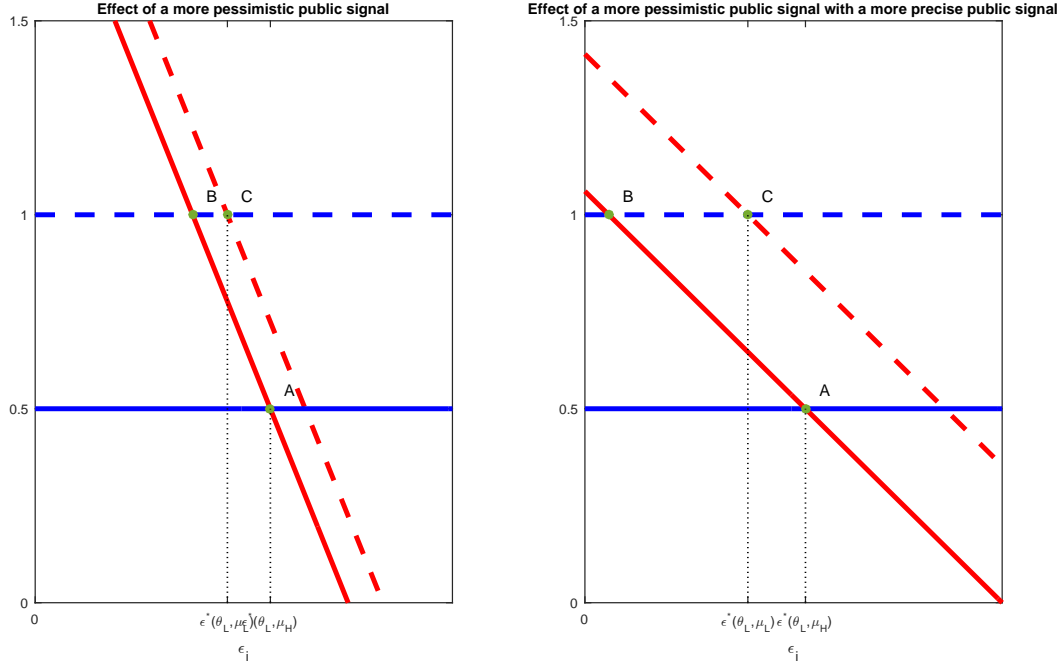
$$\frac{\partial A}{\partial \alpha} = \frac{(\sqrt{\alpha + \beta} - \sqrt{\alpha})^2}{\sqrt{\alpha}\sqrt{\alpha + \beta}} > 0$$

The fact that the effect of μ on the cutoff is positive, and that the effect of θ is negative, confirms our graphical analysis. Note that, contrary to common wisdom, debt dollarization is not caused by weak fundamentals, but by negative public information on the fundamentals. This is because in our model, dollar debt issuance is an equilibrium outcome that arises from the relative assessment of domestic and foreign regarding the state of the economy. Weak fundamentals make the domestic agents less confident than foreign investors, while weak signals make the foreign investors less confident.

Note that these implications derive crucially from our assumption that domestic borrowers have an informational advantage over foreign investors. Otherwise, our predictions would be reversed. Strong fundamentals would generate more optimism among foreign investors than among domestic borrowers, so that the former would be more willing to lend in peso. On the opposite, a poor signal would drive more pessimism among domestic borrowers than among foreign investors, leading to more peso borrowing as well.

The positive derivative of A means that a more precise public signal (a higher α) leads to a stronger increase in dollar (peso) debt as a response to a negative (positive) public signal. To understand, consider the effect of a negative public signal. As seen earlier, there are two counteracting effects: an interest rate shift (the peso rate increases) and an expectation shift (domestic depreciation expectations increase). If the public signal is more precise, the beliefs of the domestic agents are less dispersed, so that more agents will switch to dollar debt as a result of the interest rate shift. On the other hand, domestic agents will rely more on the public signal when forming expectations, so more agents will switch to peso debt. The interest rate shift effect dominates, so that a higher precision of the public signal leads to

Figure 4: Cut-off value for ϵ_i for different levels of precision α



This figure represents the left-hand side of equation (7) (blue line), which is a transformation of the foreign investors' expected probability of devaluation, against the right-hand side (red line), which is a transformation of the domestic investors' expected probability of devaluation, as a function of ϵ_i . The intersection between these two lines gives ϵ^* , the cutoff value for ϵ_i . If $\epsilon_i < \epsilon^*$, then investor i is relatively more pessimistic than the foreign investors and borrows in domestic currency. If $\epsilon_i > \epsilon^*$, then investor i is relatively more optimistic than the foreign investors and borrows in foreign currency. The figure is based on the following parametrization: $\theta^* = 1.5$, $\theta_L = 0.5$, $\theta_H = 1$, $\mu_L = 0.5$, $\mu_H = 1$, $\beta = 1$. In the left panel, $\alpha = 0.25$. In the right panel, $\alpha = 1$.

more dollarization in this case. Graphically, the two effects can be represented respectively in Figure 4 as the switch from point A to point B, and as the switch from point B to point C.

3 Strategic behavior of the central bank

In the baseline model, we have assumed that the central bank's decision to devalue depends on the exogenous fundamentals θ . We now make the more realistic assumption that the central bank behaves strategically. Namely, it is more likely to devalue when there is a

relatively large share of peso debt $M(\theta, \mu)$ in the economy, and therefore that action cannot hurt a large proportion of borrowers. The rule followed by the CB is such that the devaluation occurs if and only if:^{12,13}

$$\theta \leq M(\theta, \mu) \quad (8)$$

The difference with the baseline is that this gives rise to strategic complementarities between domestic investors. If a domestic investor expects that the other domestic investors borrow in dollars, then they expect that a devaluation is less likely, so they will be inclined to borrow in dollars.

As it has been extensively shown in 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, $\underline{\theta}$, 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, $\bar{\theta}$, 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 and 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. Under common knowledge a problem of indeterminacy arises because the existence of multiple equilibria does not allow to make any definitive prediction as to whether the currency is going to be devalued or not. But in our framework, as domestic agents receive private signals, we depart from the assumption of common knowledge on the fundamentals and we can show that the equilibrium is unique.¹⁴

As in the baseline model, we look at monotone (or threshold) equilibria. That is, equilibria in which $m(x, \mu)$ is monotonic in x . A monotone equilibrium is such that, for any given

¹²We will show in Section 5 that this policy function can be endogenously derived in a model in which the Central Bank chooses the optimal devaluation rate in order to maximize a welfare function that depends on the aggregate utility of the economy and on the deviation of the exchange rate from its shadow value.

¹³As 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.

¹⁴See Appendix A.2 for a proof.

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 threshold $x^*(\mu)$. Given the threshold $x^*(\mu)$ below which the agents borrow in pesos, the share of peso debt $M(\theta, \mu)$ is decreasing in θ , as is clear from Equation (2). As a consequence, $\theta - M(\theta, \mu)$ is increasing in θ and there exists a unique $\theta^*(\mu)$ such that a devaluation occurs if and only if the state of the fundamentals is less than that threshold. This threshold is characterized by:

$$\theta^*(\mu) = M(\theta^*(\mu), \mu),$$

which, combined with equation (2), amounts to

$$\theta^*(\mu) = \Phi \left(\sqrt{\beta}(x^*(\mu) - \theta^*(\mu)) \right). \quad (9)$$

A monotone equilibrium is then identified by the threshold functions $x^*(\mu)$, but also $\theta^*(\mu)$.

This modifies the problem as follows. Now, the indifference equation (6) depends on the endogenous devaluation threshold $\theta^*(\mu)$:

$$\theta^*(\mu) - \mu = \sqrt{\frac{\alpha + \beta}{\alpha}} \left(\theta^*(\mu) - \frac{\alpha}{\alpha + \beta} \mu - \frac{\beta}{\alpha + \beta} x^*(\mu) \right) \quad (10)$$

In order to constitute an equilibrium in monotone strategies, $\theta^*(\mu)$ and $x^*(\mu)$ must jointly solve (9) and (10). It is useful to again use $\epsilon^*(\theta, \mu)$, where $\epsilon^*(\theta, \mu) = x^*(\mu) - \theta$. We establish the following proposition:

Proposition 2. *From the indifference and threshold equations, we can show:*

$$\frac{\partial \epsilon^*(\theta, \mu)}{\partial \mu} = A.Z(\mu) > 0 \quad \text{and} \quad \frac{\partial \epsilon^*(\theta, \mu)}{\partial \theta} = -1 < 0$$

where $Z(\mu)$ is a multiplier term:

$$Z(\mu) = \frac{1}{1 - B.C(\mu)}$$

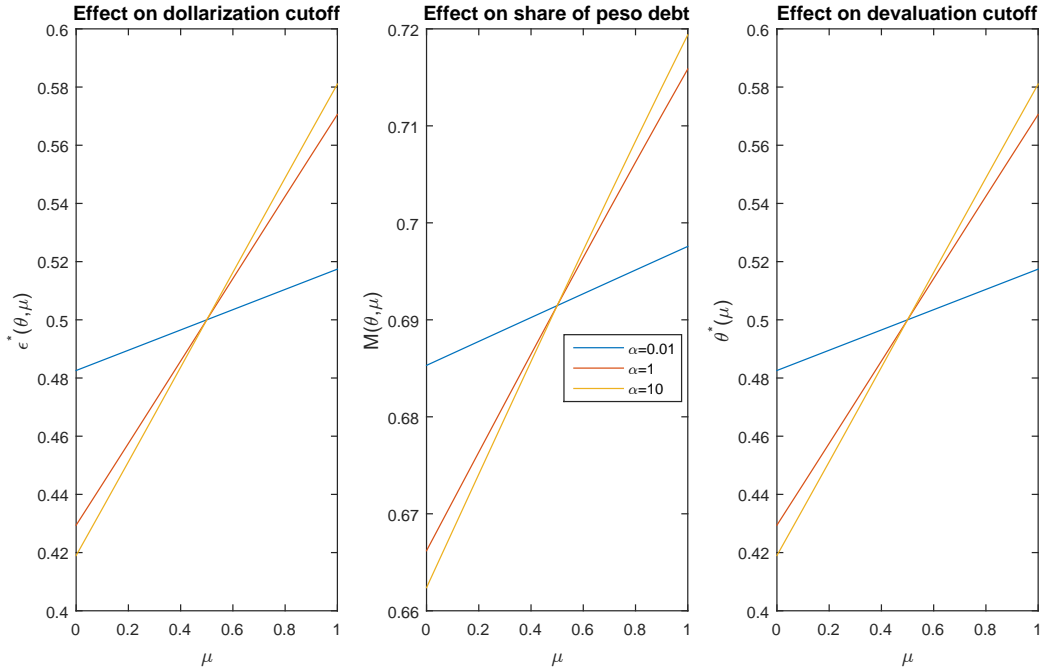
with $B = \sqrt{\alpha + \beta}(\sqrt{\alpha + \beta} - \sqrt{\alpha})/\beta = 1 - A$. and $C(\mu)$ describes how the central bank's threshold θ^* is affected by the agents' threshold x^* :

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

As both B and $C(\mu)$ are strictly positive and lower than 1, then $Z(\mu) > 1$.

Proof. See proof in Appendix A.1 □

Figure 5: Effect of the signal μ



This figure represents the effect of the public signal μ on θ^* , ϵ^* and on peso borrowing M , for a given θ . We use the following parametrization: $\theta = 0.5$ and $\beta = 1$.

The effect of θ and μ on the cutoff are similar to the baseline case, up to a multiplier term in the case of μ . The fact that this multiplier is larger than 1 reflects an amplification effect due to strategic complementarities. Take for example the effect of a weaker signal. A deterioration $\partial\mu$ in the signal, for a given central bank's strategy, increases the probability of crisis, which leads domestic agents to borrow more in pesos: the dollarization cutoff increases

by an amount $\partial\epsilon_0^* = A\partial\mu$, equal to the baseline. However, a lower dollarization means that the central bank has even less incentives to defend the currency. The devaluation cutoff increases by $\partial\theta_0^* = AC(\mu)\partial\mu$, where C depends on the normal density function around the dollarization cutoff point, for a given signal μ . The more agents are concentrated around the cutoff point, the more they will switch to peso debt, the higher the incentives to devalue. Furthermore, as the agents know this, they will increase their peso borrowing even further: the dollarization cutoff increases by an additional amount $\partial\epsilon_1^* = B\partial\theta_0^* = ABC(\mu)\partial\mu$. These feedback effects accumulate, so that the dollarization cutoff ϵ^* increases by $\partial\epsilon = \partial\epsilon_0^* + \partial\epsilon_1^* + \dots = A.Z\partial\mu$, an amount greater than the baseline.

Figure 5 shows the effect of μ on the cutoff value for dollarization $\epsilon^*(\theta, \mu)$ and on the share of peso debt $M(\theta, \mu)$. It confirms that the main insights of the baseline model are still valid when we take into account the strategic behavior of the central bank. First, the cutoff value, and hence the share of peso debt decreases when the signal becomes less optimistic (for given fundamentals), and the more so as the public signal is more precise (α is higher). Note that, as the signal becomes more pessimistic, the cutoff value for devaluation $\theta^*(\mu)$ decreases. This is because, due to the higher dollarization, the central bank has more incentives to support the stability of the currency.

All in all, the model's testable implications are the same as in the simple model, namely:

- (1) Stronger fundamentals θ increase the share of dollar borrowing, for a given public signal μ .
- (2) (a) A stronger public signal μ , given the fundamentals θ , decreases the share of dollar borrowing, and (b) this effect is stronger, the higher the precision of the public signal α .

4 Empirical Analysis

In this section we provide empirical evidence consistent with the two predictions derived from our model:

1. Stronger fundamentals (or a predicted appreciation) increase the share of dollar borrowing, for given public signals.
2. (a) A positive public signal (or a predicted appreciation), given the fundamentals,

decreases the share of dollar borrowing, and (b) this effect is stronger, the more precise the public signal.

To this end we obtain the proportion of bonds in foreign currency by the private non-financial sector. These data come from the Bank of International Settlement (BIS) consolidated banking statistics. They cover 17 countries over the period Q1-1990 to Q4-2019 and concern only new bonds issued in the international market.

The public signal is measured by the sovereign dollar debt credit rating.¹⁵ We use the Standard & Poors rating because it is the most populated for our sample countries. The precision of the public signal is captured by a dummy variable that takes value one if a sovereign is rated by more than one credit rating agency and the rating split (the difference between the highest and lowest grade) is less than two notches.

We collect various fundamentals which are susceptible to be relevant drivers of the exchange rate, which tend to be published at low frequency and with lag, and which are sufficiently populated: the current account, the inflation rate, the international reserves, and the real GDP growth. These data come from the IMF International Financial Statistics. The effective exchange rate is collected from the BIS statistics database.

Table C in the Appendix reports descriptive statistics of our data. Our sample is unbalanced, some countries enter the BIS statistics later and ratings tend to be more frequently available statistics in the 2000s. On average 92 percent of the bonds issued in the international market are denominated in foreign currency. But the variability in the data is important, especially across countries, with a standard deviation above 20 percent. Our sample period is sufficiently long that we cover several cycles hence the macroeconomic variables also display a lot of variability both across countries and over time. The range of credit ratings is also wide from 4 to 23 with a higher numerical rating indicating weaker credit quality. And on average 30 percent of the ratings are unprecise. In Table C we provide a correlation matrix of all the variables. Interestingly, the credit rating is more strongly correlated with fundamentals that tend to be more frequently available and published with a shorter lag, namely the international reserves and the inflation rate. Consistent with our

¹⁵Dittmar and Yuan (2008) show that in emerging markets information flows from the sovereign market to the corporate market, hence improving the price discovery process.

predictions the correlation between the share of foreign currency is positively correlated with the rating, negatively correlated with the precision of the rating.

Our empirical strategy proceeds in two steps. First, we estimate the exchange rate change predicted by fundamentals using the following specification:

$$\Delta EER_{t+1} = c + F_{it}\beta + \alpha_i + \gamma_t + \epsilon_{it} \quad (11)$$

Where F is the vector of fundamental macro variables, c is a constant, and α_i and γ_t are country and time fixed effects, respectively.

Results of estimating equation (11) are reported in Table 4 column (1). As one would expect stronger fundamentals are associated with a significant future appreciation of the domestic currency. Interestingly and consistent with our prior the public signal captured by the rating in contrast is not a good predictor of changes in the value of the currency.

The predicted exchange rate change is then:

$$\widehat{\Delta EER}_{t+1} = F_{it}\hat{\beta} \quad (12)$$

Second, we test prediction (1) and (2) using the following specification:

$$fs_{it} = c + \beta_1 \widehat{\Delta EER}_{t+1} + \beta_2^R \text{ating} + \beta_3 \text{Precise} + \beta_4 \text{Rating} * \text{Precise} + \gamma_t + \epsilon_{it} \quad (13)$$

Where fs is the proportion of newly issued bonds denominated in foreign currency, $Rating$ is the S&P sovereign rating, and $Precise$ is a dummy indicating whether the rating signal is precise.

The graphical evidences shown in Figures 1 and 2 are confirmed by the regression analysis reported in Table 4. In column (1) we find that a predicted appreciation of the currency and a lower credit rating are associated with an increase in borrowing in foreign currency, consistent with prediction (1) and (2.a). In column (2) the effect of the rating is stronger if the rating signal is precise and, consistent with prediction (2.b), a more precise rating signal reduces the share of dollar borrowing. This remains true if we augment the specification with country fixed effect exploiting only variations within country over time. This is not

Table 1: First stage: predicting the exchange rate change

	I	II
Real growth %	0.705 (0.225)***	
Inflation %	-0.558 (0.125)***	
Reserves/GDP %	0.082 (0.047)*	
Current account/GDP %	0.572 (0.312)*	
Rating		-0.291 -0.324
Time FE	yes	yes
Country FE	yes	yes
R2	0.27	0.15
N	1,031	1,013

Note: The dependent variable is the log change in the nominal effective exchange rate; a higher value indicated a higher predicted appreciation of the domestic currency. Rating is the S&P numerical rating of the sovereign dollar debt; a higher value indicates lower credit quality. Standard errors are clustered at the country level.

Table 2: Explaining the propensity to borrow in foreign currency

	I	II	III
Rating	2.254 (0.572)***	1.47 (0.517)**	0.602 -1.253
$\widehat{\Delta EER}$	1.614 (0.658)**	1.655 (0.624)**	0.048 -0.774
Precise		-13.321 (5.415)**	-15.618 (6.480)**
Rating*Precise		0.952 (0.451)*	1.324 (0.357)***
Time FE	yes	yes	yes
Country FE	no	no	yes
R2	0.19	0.2	0.17
N	715	715	715

Note: The dependent variable is the percentage of new debt obligations issued by the private sector denominated in foreign currency. Rating is the S&P numerical rating of the sovereign dollar debt; a higher value indicates lower credit quality. $\widehat{\Delta EER}$ is the predicted log change in the nominal effective exchange rate; a higher value indicated a higher predicted appreciation of the domestic currency. Precise is a dummy that takes value one if the government is rated by more than two rating agencies and the rating split is less than 2 notches. Standard errors are clustered at the country level.

our preferred specification because the variability in our data is much more important across countries than within countries.

5 Policy discussion

The previous section has shown that dollarization accrues more on average to countries with either good fundamentals or poor signals. Besides, we have shown that a higher precision of the public signal leads a country with a given poor signal to borrow even more in foreign currency. This evidence is consistent with a model where domestic agents have an informational advantage over foreign investors about the country's fundamentals. In this section, we examine the policy implications of these findings.

To do so, we show that the central bank policy function can be endogenously derived in a model in which the Central Bank maximizes a welfare function that depends on the terms of trade and debt repayments. We will use this welfare function to evaluate the desirability of increasing the precision α of the public signal, which we refer to as “transparency”. To understand the effect of α on welfare, it will be important to understand its effect on the spread, on portfolio choice and on the probability to devalue, so we first discuss these variables before discussing welfare itself.

5.1 Foreign currency borrowing and fundamentals

To determine the unconditional effect of fundamentals on dollarization and how its is affected by transparency, we need to take into account the fact that the signal and the fundamentals are correlated. Taking this correlation into account, we show that a higher precision of the public signal *reduces* foreign currency borrowing when the fundamentals are good. Indeed, more transparency reduces the information asymmetry between foreign lenders and domestic borrowers and reduces the spread between the interest rate on peso debt and the interest rate on dollar debt, pushing more domestic borrower to switch to peso debt.

To understand the role of fundamentals, it is useful to write the signal μ as the sum of θ

and a shock $\sqrt{\alpha}^{-1}\lambda$, with $\lambda \sim N(0, 1)$: $\mu = \theta + \alpha^{-1}\lambda$. We then can write M as follows:

$$M(\theta, \lambda) = Pr(\epsilon_i \leq -(1 - A)(\theta - \theta^*) + A\sqrt{\alpha}^{-1}\lambda) \quad (14)$$

As per Proposition 1, $1 - A$ is positive and decreasing in α , which implies that countries with a positive $\theta - \theta^*$ will be less dollarized. Foreigners are more able to recognize countries with good fundamentals, thanks to the more precise public signal, and hence charge a lower interest rate on peso debt, which lowers the spread. Domestic borrowers are then more inclined to denominate their debt in pesos. This is illustrated by the blue lines in Figure 6, which represent the effect of α on the average UIP deviation $r - P$ and on peso debt M , in a case where $\theta > \theta^*$, and in the absence of noise in the signal ($\lambda = 0$). Note that borrowers with poor fundamentals (negative $\theta - \theta^*$) will on the opposite increase their dollar borrowing as α increases, as shown in Figure 6.

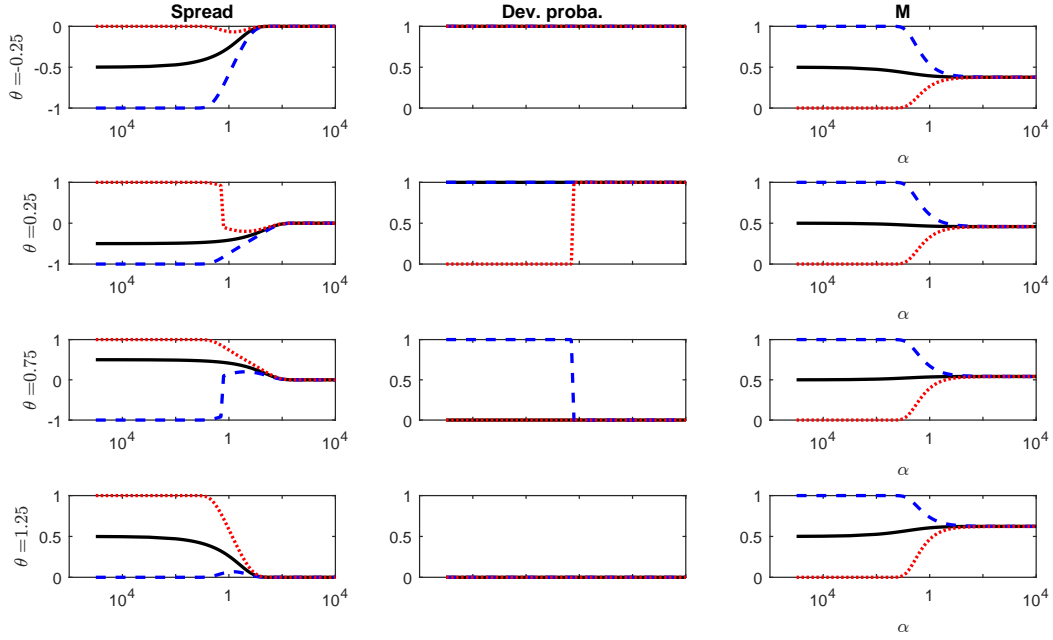
Therefore, by reducing disagreement between foreigners and domestic borrowers, more transparency leads to lower dollarization in countries with good fundamentals. In countries with poor fundamentals, it increases dollarization.

5.2 Public signals and the probability to devalue

Because the probability to devalue is endogenous and depends on foreign currency borrowing, the way agents adjust their portfolio to the public signals is key to understanding the probability to devalue conditional on the fundamentals. We have found in the data, and consistently with our model, that a higher precision of the public signal leads a country with a given poor signal to borrow even more in foreign currency. However, note that the volatility of μ itself is also affected by α . Taking this volatility into account, we will see that a higher precision of the public signal actually reduces the noise-driven volatility of foreign currency borrowing. Again, this is due to the fact that more transparency reduces the information asymmetry between foreign lenders and domestic borrowers.

Consider again equation (14), but focus now on the role of the signal noise, λ . With higher precision, A is higher, and a given relatively poor signal ($\lambda < 0$) will generate more foreign currency borrowing, as foreigners will charge a higher peso interest rate. However,

Figure 6: Effect of α , conditional on θ and λ



Note: This chart depicts the effect of α on the average UIP deviations $r - P$, with P the domestic agents' average subjective devaluation probability, on the probability to devalue, and on peso borrowing M , for different values of θ , in the model of Section 3. The solid black lines corresponds to an unbiased public signal ($\lambda = 0$), the dashed red lines correspond to a negative bias in the public signal ($\lambda = -1$) and the dashed blue lines correspond to a positive bias in the public signal ($\lambda = 1$).

with a higher precision, the volatility of noise $\sqrt{\lambda}^{-1}$ is also smaller. Overall, we can show that $A\sqrt{\lambda}^{-1}$ is decreasing in α , so that poor signals generate less additional foreign currency borrowing. This is represented by the red dashed line in Figure 6, which represent the effect of α in a case where $\theta > \theta^*$, and with negative noise in the public signal ($\lambda < 0$). Note that, on the opposite, in the case of an excessively optimistic signal where domestic agents tend to issue peso debt (green dashed line, representing a case with $\lambda > 0$), the peso debt share will decrease with α .

Therefore, by reducing disagreement between foreigners and domestic borrowers, more transparency leads to a less volatile currency composition of debt, for given fundamentals. The consequences on the probability to devalue can be seen in Figure 7, which shows the average devaluation probability as a function of α for different values of θ . For very high

(very low) values of θ , the CB always defends (devaluates) the currency. For intermediate values, the realizations of M will determine the decision to devalue. When α is small, the volatility of the public signal is high, so financial conditions will vary a lot, depending on μ , so that there will be realizations of μ for which M will be high, which will generate a devaluation, and realizations for which M will be low, which will lead the central bank to defend the currency. We see in the figure that, indeed, for low values of α , the probability to devalue is close to 0.5. As α increases, M becomes more stable as foreign investors receive more accurate signals. As a result, the probability to devalue converges to 1 for poor fundamentals and to 0 for good fundamentals. Transparency thus limits the situations where the exchange rate is driven by foreign investors' misinformation.

5.3 Welfare

Here we show how the central bank policy function can be endogenously derived in a model in which the Central Bank maximizes a welfare function that depends on the terms of trade and debt repayments. we then study how this welfare function changes with the precision of the public signal α .

We assume that the utility function of the agents is of the form

$$U_i = R(E, E^*) - d_i$$

where $R(E, E^*) = -\frac{X}{2}[E - (E^* + 0.5)][E - (E^* - 0.5)]$ and $d_i = E(1 - m_i)(1 + r^*) + m_i(1 + r)$ are total debt repayments in period 2, expressed in domestic currency. The foreign interest rate r^* is normalized to 0, as in the baseline model, so that $d_i = [(1 - m_i)E + m_i(1 + r)]$. E^* is the shadow exchange rate, that is, the exchange rate that maximizes the first term. We can think of $R(E, E^*)$ as the real revenues of the country, which depend on the terms of trade, and hence on the nominal exchange rate in the presence of nominal rigidities. X controls for the relative weight of real income as compared to financial costs d_i . Note that R is maximized for $E = E^*$. For $E^* = 3/2$, a CB that would maximize $R(E, E^*)$ only would be indifferent between $E = 1$ (defending the currency) and $E = 2$ (devaluation).

The welfare function The objective of the central bank is to set E in order to maximize the sum of the individual utilities $W = \int_0^1 U_i di$. using $\int_0^1 m_i di = M$, we obtain the central bank's objective:

$$W(M, E^*, r, E) = R(E, E^*) - (1 - M)E - M(1 + r) \quad (15)$$

which we obtained using $\int_0^1 m_i di = M$. In period 2, the central bank observes the shadow exchange rate E^* , the interest rate r and M , and chooses $E = 1$ or $E = 2$ in order to maximize W . This objective features a “conservative bias”: because E affects negatively the financial revenues whenever part of the debt is in dollars, the CB will have an incentive to defend the currency, even in cases where a devaluation would have increased the real revenues.

The central bank devalues the currency if and only if $W(M, E^*, r, 2) > W(M, E^*, r, 1)$, which is equivalent to the devaluation rule (8), where

$$\theta = 1 - X \left(E^* - \frac{3}{2} \right)$$

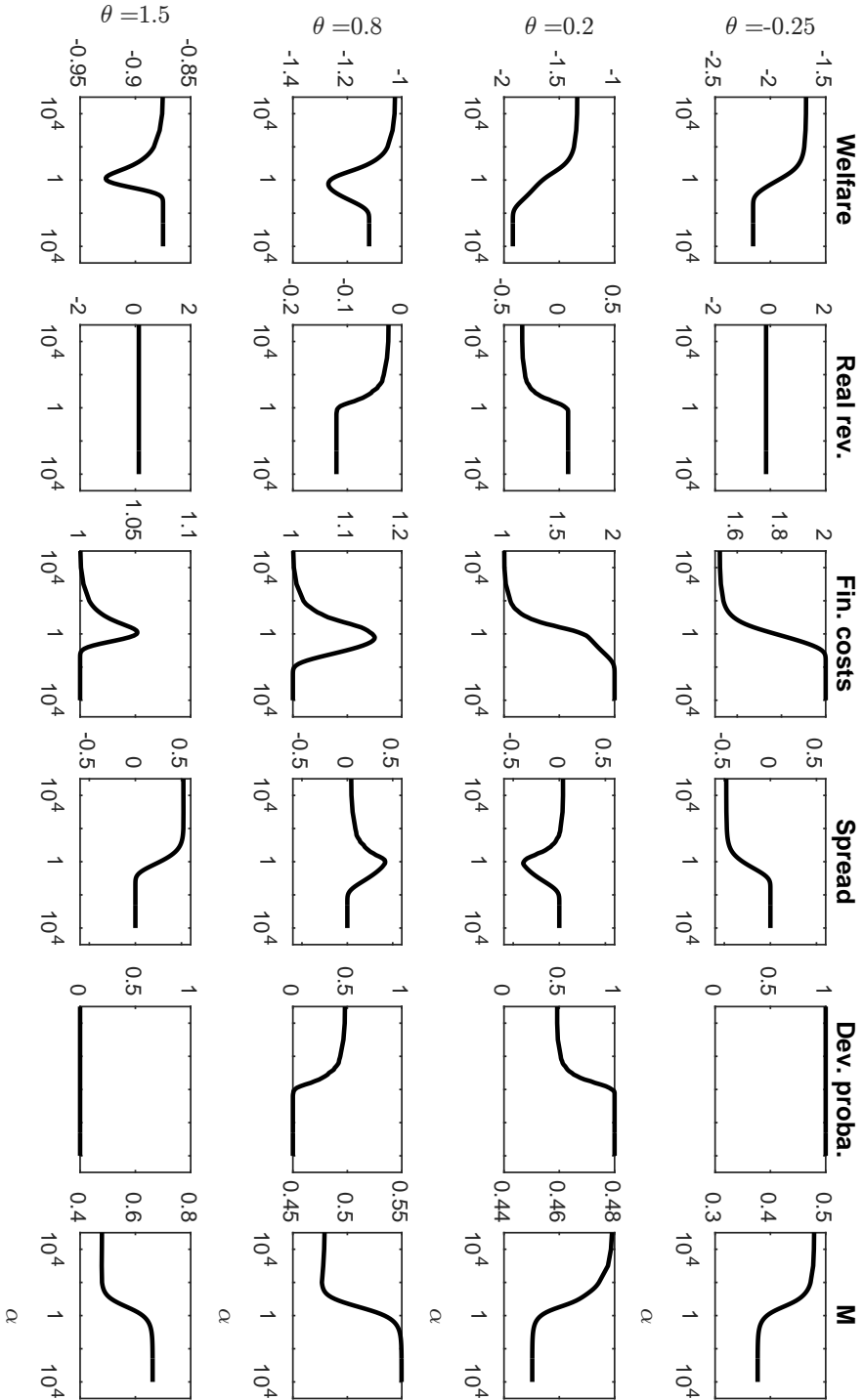
corresponds to the “reduced-form” fundamentals and is a function of the structural fundamentals E^* . Indeed, when the shadow exchange rate E^* is high, it is optimal to devalue the currency to get closer to the country's optimal terms of trade. Moreover, when M is high, only a small fraction of domestic agents hold debt denominated in foreign currency, which implies that an increase in the relative price of foreign goods does not affect the country's total debt repayments too much.

The effect of α on welfare We simulate the model of Section 3, and examine the effect of α on the welfare function defined in (15). We set $X = 1$ and $\beta = 1$ in our baseline calibration.¹⁶

Figure 7 represents the effect of the public signal's precision α public signal μ on welfare, its real and financial components, on the realized spread $1 + r - E$, on the devaluation probability and on the share of peso debt M . It appears that the effect of α is ambiguous.

¹⁶We consider alternative parameters in the Appendix and the results are unchanged.

Figure 7: Effect of α , conditional on θ



This figure represents the effect of the public signal's precision α on welfare, its real and financial components R and d , on the realized spread $1 + r - E$, on the devaluation probability and on the share of peso debt M . We use the following parametrization: $X = 1$ and $\beta = 1$. The fundamental values $\{-0.25, 0.2, 0.8, 1.5\}$ correspond to the shadow exchange rates $\{2.75, 2.3, 1.7, 1\}$.

For values of θ that are very low ($\theta = -0.25$), the real revenues do not change with α , because the CB always devalues. The financial costs, in contrast, increase with α . This is driven by the spread, $1 + r - E$, which is initially negative, then goes to zero as α increases. Remember that the foreign investors do not observe the fundamentals. Here, this lack of information leads them to finance peso loans with better conditions than if they had a more accurate assessment of the fundamentals. This represents an informational rent that benefits domestic borrowers, but as α increases, this rent declines. As a result, welfare decreases with α .

For low, but intermediate values of the fundamentals ($\theta = 0.25$), the financial costs are increasing in α as well. But now, as we have seen, the probability to devalue increases with α . This increases the real revenues. Indeed, for these values of parameters, the optimal exchange rate regarding the real revenues is $E = 2$. Devaluating the currency, in this case, is the action that is aligned with the fundamentals. However, the increase real revenues are not enough to offset the financial costs, so welfare declines as α increases.

For values of θ that are very high ($\theta = 1.25$), the central bank always defends the currency independently from M , because it is optimal to defend even for $M = 1$. This is the case for instance with $\theta = 1.5$. In that case, only the financial costs are affected by α . This is again driven by the spread, $1 + r - E$, but not only. This spread, which is initially positive, then goes to zero as α increases. Here, the asymmetry of information between foreigners and domestic borrowers hurts the latter, as investors' lack of information leads them to finance peso loans with worse conditions than if they had a more accurate assessment of the fundamentals. However, the conditions improve as foreigners get more precise public signals. Another effect, discussed above, is driven by the debt's currency composition. The public signal's precision α tends to increase the share of peso debt when the fundamentals are good. This is because the positive spread declines as foreigners' relative pessimism vanishes. But when the spread on peso debt is large and positive, this increases the financial costs of domestic borrowers. These two channels combined generate a humped-shaped effect of α on financial costs. As a result, locally, α has a positive effect on welfare only when the public signal is above a certain level, and welfare is maximized either for very high or very low values of α .

For high, but intermediate values of the fundamentals ($\theta = 0.75$), the financial costs follow a similar humped shape. Additionally, now, the probability to devalue decreases with α , which also affects the real revenues. The real revenues actually decrease with α . This is due to the conservative bias highlighted earlier. Indeed, for this value of θ , the real revenues would be maximized with a devaluation ($E^* = 1.75$). But the fact that agents issue debt in dollars forces the central bank to defend the currency to limit the financial costs. As α increases, there always remains a fraction of agents who borrow in dollars. Indeed, as the asymmetry of information between domestic borrowers and foreign investors vanishes, their average assessments of the fundamentals converge, but the individual domestic beliefs remain dispersed around the average, so there remain some domestic agents who are more optimistic than foreigners and thus who are willing to issue debt in dollars. As a result, locally, α still has a positive effect on welfare only when the public signal is above a certain level, but welfare never becomes as high for large value of α as it is for low values of α , because of the drop in real revenues.

All in all, the highest possible transparency is not the best policy, except for unambiguously good fundamentals. In all other cases, increasing transparency may sometimes be good locally, but achieving full transparency is not optimal. For poor fundamentals, this result is explained by the declining informational rent. For good but moderate fundamentals, it is driven by the conservative bias and the endogenous choice of portfolio composition.

With a liberal bias In Figure 8 in the Appendix, we show the result of a simulation where households value the financial costs in dollars: d_i/E . In that case, there is a “liberal bias”, as the financial costs are negatively affected by a devaluation as long as the share of peso debt is not equal to zero. Interestingly, welfare shows similar patterns across the different values of θ , which suggests that our results do not hinge on the conservative bias of the CB.

To understand, note that for each θ , we observe similar probability to devalue, share of peso debt and spread to the case with conservative bias. But note that these θ s correspond to lower values of E^* . In particular, now, for high but intermediate θ , the fact that the probability to devalue goes to zero when α increases is in line with the real fundamentals

of the economy. Indeed, now the real revenues are increasing as the probability to devalue declines. Financial costs are still humped-shaped, but are higher with high α s than with low α s. This is because as the CB defends the currency, agents holding peso debt have higher financial expenses. All in all, welfare is still not maximized with the highest possible α . With low but intermediate θ , not only are financial costs still increasing in α , but the real revenues are now decreasing. This is because of the liberal bias: for $\theta = 0.2$, the shadow exchange rate is $E^* = 1.4$, for which it would be optimal to defend the currency if the CB was concerned only with real revenues. As a result, welfare is still decreasing in α .

Acknowledgements

We would like to thank Philippe Bacchetta, Fabio Ghironi, Matteo Iacoviello, Peter Ireland, Guido Lorenzoni, Alessandro Missale and seminar participants at Boston College, MIT, the Graduate Institute of International and Development Studies, and Unil. Special thanks to Filippo Balestrieri for helpful comments and stimulating discussions. All errors are ours. Financial support from the National Centre of Competence in Research, Financial Valuation and Risk Management (NCCR FINRISK) is gratefully acknowledged.

[illegible]

A Proofs

A.1 Proof of Proposition 2

Substituting equation (2) into equation (9) we get:

$$\theta^*(\mu) = \Phi(\sqrt{\beta}(x^*(\mu) - \theta^*(\mu))). \quad (16)$$

Through (16), $\theta^*(\mu)$ is implicitly defined as a function of $x^*(\mu)$: $\theta^*(\mu) = \Theta^*(x^*(\mu))$.

By differentiating (10) with respect to μ , we obtain

$$x^{*'}(\mu) = A + B\Theta^{*'}(x^*(\mu))x^{*'}(\mu)$$

Hence

$$x^{*'}(\mu) = \frac{A}{1 - BC(\mu)}$$

with $C(\mu) = \Theta^{*'}(x^*(\mu))$. Then, notice that $\partial\epsilon^*(\theta, \mu)/\partial\mu = x^{*'}(\mu)$. Finally, since $x^*(\mu)$ is independent of θ , $\partial\epsilon^*(\theta, \mu)/\partial\theta = -1$.

A.2 Equilibrium uniqueness

Equation (10) in the text can be described as

$$G(\theta^*(\mu)) = g(\mu), \quad (17)$$

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

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

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 .

$$G(\underline{\theta}) = \sqrt{\frac{\beta}{\alpha(\alpha + \beta)}} \Phi^{-1}(0) = -\infty, \quad (18)$$

$$G(\bar{\theta}) = \sqrt{\frac{\beta}{\alpha(\alpha + \beta)}} \Phi^{-1}(1) = \infty, \quad (19)$$

where we assumed that $\underline{\theta} = 0$ and $\bar{\theta} = 1$. Equations (13) and (14) show that there is a solution $\theta^*(\mu) \in (\underline{\theta}, \bar{\theta})$. 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:

$$\frac{\partial G(\theta)}{\partial \theta} = 1 + \frac{\beta}{\sqrt{\alpha(\alpha + \beta)}} + \sqrt{\frac{\beta}{\alpha(\alpha + \beta)}} \frac{1}{\phi(\Phi^{-1}(\theta))} - \sqrt{\frac{\alpha + \beta}{\alpha}} > 0 \quad (20)$$

Since $\max_{\omega \in \mathbb{R}} \phi(\omega = \frac{1}{\sqrt{2\pi}})$, we can rewrite (15) as

$$\frac{\partial G(\theta)}{\partial \theta} = 1 + \frac{\beta}{\sqrt{\alpha(\alpha + \beta)}} + \sqrt{\frac{\beta}{\alpha(\alpha + \beta)}} \sqrt{2\pi} - \sqrt{\frac{\alpha + \beta}{\alpha}} > 0 \quad (21)$$

Equation (16) can be manipulated and rewritten as

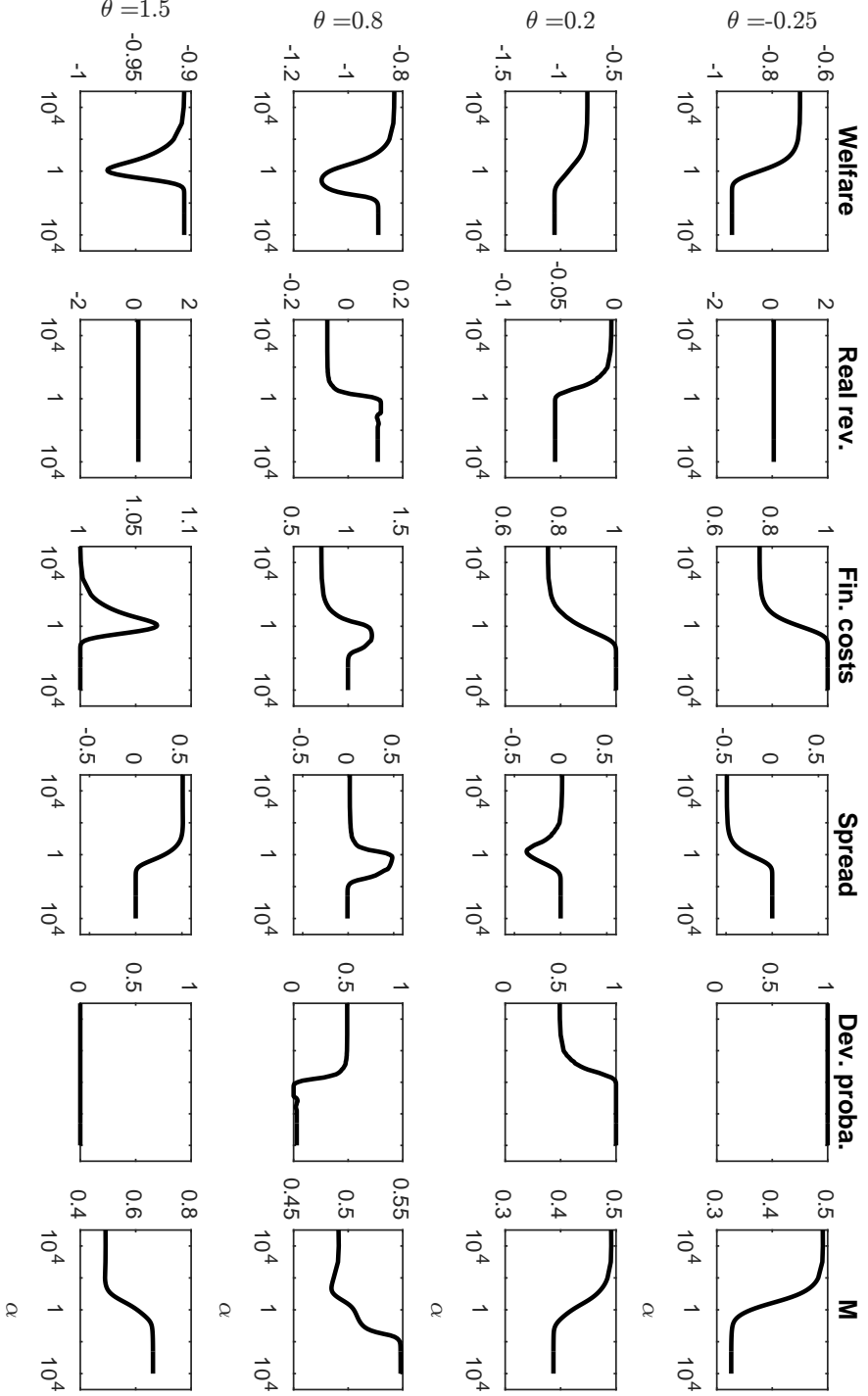
$$-\frac{1}{\sigma_x + \sqrt{\sigma_x^2 + \sigma_\mu^2}} < \sqrt{2\pi}, \quad (22)$$

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 Additional Figures

C Additional Tables

Figure 8: Effect of α , conditional on θ with aliberal bias



This figure represents the effect of the public signal's precision α on welfare, its real and financial components R and d , on the realized spread $1 + r - E$, on the devaluation probability and on the share of peso debt M , when the CB maximizes $R(E, E^*, r) - d/E$. We use the following parametrization: $X = 1$ and $\beta = 1$. The fundamental values $\{-0.25, 0.2, 0.8, 1.5\}$ correspond to the shadow exchange rates $\{1.625, 1.4, 1.1, 0.75\}$.

Table 3: Descriptive Statistics

Variable	Obs	Mean	Std.Dev.	Min	Max
(1) Foreign currency share	1147	92.013	20.288	0	100
(2) ΔEER	1170	-1.074	6.025	-83.463	18.436
(3) Real GDP growth %	1827	1.032	1.074	-4.149	9.438
(4) Inflation rate	1869	5.15	25.711	-3.923	751.061
(5) Reserves/GDP %	1887	14.248	10.402	0.05	51.785
(6) Current account/GDP %	1734	0.053	1.554	-4.302	6.328
(7) Rating	1361	11.386	3.14	4	23
(8) Precise	1432	0.703	0.457	0	1

Note: The data cover 17 emerging market countries over the period Q1-1990 to Q4-2019. Foreign currency share is the share of private sector newly issued bonds denominated in foreign currency. ΔEER is the log change in the nominal effective exchange rate. A higher value indicates an appreciation of the domestic currency. Rating is the sovereign dollar debt S&P rating. Precise is a dummy that takes value 1 if a country is rated by more than 1 agency and the rating split (the difference between the highest and lowest rating) is lower than 2 notches.

Table 4: Pairwise correlations

Variables	-1	-2	-3	-4	-5	-6	-7	-8
(1) Foreign currency share	1							
(2) ΔEER	-0.011	1						
(3) Real GDP growth	0.024	0.239*	1					
(4) Inflation rate	0.052	-0.329*	-0.122*	1				
(5) Reserves/GDP	-0.019	0.135*	0.122*	-0.156*	1			
(6) Current account/GDP	-0.065	0.061	0.086*	-0.016	0.456*	1		
(7) Rating	0.183*	-0.156*	-0.185*	0.250*	-0.501*	-0.149*	1	
(8) Precise	-0.117*	0.086*	-0.109*	-0.131*	0.192*	-0.01	-0.220*	1

Note: * shows significance at the .01 level.