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Why Do Emerging Market Economies Borrow in Foreign Currency?

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Abstract

This paper explores the hypothesis that the dollarization of liabilities in emerging market economies is the result of a lack of monetary credibility. I present a model in which firms choose the currency composition of their debts so as to minimize their probability of default. Decreasing monetary credibility can induce firms to dollarize their liabilities, even though this makes them vulnerable to a depreciation of the domestic currency. The channel is different from the channel studied in the earlier literature on sovereign debt, and it applies to both private and public debt. The paper presents some empirical evidence and discusses policy implications.

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Contents

I. Introduction

In an influential paper, Barry Eichengreen and Ricardo Hausmann have advanced the idea that less developed countries are more vulnerable to international financial crises than developed countries because of the currency composition of their debts. Namely, for less developed countries "the domestic currency cannot be used to borrow abroad or to borrow long term, even domestically"(Eichengreen and Hausmann, 1999, p.3). Instead, many emerging market countries borrow in foreign currency, a situation that Eichengreen and Hausmann describe as the "original sin" of international finance.[2]

This paper addresses the following question: Why is it that emerging market borrowers find it more difficult or less desirable to issue long-term debt denominated in domestic currency? Put succinctly, the hypothesis proposed in this paper is that the "original sin" is the result of a lack of credibility in domestic monetary policy.[3] Unpredictable monetary policy makes borrowers unsure about the future *real* value of their domestic currency debts and may induce them to dollarize their liabilities. This is so even though foreign currency debt is itself dangerous, especially in the event of a large depreciation. I illustrate this point with a fixed currency peg model in which increasing the probability of devaluation induces domestic firms to borrow in foreign currency. Somewhat paradoxically, an increase in the devaluation risk may lead domestic borrowers to take *less* insurance against this risk.

The argument that foreign currency debt results from a lack of monetary credibility may not sound new. In fact, it is a classical argument in the literature on sovereign debt, which has emphasized how foreign currency debt provides discipline for monetary policymakers tempted by the evil of discretion (Calvo, 1996; Bohn, 1990). My argument is quite different, however, it relies on optimal hedging at the level of individual borrowers rather than incentives at the government level. Furthermore, it is more general in the sense that it can be applied to both sovereign and private debt. This is useful since some recent crises, especially in Southeast Asia, involved primarily private, not sovereign, debt.

Although this paper is primarily theoretical, I present some evidence that suggests a link between monetary credibility and the currency composition of debt. As Hausmann and Panizza (2002) show, this link disappears if one looks at debts issued in the main international financial centers, which are almost completely in foreign currency for

[2] Several recent papers look at various problems caused by foreign currency debt and currency mismatches in balance sheets; see Aghion, Bacchetta, and Banerjee (2001), Burnside, Eichenbaum, and Rebelo (2001), or Jeanne and Zettelmeyer (2002).

[3] Or the lack of credibility of fiscal policy, to the extent that monetary policy is fiscally determined.

developing countries, irrespective of their monetary policy.[4] Thus, on empirical grounds, lack of monetary credibility seems more convincing as an explanation for the currency composition of *domestic* debt than it is for *international* debt. As I argue below, the explanation for the currency composition of international debt has probably more to do with financial practices in the center of the international financial system than with monetary policy in its periphery. It is important to emphasize this distinction, as some papers in this volume look exclusively at international debt (e.g., Flandreau and Sussman, 2002).

The paper is structured as follows. Section II discusses this paper's relationship to the existing literature. I then present the assumptions of a simple partial equilibrium model of the currency composition of a firm's debt and analyze the entrepreneur's problem (Sections III and IV). Section V shows how monetary policy can provide insurance to domestic borrowers, who take advantage of it by borrowing in domestic currency. Section VI studies how the currency composition of debt depends on the firm's international exposure. Section VII illustrates how a lack of monetary credibility can generate liability dollarization. Section VIII shows how the basic argument can be transposed to sovereign debt. Section IX presents some stylized facts. Section X discusses some policy implications, and Section XI concludes with thoughts on possible further developments of the ideas presented.

II. Literature

An important branch of literature focuses on the currency composition of *sovereign* debt. The main theme in that literature is that foreign currency debt may be a solution to the time consistency problem in monetary policy. The temptation to inflate is lower for a government that cannot inflate away its debt because it is in foreign currency (see, e.g., Calvo 1996; Bohn, 1990).

This argument works well for sovereign debt but as noted by Calvo (2001), it is difficult to transpose to private debt. The problem is that private borrowers, whose individual debt is typically very small relative to the economy, do not internalize the impact of their liabilities on domestic policy. These borrowers are unwilling to bear the private risks of foreign currency debt in order to produce the public good of a better policy. As a result, transposing the discipline argument to private debt implies that there is *too little* foreign currency debt in the private sector (Tirole, 2002).

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[4] Hausmann and Panizza (2002) distinguish between *domestic* and *international* original sin. The former refers to debt issued domestically while the latter relates to debt issued under a foreign jurisdiction (e.g., bonds issued in New York, London, or Tokyo). The distinction is in terms of the jurisdiction of issuance, not the residency of the debt-holders. In Hausmann and Panizza's terminology, the present paper looks for an explanation of domestic, not international, original sin.

A number of recent papers endogenize the currency composition of private debt, but looks at channels that are not primarily related to monetary policy. These papers have developed instead the following themes.

- Foreign currency debt arises because of the moral hazard created by bailout guarantees: McKinnon and Pill (1999), Burnside, Eichenbaum and Rebelo (2001), Schneider and Tornell (2001).

- Foreign currency debt arises because of a lack of domestic financial development: Caballero and Krishnamurthy (2003).

- Foreign currency debt arises because of commitment or signaling problems at the level of domestic firms: Jeanne (2000), Aguiar (2000), Chamon (2001), Broda and Levy Yeyati (2003).

The first two arguments invoke failures in other areas than monetary policy.[5] These failures can play a role in principle--and some of them may have played a significant role in Southeast Asia.[6] However, the mere fact that we are talking about currencies should make monetary policy a prime suspect. It makes sense to explore how far we can go simply with monetary policy.

More closely related to this paper are the contributions of Ize and Levy Yeyati (1998) and Ize and Parrado (2002). These authors look how domestic monetary policy influences the currency composition of domestic portfolios. They show that suboptimal monetary policy (which like in this paper could refer to a policy that is procyclical or lacks credibility) increases the demand for foreign currency assets. In the general equilibrium model of Ize and Parrado (2002) this portfolio effect induces liability dollarization, because domestic firms are risk-neutral, and ready to accommodate the demand of households for foreign currency assets.

By contrast with these papers, I focus here on the determinants of liability dollarization on the side of borrowers. In my model, the currency composition of portfolios is indeterminate because all agents are risk-neutral. Dollarization is driven instead by borrowers' attempt to reduce their probability of default. This demand-side approach tends to reinforce the results

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[5] These other policy areas could be related to monetary policy, however. For example, a sound monetary framework could be a necessary condition for financial development. Indeed, the model presented in this paper suggests that monetary credibility is necessary to the development of a long-term domestic-currency debt market.

[6] The evidence is not very encouraging for Latin America. Barajas and Morales' (2003) study of the determinants of dollarization in the banking sectors of 14 Latin American countries find that contrary to Caballero and Krishnamurty's prediction, financial development (measured by the ratio of private sector credit to GDP) is *positively* correlated with dollarization, while deposit insurance coverage (a measure of moral hazard) has ambiguous effects.

obtained in the portfolio approach: in particular, my model has positive and normative implications similar to those in Ize and Parrado (2002).

Finally, this paper is also related to the corporate finance literature on optimal hedging. Smith and Stulz (1985) and Froot et al (1993) present models in which a firm hedges so as to reduce the expected cost of default. Albuquerque (2001) looks at the optimal currency hedging strategies in a similar context. These papers typically assume the existence of derivative instruments (in particular, currency options) that allow firms to engage in nonlinear hedging strategies. Here the analysis is restricted to the more simple linear hedging strategies that are achieved by varying the currency composition of debt—consistent with the scarcity of currency hedging instruments observed in emerging market countries (Cowan, 2003). The role played by market incompleteness in my results is discussed in the concluding section.

III. The Currency Composition of Corporate Debt: A Simple Framework

I adopt a deliberately partial equilibrium approach, by looking at the choice of the currency composition of its debt by a small firm that takes domestic monetary policy as given. The analysis is based on the classical model of debt with costly state verification (Townsend, 1979; Gale and Hellwig, 1985) that is extended to incorporate a choice between domestic currency debt and foreign currency debt.[7]

The model has two periods $t = 0,1$. The domestic and foreign currencies are called peso and dollar respectively, and the exchange rate at time 1 (the price of one dollar in terms of pesos) is denoted by S.

I focus on one entrepreneur in an emerging market economy. The entrepreneur is endowed with a project that requires the sacrifice of I^* dollars in period 0 and yields a stochastic return in period 1. The return of the project can be expressed in terms of dollars, R^*, or in terms of peso, $R = SR^*$. Both are stochastic viewed from period 0.

The domestic entrepreneur has no funds in period 0, and must borrow from (domestic or foreign) investors. Debt contracts are written in nominal terms, and can be denominated in dollar or peso. In period 0 the entrepreneur promises to repay D pesos and D^* dollars in period 1. D and D^* are non-negative. If the entrepreneur cannot repay his debt, the creditors pay a "verification cost" of C^* dollars and collect the project's payoff. The entrepreneur receives nothing in the event of default. The risk-free dollar interest rate is normalized to

[7] The model of debt with costly state verification has been used in the macroeconomic literature on monetary policy, for example by Bernanke, Gertler and Gilchrist (1998). Other models of costly default could be considered, such as Diamond's (1984) model of debt with a non pecuniary punishment for default, or models where default involves the early termination or restructuration of projects (Bolton and Scharfstein, 1990; Dewatripont and Tirole, 1994).

zero. There is perfect competition on the side of lenders, who reap no rent from lending to the entrepreneur.

For simplicity, I assume that the entrepreneur and investors are risk-neutral, and maximize their net incomes expressed in terms of dollars. This assumption abstracts from potentially interesting determinants of the currency composition of debt, but considerably simplifies the analysis. The final utilities of the entrepreneur and its creditors are respectively given by

$$U = \max\left(0, \frac{R-D}{S} - D^*\right)$$
$$V = \min\left(\frac{R}{S}, \frac{D}{S} + D^*\right) - \delta C^*$$

where δ is a dummy variable that is equal to one if the entrepreneur defaults, and to zero otherwise.

The entrepreneur chooses his debt structure taking the stochastic distribution of R and S as given. At time 0 the entrepreneur maximizes his expected dollar income subject to the participation constraint of the lenders

$$(P)\begin{cases} \max_{D,D^*} E(U) \\ E(V) \geq I^* \end{cases}$$

Ex post (in period 1) the state of the economy $x \in X$ is revealed. Each state is characterized by an exchange rate $S(x)$ and a return $R(x)$. State x occurs with probability $\pi(x)$. I look how the equilibrium currency composition of debt depends on the structure of states, i.e. the mapping

$$X, \pi(\cdot), S(\cdot), R(\cdot) \Rightarrow (D, D^*)$$

IV. The Entrepreneur's Problem

In equilibrium, the participation constraint of lenders binds so that the entrepreneur's utility is equal to the total payoff of the project (net of the default cost) minus the cost of the investment

$$E(U) = E(U+V) - I^* = E(R^*) - E(\delta)C^* - I^*$$

$E(R^*)$ and I^* being given, the entrepreneur chooses the currency composition of his debt so as to minimize the probability of a default $E(\delta)$, subject to the participation constraint of lenders. Although the default cost is paid by the creditors ex post, it is borne by the entrepreneur ex ante. The entrepreneur's problem can be re-written

$$(P') \qquad \begin{cases} \min_{D,D^*} E(\delta) \equiv \Pr(R^* < D^* + D/S) \\ E(V) \geq I^* \end{cases}$$

Proposition 1. *The entrepreneur chooses the currency composition of his debt so as to minimize the probability of default conditional on the lenders' participation constraint.*

Note the contrast with moral hazard theories of foreign currency debt. In those theories, entrepreneurs borrow in foreign currency to undertake excessive risk—for example in the hope of a bailout (Burnside et al, 2001) or because of the limited liability constraint (Chamon, 2001). Here the entrepreneur attempts to *minimize* the risk of default, i.e. the currency composition of debt is the result of an optimal hedging strategy. The entrepreneur does not benefit from increasing the default probability because the determinants of this probability are observed at the time of borrowing and fully priced in the debt contract.

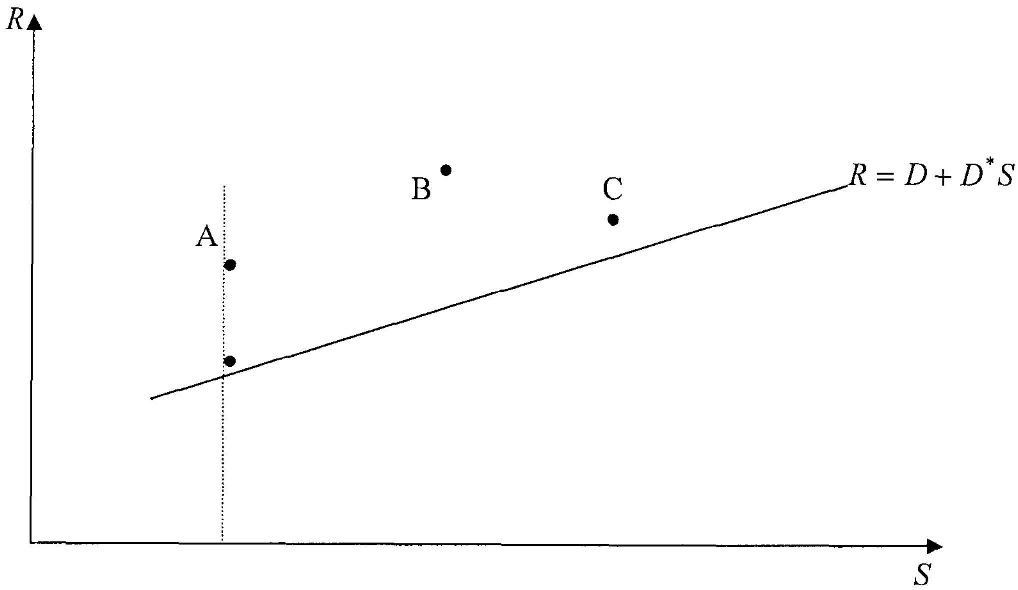
The entrepreneur reduces the probability of default to zero, if possible. He can do so if the maximum expected repayment that can be pledged to creditors conditional on a default-free debt structure (such that the firm does not default in any state $x \in X$) is larger than I^*. If not, the entrepreneur cannot finance his project with a default-free debt structure and must accept the risk of a default in some states.

Let us denote by $\hat{V}$ the maximum expected repayment that the entrepreneur can pledge to creditors conditional on a zero probability of default. $\hat{V}$ is the solution to the following problem:

$$\begin{cases} \max D^* + DE(1/S) \\ \forall x \in X,\ D + D^*S(x) \leq R(x) \end{cases}$$

The constraints in this problem are represented graphically in Figure 1, with the exchange rate S on the x-axis and the peso payoff R on the y-axis. Each point corresponds to a state $x \in X$. A default-free debt structure (D, D^*) is such that the line $R = D + D^*S$ is below all the points.

Figure 1. A Default-Free Debt Structure



It is easy to see that if the points corresponding to the states are not all on the same line,[8] then at least one point will have to be some distance above the line $R = D + D^{*}S$ in a default-free debt structure (for example point A or B in figure 1). In the corresponding state the firm repays strictly less than the return of the project. As a result, $\hat{V}$ is in general strictly lower than the expected payoff $E(R/S)$.

The interesting case is when $\hat{V} < I^{*} < E(R/S)$. Then the project is profitable but cannot be financed without taking the risk of a default. The entrepreneur must increase V by accepting to default in some states. He will do so if the project remains profitable in spite of the default risk. For the entrepreneur, choosing the currency composition of debt is equivalent to choosing the states in which he defaults.

V. Monetary Policy as a Source of Insurance

Intuitively, the extent to which the entrepreneur can insure himself against the risk of default depends on the macroeconomic environment, and in particular on the correlation between the exchange rate and the return of the project. The following result states a condition under which the entrepreneur can hedge perfectly against the risk of default by borrowing in domestic currency.

> **Proposition 2.** *If* $\min R \geq I^{*} / E(1/S)$ *the entrepreneur reduces his default probability to zero by borrowing in domestic currency.*

The intuition and the proof are straightforward. Conditional on no default, the entrepreneur can finance the investment by issuing a quantity of domestic currency debt equal to $D = I^{*} / E(1/S)$. Conversely, if the minimum realization of R is larger than $I^{*} / E(1/S)$, the entrepreneur can always repay D, and the default probability is zero. In other words, an entrepreneur who expects to receive a minimum quantity of pesos takes no risk by committing himself to repay a lower quantity of pesos.

The condition stated in Proposition 2 can be interpreted as a condition on the macroeconomic policy environment in which the entrepreneur operates. In a general equilibrium macroeconomic model, R and S would be determined by exogenous shocks and monetary and fiscal policies. The condition in Proposition 2 is more likely to be fulfilled if counter-cyclical monetary and fiscal policies limit the downside realizations of the firm's peso income. Conditional on such policies, the entrepreneur insures himself against default by borrowing in domestic currency.

Proposition 2 gives a condition under which the entrepreneur borrows in domestic currency. The hypothesis developed in this paper is that this condition is less likely to be satisfied in less developed countries than in more developed ones, so that firms tend to borrow more in

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[8] Which is possible only if there are three states or more.

foreign currency in the former than in the latter. Of course, foreign currency debt may expose borrowers to risks. But conditional on the macroeconomic environment, foreign currency debt may be less risky at the margin than domestic currency debt. This insight is very general and can be developed in different contexts.

VI. A CAPM FORMULA

I now show that conditional on a new assumption on the distribution of R and S, the entrepreneur's problem can be simplified in a way that gives a simple closed-form expression for the currency composition of debt. This expression is interesting in its own sake, and because it brings out the link between a firm's international exposure and the currency composition of its debt. The new assumption is that $1/S$ and R/S are normally distributed and that the probability of default is strictly positive but smaller than ½.

Let me define the project's net return as the payoff net of debt, expressed in terms of dollars

$$r \equiv \frac{R-D}{S} - D^*$$

Then the entrepreneur can find the optimal currency composition of his debt by solving the following mean-variance problem

$$(P'')\begin{cases}\min Var(r)\\ E(r) = \text{constant}\end{cases}$$

that is, by minimizing the variance in the net return conditional on its mean.

The reason is the following. If (D, D^*) were not a solution to the mean-variance problem *(P")*, then it would be possible to simultaneously decrease the probability of default and increase the utility of lenders, implying that (D, D^*) would not be a solution to problem *(P')* either. To see this, assume that the variance of r can be decreased while keeping $E(r)$ constant. Then the tail probability of a default is also decreased (see Figure 2).[9] The utility of lenders also increases for two reasons: the verification cost is paid less often and the average residual value of the project conditional on a default is higher. More formally, the expected payoff of lenders can be written

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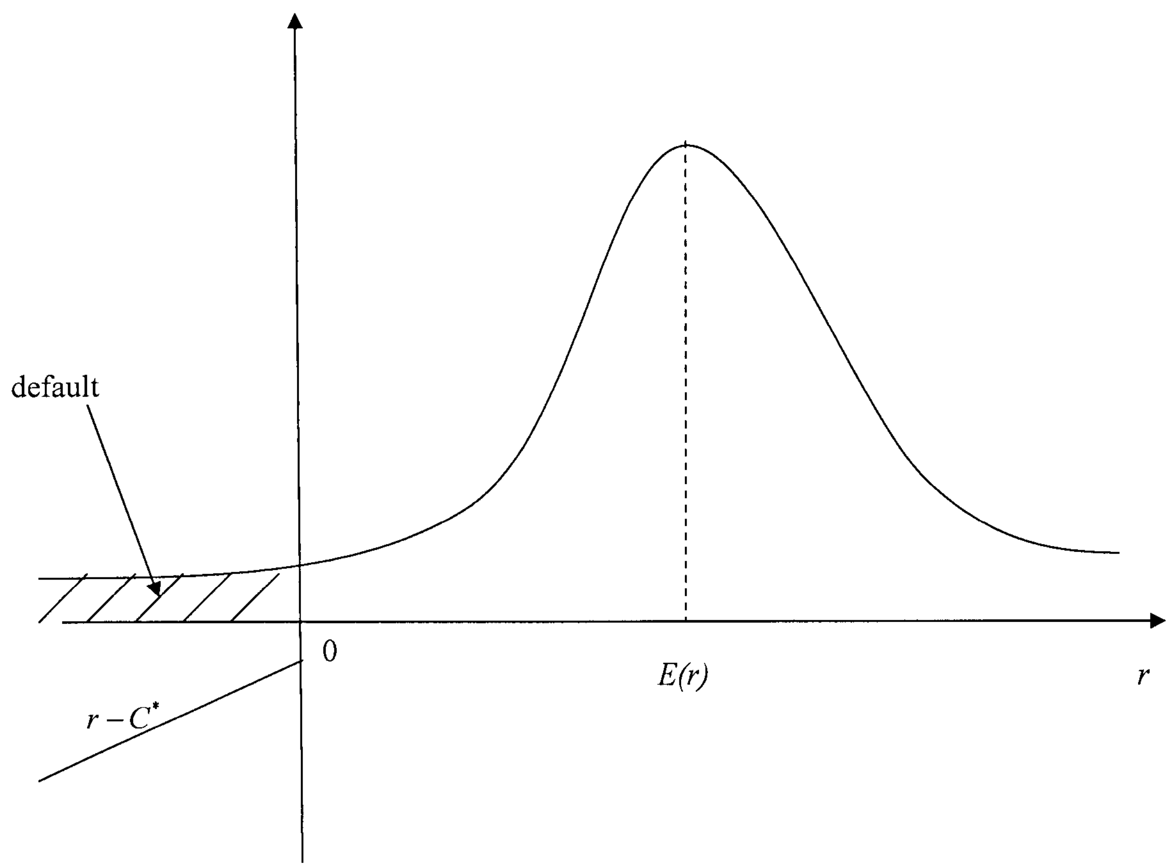
[9] This is where the assumption that the default probability be strictly positive but smaller than ½ is necessary. If the default probability were zero there would be no strict benefit to reducing the variance in r. If it were larger than ½ the tail probability event would no longer be the default but the absence of default: reducing the variance of r would increase the default probability.

Figure 2. Proof of Proposition 3



$$V = D^* + DE\left(\frac{1}{S}\right) + \int_{-\infty}^{0} (r - C^*) f(r) dr = E\left(\frac{R}{S}\right) - E(r) + \int_{-\infty}^{0} (r - C^*) f(r) dr$$

where *f(.)* is the probability density function of *r* (which is normal by assumption). The first equality says that the value of debt is equal to the expected repayment conditional on no default, plus a negative term reflecting the lower repayment and the payment of the verification cost conditional on a default. The second equality is then derived by substituting out D and D^* using the definition of *r*. The last expression increases if one reduces the variance in *r* while keeping *E(r)* constant (see Figure 2).

Then noting that $Var(r) = Var(R/S) + D^2 Var(1/S) - 2DCov(R/S, 1/S)$ and maximizing this expression over *D*, it follows that the optimal level of domestic currency debt is given by the following proposition.

> **Proposition 3.** *Assume* R/S *and* $1/S$ *are normally distributed and the probability of default is strictly positive but less than* $1/2$. *Then the optimal level of domestic currency debt is given by*:
>
> $$D = \frac{Cov(R/S, 1/S)}{Var(1/S)}$$

This expression is reminiscent of the Capital Asset Pricing Model. This is not surprising since problem *(P")* is a mean-variance portfolio optimization problem. The entrepreneur's problem is to minimize the probability of a negative net return conditional on the value of his debt, which (with normal distributions) is achieved by minimizing the variance in the net return conditional on its mean.[10]

The covariance term in the expression above depends on the correlation between the firm's receipts and the exchange rate. To illustrate, let me assume that part of the firm's nominal income is given in pesos while the other part is in dollars

$$R = a + bS$$

where a and b are stochastic, uncorrelated with *1/S*.

Coefficients a and b could be interpreted as reflecting the international exposure of the firm. For example, a firm that extracts and sells a tradable good for which the Law of One Price applies (say oil) has a equal to zero and b equal to the dollar price of its net output. On the other hand, a firm active in the non-tradable sector should have a higher a and a lower b.

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[10] Indeed, this is the way Roy (1952) arrived at the CAPM model at the same time as Markowitz (1952)—see Bernstein (1993).

Applying Proposition 3 then gives

$$D = E(a)$$

The firm's peso debt is equal to the expected value of its peso-denominated receipts. Thus, firms that are internationally less exposed (with higher a and lower b) tend to have more debt denominated in domestic currency. This is consistent with popular conceptions of optimal currency hedging, and with the available evidence on firms' hedging behavior.[11] The following section presents another specification of the model where optimal hedging takes a more surprising form.

VII. Monetary Policy as a Source of Risk

This section presents the main point of this paper: lack of monetary credibility can induce domestic firms to borrow in foreign currency, even though this makes them vulnerable to large depreciations of the domestic currency.

I illustrate this general point with an example. For the sake of relevance and simplicity, I consider the case of a fixed currency peg. However, the logic of the argument carries over to floating exchange rate regimes, as I shall argue at the end of this section. The case of a fixed currency peg is important because the emerging market countries that had a crisis in the 1990s also had a fixed currency peg. Furthermore, currency pegs have been faulted for generating excessive levels of foreign currency debt, by generating a "false sense of security" (Corden, 2002) or because of implicit guarantees on foreign currency debt (Burnside et al, 2001; Martinez and Werner, 2001). I present here a different channel, based on the lack of credibility of the currency peg.

The CAPM formula derived in the previous section relied on assumptions on the conditional distribution of the exchange rate that are not satisfied by an imperfectly credible fixed currency peg. Thus I return to the general specification of the model that was presented in section II. For simplicity, I consider an example with three states---the minimum number of states for the hedging problem to be non-trivial.

The structure of states is described in the following table.

[11]Aguiar (2002), Gelos (2003) and Martinez and Werner (2001) find a strong correlation between foreign currency debt and the share of sales exported for Mexican firms. Cowan (2003) finds the same pattern for a larger sample of Latin American countries.

Table 1. A Fixed But Adjustable Currency Peg

State	Exchange Rate	Nominal Return	Probability
0: Fixed Peg	S_0	R_0	$1-\mu$
1: Small Devaluation	S_1	R_1	μp_1
2: Large Devaluation	S_2	R_2	μp_2

At time 0, the domestic authorities announce that they will maintain a fixed exchange rate peg S_0. They fulfill this promise with probability $1-\mu$. With probability μ they do not, and there is a devaluation. The devaluation can be small ($S = S_1 > S_0$) or large ($S = S_2 > S_1$). The conditional probabilities of a small and a large devaluation are respectively p_1 and $p_2 = 1 - p_1$. The question I look at is how the currency composition of debt changes as the credibility of the fixed peg decreases (μ increases).

I assume that a depreciation is associated with an increase in the peso value of the firm's revenue but a decrease in its dollar value. This could be the case, for example, because the entrepreneur is active in a non-tradable industry with a low exchange rate pass-through. This case is interesting to consider because liability dollarization is more challenging to explain in the non-tradable sector, where the currency mismatch is the most damaging in the event of a devaluation.

$$R_0 < R_1 < R_2 \quad , \quad \frac{R_0}{S_0} > \frac{R_1}{S_1} > \frac{R_2}{S_2}$$

Finally I make the following concavity assumption:

$$\frac{R_2 - R_1}{S_2 - S_1} < \frac{R_1 - R_0}{S_1 - S_0}.$$

The peso income of the firm increases less than proportionately with the size of the nominal devaluation. This assumption is essentially technical: it simplifies the analysis by making the problem concave (in a sense defined more precisely in the appendix). The analysis is not difficult to extend to the (convex) case where the direction of the inequality in the expression above is reversed.[12] However, it is important that the inequality be strict---otherwise, the problem becomes linear and perfect insurance is possible.

[12] The only difference is that the entrepreneur defaults in state 1 (small devaluation) instead of state 2 (large devaluation).

The equilibrium currency composition of debt is characterized as follows.

Proposition 4. *The minimum share of foreign currency debt in total debt is increasing with the devaluation probability* μ *. There are two thresholds in the devaluation probability,* $\underline{\mu}$ *and* $\overline{\mu}$*, such that*

(i) *if the devaluation probability is smaller than* $\underline{\mu}$ *, the entrepreneur issues no or little foreign currency debt and defaults with probability zero;*

(ii) *if the devaluation probability is between* $\underline{\mu}$ *and* $\overline{\mu}$ *, the level of foreign currency debt is high enough to trigger a default conditional on a large devaluation.*

(iii) *if the devaluation probability is larger than* $\overline{\mu}$ *, the entrepreneur cannot finance his project.*

The intuition runs as follows (the formal proof is given in Appendix I). If the fixed peg is perfectly credible ($\mu = 0$),the firm receives R_0 with certainty and there is no exchange rate risk. The firm can borrow in domestic currency and never defaults, provided that the project is profitable ($R_0 / S_0 > I^*$). The foreign and domestic currencies are perfectly substitutable and as a result the minimum share of the foreign currency in total debt is zero.

As the probability of a devaluation increases, so does the peso nominal interest rate. Given risk neutrality and free capital mobility, uncovered interest parity implies that the risk-free peso interest rate is given by

$$1 + i = \frac{E(S)}{S_0},$$

where the exchange rate is assumed to be equal to the fixed peg level S_0 in period 0.

Dollar debt is dangerous for the standard reason---it may bankrupt the firm if there is a large devaluation. However, domestic currency debt is also dangerous because it implies a high ex post real repayment in the *no-devaluation* state. There is a level of the peso interest rate above which the entrepreneur can no longer avoid default in all states. The firm is caught in a dilemma between issuing "too much" foreign currency debt—and defaulting conditional on a large devaluation—and issuing "too much" domestic currency debt—and defaulting conditional on the maintenance of the fixed peg. The entrepreneur chooses to default in the state that is less likely, which is the large devaluation state if the devaluation probability is small enough. This is achieved by issuing foreign currency debt.

Hence in equilibrium the firm issues "too much" foreign currency debt when the credibility of the fixed peg falls below a threshold. The level of foreign currency debt is excessive in the sense that it bankrupts the firm conditional on a large devaluation. While ex post this might look as a failure to hedge appropriately, the firm's behavior is in fact optimal ex ante, given the high interest rate on peso debt. It might seem counterintuitive that the firm stops hedging against the risk of a large devaluation precisely when this risk increases. However, this reflects optimal hedging, given that the hedging possibilities shrink at the same time as the risk increases.

Figure 3 provides a numerical illustration of Proposition 3.[13] As the devaluation probability increases so does the spread on peso debt. When the peso spread exceeds some threshold, the firm stops hedging against the risk of a large devaluation and borrows almost completely in foreign currency.[14] A spread appears in the interest rate at which the firm can borrow dollars because of the risk of default. However, the spread remains higher on peso debt, the difference being due to the risk of depreciation. Finally, if the devaluation probability is too high the firm cannot borrow at all because the net value of its project becomes negative.

Practitioners often entertain the view that foreign currency debt arises "simply" because the interest rate is so much higher on domestic currency debt. This argument is often dismissed by economists as a case of nominal illusion—the practitioner failing to see the difference between nominal and real interest rates. As this model shows, the practitioner's view makes perfect sense once it is interpreted as relating to the uncertainty in the ex post real interest rate, and there are bankruptcy costs. The variability in the *ex post* real interest rate explains why domestic currency debt is dangerous—potentially more so than foreign currency debt.

To conclude this section, let me note that the argument is not specific to fixed currency pegs. A floating exchange rate regime that lacks credibility could induce liability dollarization through the same channel as with a fixed peg. Let us assume that state 0, instead of being a fixed peg, is a managed floating exchange rate regime in which the monetary authorities let the exchange rate adjust to shocks within some range. That is, state 0 can be decomposed in a "cloud" of n sub-states $O_1,...,O_n$. The managed float is imperfectly credible in the sense that there is a risk of a very large depreciation (a free fall of the currency). Then if the peso interest rate increases because a large depreciation is perceived as more likely, domestic borrowers will dollarize their debts for the same reason as in the fixed peg case. Imperfectly credible floating exchange rates might not be very different, in this respect, from imperfectly credible fixed pegs.[15]

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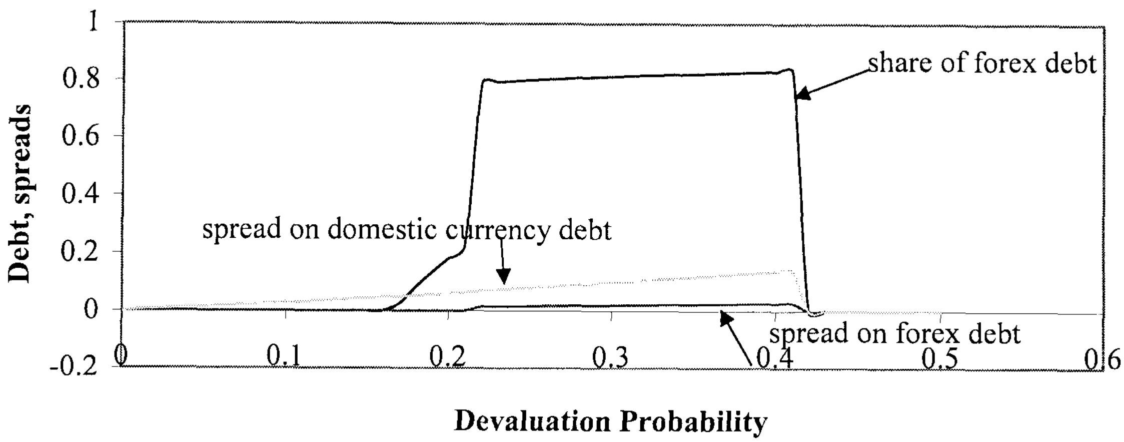
[13] Figure 3 was constructed using the following parameter values: $(S_0, S_1, S_2) = (1, 1.3, 5)$, $(R_0, R_1, R_2) = (1.05, 1.3, 2)$, $(p_1, p_2) = (0.9, 0.1)$ and $C = 0.1$.

[14] The shift involves a discontinuous upward jump in foreign currency debt because of the discontinuous increase in the default probability.

[15] Arteta's (2001) empirical study suggests that floating regimes exacerbate, rather than ameliorate, currency mismatches in domestic financial intermediation.

Figure 3. Devaluation Risk and Foreign Currency Debt



VIII. Sovereign Debt

The model has been applied so far to the currency composition of corporate debt. It would be nice if the analysis could somehow be extended to sovereign debt, since monetary credibility would then offer a unified explanation for the dollarization of private and public liabilities. This section presents a variant of the model that makes it applicable to sovereign debt.

Let us consider a country that needs foreign capital to exploit a natural resource. The country must invest I^* dollars in period 0 to produce a quantity of tradable good worth $R^* > I^*$ dollars in period 1. The domestic government finances the investment by selling sovereign debt to foreign investors. Like in the private debt model, the government promises to repay D pesos and D^* dollars in period 1. It actually repays if the output of tradable good is sufficiently high ($R^* > D^* + D/S$); otherwise the country defaults on its sovereign debt, and foreign creditors collect $R^* - C^*$, where C^* represents the cost of a sovereign default.

The difference with the case of a firm is that monetary policy is no longer exogenous: the government determines the exchange rate *S*. For simplicity, let me assume that the exchange rate is set in period 0 by an incumbent policy-maker who may or not stay in power in period 1. The incumbent policy-maker commits to a fixed exchange rate peg $S = 1$, conditional on his staying in power in period 1. Hence, if the policy-maker is certain to stay in power, foreign currency debt and domestic currency debt perfect substitutes and the minimum level of foreign currency debt is zero.

Assume however that with an exogenous probability μ, the incumbent policy-maker is replaced by an opportunist policy-maker who engineers hyperinflation so as to reduce the value of domestic currency debt to zero (effectively expropriating the foreign holders of domestic currency debt). For simplicity, hyperinflation is modeled as setting *S* to infinity, or equivalently *1/S* to zero. The incumbent policy-maker chooses the currency composition of sovereign debt given μ so as to minimize the probability of default.

For simplicity, let me further assume that R^* is known in period 0.[16] Because R^* is deterministic, the incumbent policy-maker can set the default probability to zero. A default-free sovereign debt structure must satisfy

$$\begin{cases} I^* = D^* + (1-\mu)D \\ D^* + D \leq R^* \end{cases}$$

[16] That R^* is constant implies that the country can perfectly hedge against a default, and that domestic currency debt cannot strictly dominate foreign currency debt. Like for a firm, the analysis can be extended to a stochastic R^*, but the optimal currency composition is then more complicated to derive.

The first equation is the zero-profit condition for lenders and the second equation ensures that maintaining the fixed peg does not trigger a default. Substituting D out gives

$$D^* \geq R^* - \frac{R^* - I^*}{\mu}$$

The minimum level of foreign currency debt increases with μ, from zero if $\mu \leq 1 - I^* / R^*$ to I^* for $\mu = 1$. The intuition is similar to the case of a firm. Domestic currency debt is dangerous if the fixed peg is maintained. As the credibility of the fixed peg decreases and the interest rate on peso debt increases, domestic currency borrowing must be reduced to avoid a default if the fixed peg is maintained.

There are several ways the model could be made more realistic as a model of sovereign debt, of course. The main purpose of the model in this section, however, was not realism. Rather, it was to show how the basic argument can be extended from private to sovereign debt with minimum changes to the model.

IX. A Look at the Data

This section takes a look at the data in light of the model. At this point it is important to distinguish between domestic and international original sins, i.e., between debt issued domestically and debt issued abroad. This distinction does not arise very naturally in my model, in which the jurisdiction under which debt is issued and the residency of investors are both irrelevant for the equilibrium currency composition of debt. But it cannot be avoided in assessing the relevance of the model for the real world.

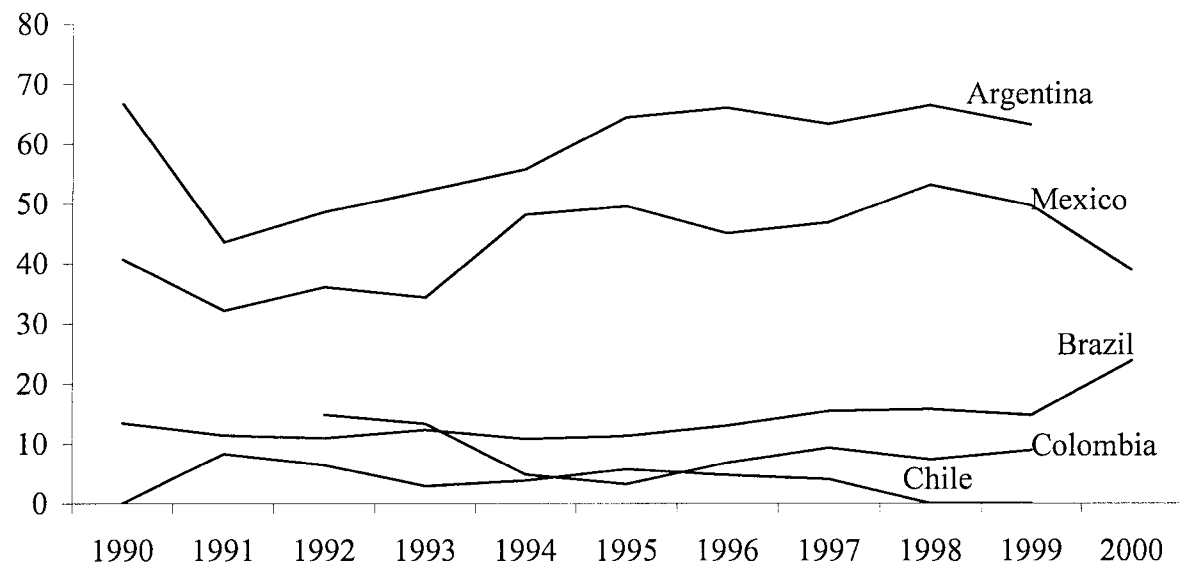
As documented by Hausmann and Panizza (2002) debt issued *abroad* by emerging market economies is overwhelmingly in foreign currency, and the little cross-country variations that exist do not seem to result from differences in countries' policies. By contrast, the extent of domestic debt dollarization differs a lot across countries. This is illustrated in Figure 4, showing the share of dollar debt in total liabilities of publicly traded firms in five Latin American countries.[17]

The contrast between domestic and international original sin is somewhat puzzling. Why is it that some borrowers can issue domestic currency debt domestically, but not under a foreign jurisdiction? One might conjecture that international original sin has more to do with the way the international financial system works at its center than with countries at the periphery. That is, the international original sin seems more about the way finance is done in New York,

[17] I thank Kevin Cowan and Hoyt Bleakley for sharing these data with me.

Figure 4. Dollar Debt, Percent of Liabilities

Share of dollar debt in total liabilities for a sample of publicly traded firms



Source: Bleakley and Cowan, based on Bloomberg/Economatica.

London or Tokyo than about the way monetary policy is done in Chile or Malaysia.[18] This said, one should not focus exclusively on the international segment of the debt market. The magnitude of the problems posed by the incompleteness of this particular market depends a lot on the alternative sources of credit. Countries in which borrowers can issue domestic currency debt in domestic markets are likely to suffer much less from international original sin.

Thus it seems important to include domestic debt in the empirical analysis. My aim here is to show that once domestic debt is included, a rough look at the data is rather encouraging for the monetary hypothesis. This evidence is meant as suggestive and much further research would be needed to actually test this hypothesis against alternatives.

One difficulty in measuring domestic original sin is the lack of a consistent cross-country data set on domestic debts in emerging market countries. I draw here on two data sources: the *JP Morgan Guide to Local Markets* compiled by Hausmann and Panizza (2002, Table 3), and the BIS data set used by Burger and Warnock (2003).[19] The Hausmann-Panizza data set covers domestic sovereign debt for 24 emerging market countries. The Burger-Warnock data set has a wider coverage in terms of debts and countries, since it includes domestic and foreign as well as private and public debt for 50 countries (including OECD countries).[20] The advantage of the Hausmann-Panizza data set is that it provides more detailed information on the structure of debt.[21] Both data sets give the amounts of debt outstanding at the end of 2001.

The model predicts that other things equal, countries with unpredictable monetary policies should have less domestic currency debt both in absolute terms and as a share of total debt. Thus, I define two indices for the development of the domestic currency debt market: *dev1* is the size of this market as a fraction of GDP, and *dev2* is its share in total debt. In the Hausmann-Panizza data set, *dev1* is defined as the ratio of long-term fixed rate domestic government bonds denominated in domestic currency to GDP; and *dev2* is the ratio of the same numerator to total outstanding domestic government bonds. The ratios are defined in the same way for the Burger-Warnock data set, except that the universe of debt is larger—it includes debt issued abroad and debt issued by the private sector.

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[18] Incidentally, the question is not only why countries do not issue domestic currency debt in London or New York, but also why they do not issue other forms of debt, like commodity-indexed or GDP-indexed bonds (Caballero, 2002; Borensztein and Mauro, 2002). Borensztein and Mauro give an interesting discussion of possible barriers to financial innovation in the international debt market.

[19] I thank Frank Warnock and John Burger for sharing these data with me.

[20] See Appendix II for the list of countries.

[21] The Hausmann-Panizza data provide four categories of domestic currency debt: long-term fixed rate, short-term fixed rate, short-term or long-term indexed to the interest rate, and long-term indexed to prices. Long-term fixed rate debt is the best empirical counterpart for domestic currency debt in my model.

I look at the cross-country correlation between these indices and monetary instability, proxied by the volatility of inflation. To the extent that the volatility of inflation makes the ex post real interest rate more difficult to predict, it provides an appropriate measure of the determinant of liability dollarization in the model. Figure 5 presents plots of *dev1* and *dev2* against the five–year conditional volatility of the inflation rate over the period 1965-2002. In all cases the relationship is negative, as predicted by the model. Simple OLS regressions suggest that this relationship is statistically significant in three out of four cases (see Table 2).[22] The relationship is also economically significant: according to the results in the first column of Table 2, lowering inflation volatility from the Brazilian to the Swedish level increases the domestic currency debt market from virtually zero to more than 50 percent of GDP. These results are broadly consistent with those of Hausmann and Panizza (2002), Burger and Warnock (2003) and Ize and Levy Yeyati (1998), who run similar regressions. Claessens, Klingebiel and Schmukler (2003) also find that higher inflation is associated with lower development of the domestic bond market and a lower share of foreign currency bonds.

There are of course a number of reasons that these regression results should not be necessarily interpreted as causality from inflation volatility to liability dollarization. The causality could run the other way, for example because of the disciplining effect of foreign currency debt. The relationship could also be driven by common factors.[23] These caveats notwithstanding, a preliminary look at the data seems sufficiently encouraging for the monetary hypothesis to justify more rigorous testing in future research.

Table 2. Domestic Currency Debt and Monetary Credibility

	dev1–bw	dev2–bw	dev1–hp	dev2–hp
Vol—cpi	-0.123**	-0.050	-0.036*	-0.156**
	(2.34)	(1.62)	(1.77)	(7.23)
Constant	0.542	0.788	0.157	0.663
Observations	50	50	16	16

Absolute value of t statistics in parentheses.
*Significant at 10 percent
**Significant at 5 percent
dev1 is the ratio of domestic currency debt to GDP and dev2 is the ratio of domestic currency debt to total debt. Columns 1 and 2 use the Burger-Warnock data set; columns 3 and 4 the Hausmann-Panizza data set.

[22] The small number of observations in the Hausmann-Panizza data makes it difficult to take the significance test seriously, though.
[23] For example, Burger and Warnock (2003) find that the impact of monetary variables on liability dollarization is attenuated when a measure for the rule of law is added to the regressors.

Figure 5. Inflation Volatility and Domestic Currency Debt

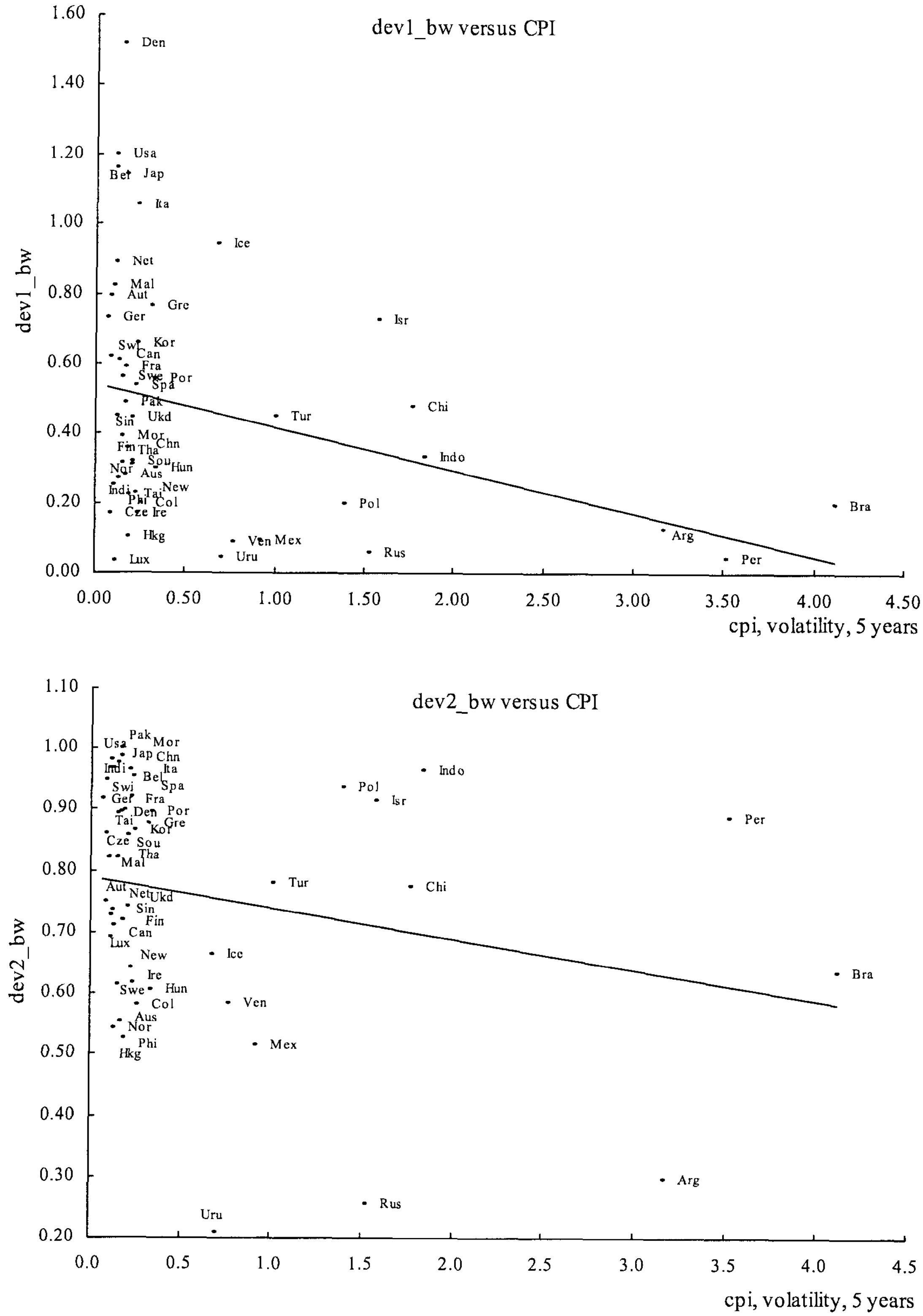
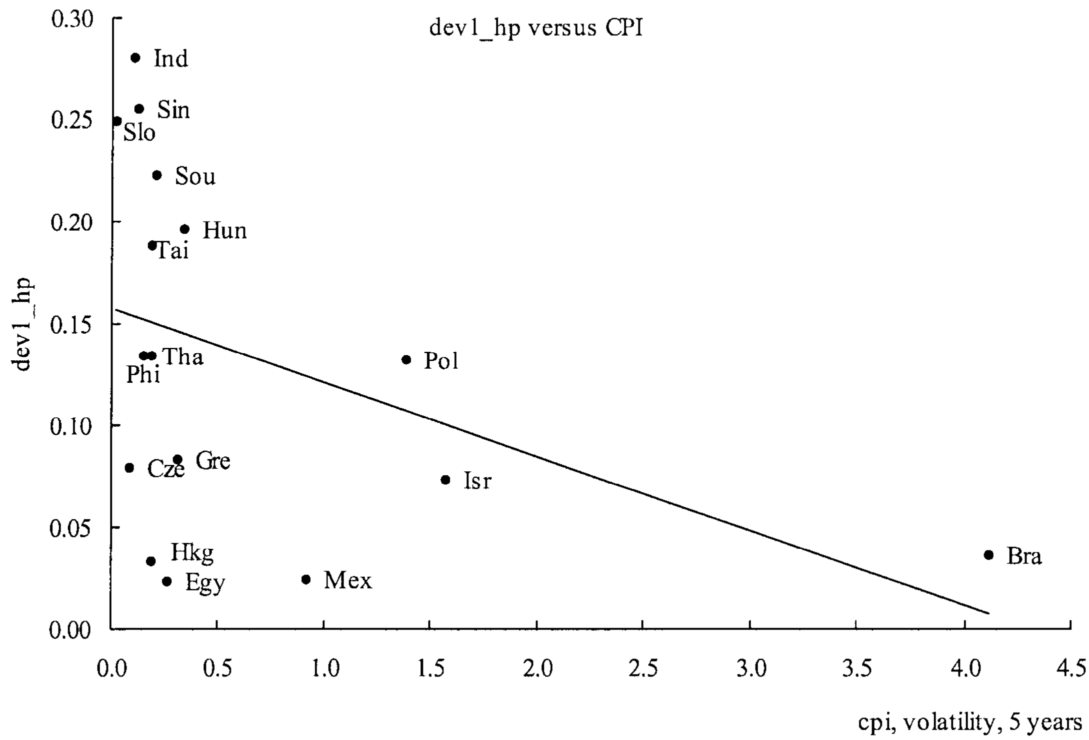
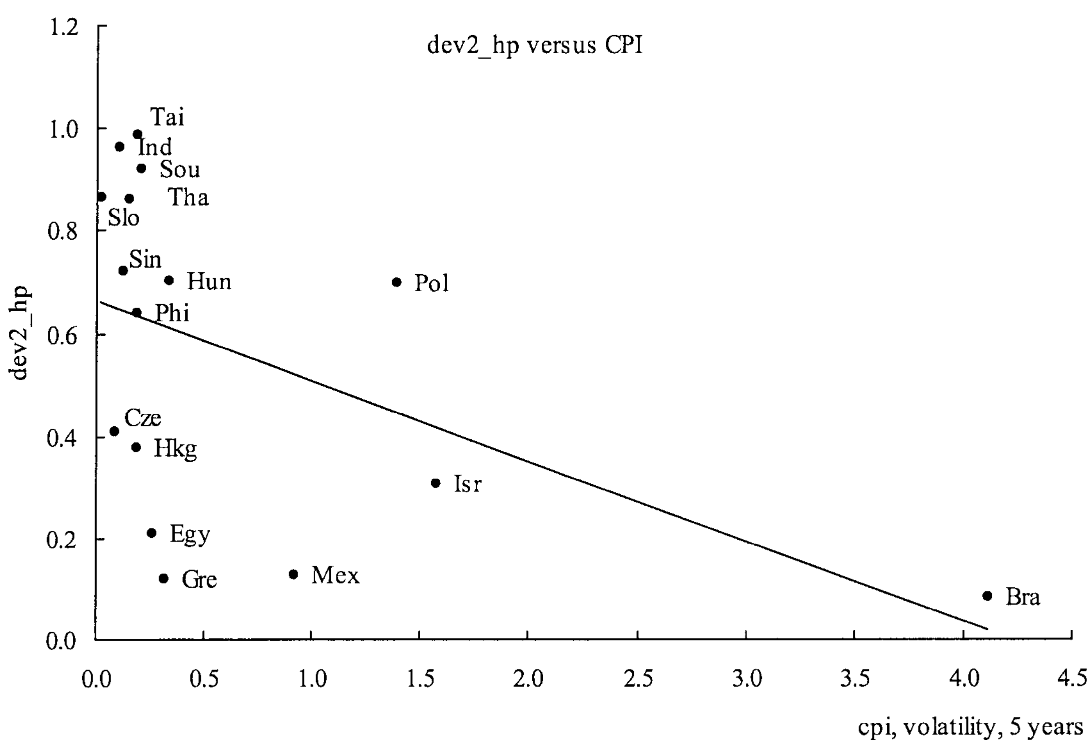


Figure 5 (continued). Inflation Volatility and Domestic Currency Debt





X. Policy Implications

A key policy question is how emerging market countries can graduate from original sin. I have presented a model in which original sin comes from the lack of monetary credibility. The policy implication, then, is straightforward: it is to establish a credible monetary regime. Improving monetary credibility should allow emerging market countries to issue more long-term domestic currency debt domestically, and thus reduce their reliance on foreign currency debt issued abroad.

That emerging economies should enhance the credibility of their monetary regime is certainly not a new policy recommendation. However, this paper highlights a new benefit of credibility. Monetary credibility induces domestic firms to borrow in domestic currency ex ante, which enhances the leverage of monetary policy ex post. Conversely, the lack of credibility induces liability dollarization, which reduces the benefit of monetary autonomy. This reinforces the standard arguments in favor of monetary credibility.

Some have advocated a *regulatory approach* to the problems posed by foreign currency debt, such as taxing, or forbidding international bank lending in foreign currency (see, e.g., Krueger, 2000; Goldstein, 2002). It is easy to see that this approach does not work in my model: for example, taxing foreign currency debt unambiguously decreases the welfare of entrepreneurs since the currency composition of debt is efficient *ex ante* conditional on monetary policy. For the regulatory approach to work, it needs some kind of externality, and the model has none. Of course, one can think of various negative externalities potentially associated with foreign currency debt.[24] However, if the core of the problem is the lack of monetary credibility, the regulatory approach is unlikely to be at the core of the solution. The solution is to establish a credible monetary framework.

There are important questions related to transition policies. A large literature focuses on the institutional reforms that may enhance monetary credibility. While these measures are certainly desirable in the class of models I have presented, monetary credibility is not established overnight in the real world, but as the outcome of a time-consuming process of building up reputation and institutions. One question, then, is what are the optimal transition policies with regard to the original sin? I shall come back to this question at the end of the paper.

XI. Concluding Thoughts and Directions for Further Research

A. Monetary Policy and Debt Structure

This paper has looked at the choice between domestic currency and foreign currency debt. However, there are other alternatives, such as indexed debt or short-term debt, which, provides a form of indexation. Indeed, we observe a lot of variety in the structure of domestic debt in emerging market economies. The large differences between Argentina, Brazil, and

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[24] An important source of externality could be financial contagion.

Chile shown in Figure 4, for example, reflect in part the importance of short-term domestic currency debt in Brazil and of inflation-indexed debt in Chile. The approach, then, could be extended by looking at the impact of monetary factors on domestic liability structures more broadly defined.

B. Nonlinear Hedging

The hedging strategies were limited in my model to the choice of the currency composition of debt. The hedging possibilities could be extended by allowing firms to use derivative instruments.[25] For example, one can check that in the three-state example of Section VII, an option to sell pesos at a strike price between S_1 and S_2 allows the entrepreneur to hedge perfectly.

When the number of states increases, however, so must the number of options to achieve perfect insurance. To the extent that options are costly, it should remain true that, other things equal, less monetary credibility leads to less insurance and more financial fragility. It would be interesting to see how the results can be generalized to the case where foreign exchange derivative markets are available.

C. General Equilibrium

The partial equilibrium model presented in this paper could be used as a building block in a more general equilibrium approach to endogenizing liability dollarization. First, the joint distribution of firms' receipts and the exchange rate could be endogenized in a general equilibrium model with money. It would be interesting, in such a model, to quantify and compare the extent of liability dollarization in the tradable and nontradable sectors. It would also be possible to quantify the welfare loss that a noncredible monetary policy can inflict through the channels emphasized in this paper.[26]

In a multi-good model, foreign and domestic investors will not assess portfolio returns with the same price indices, so that the question of the allocation of domestic and foreign currency debt in domestic and foreign portfolios is no longer trivial. It would be interesting to study the extent to which such taste differences can explain a "home bias" in the currency composition of portfolios. This could constitute a first step toward explaining the differences between domestic and international original sins.

The two extensions above can be pursued taking monetary policy as exogenous. Another question for further research is to better understand the reverse causality, from liability dollarization to monetary policy. This question has been studied in several papers on the

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[25] See Albuquerque (2001) for a comparison of forwards and options in hedging exchange risk in the presence of bankruptcy costs.

[26] Mendoza (2001) calibrates the welfare cost of lack of policy credibility in an open economy model with financial frictions, and finds it to be significant.

disciplining role of private foreign currency debt (e.g., Chamon and Hausmann, 2002; Tirole, 2002; Gale and Vives, 2002).

D. Another Interpretation of the Original Sin

Eichengreen and Hausmann (1999) use the term "original sin" to convey the idea that emerging market economies are condemned to foreign currency debt because of the way international finance works, not because of faulty domestic policies. I have argued that while this may be true for debt issued abroad, one may not need to look much further than domestic monetary policy to find an explanation for domestic original sin.

This does not mean, however, that redemption from domestic original sin is quick and easy. Establishing monetary credibility is a time-consuming process, and this process may be made more difficult by liability dollarization. One difficulty is that the government's behavior when liabilities are dollarized might give little information on how it would behave if liabilities were in domestic currency—and the temptation to inflate were greater.[27] This might create a "credibility barrier" between less developed and developed countries. For countries with low credibility, full dollarization might be a better option than attempting to overcome the barrier. Thus, even the domestic original sin could be determined in the long run by history and initial conditions.

[27] This idea is formalized in independent work by Cowan and Do (2003).

PRELIMINARIES

It is useful to distinguish two classes of problems *(P)*, the concave and convex ones. But in order to do so, I must first define the lower envelope of states in the space (S, R). Let me remove from X all the states x such that there is another state $x' \neq x$ with the same exchange rate but a strictly lower return ($S(x) = S(x')$ but $R(x') < R(x)$). (That is I remove points like A in Figure 1.) This leaves me with a subset of states $X' \subset X$. Then let me define the locus *(C)* as the curve joining all the points in X'. This curve is piece-wise linear if there is a finite number of states in X', but could be smooth if X' includes a continuum of states.

I say problem *(P)* is globally concave if curve *(C)* is globally concave, and globally convex if *(C)* is globally convex (Figure 6 illustrates the concave case). In general, it could be that problem *(P)* is neither globally convex nor globally concave because *(C)* is convex in some parts and concave in others. However, problems that are globally convex or concave have nice properties (the concave variety more so).

In particular, the maximum pledgeable income of the entrepreneur $\hat{V}$ is quite easy to compute when problem *(P)* is concave. The corresponding debt structure is such that the no-default constraint $D + D^* S(x) \leq R(x)$ is binding for the two extreme states corresponding to the lowest and highest levels of the exchange rate in X' (points A and C in Figure 6). If the no-default constraint is satisfied for these two states, then it is strictly satisfied for all other states by concavity of *(C)*.

If the firm's debt structure is not default-free, then the states in which the firm defaults also depend on the nature of problem *(P)*. If this problem is concave, the firm will default in extreme states, with the highest or lowest exchange rates. By contrast, if *(P)* is convex, the firm will default in intermediate states.

PROOF OF PROPOSITION 4

The model given in Section VII is a concave problem with three states. It can be represented like in Figure 7. The default-free debt structure (D, D^*) that maximizes the firm's pledgeable income is such that the line $R = D + D^* S$ goes through points 0 and 2. The firm's pledgeable income is

$$\hat{V} = E\left(\frac{R}{S}\right) - \mu p_1 \eta$$

where η is the gap between the dollar income of the firm and its dollar repayment in state 1. If one writes S_1 as a weighted average of S_0 and S_2 with weights $1 - \lambda$ and λ respectively, this gap is equal to

Figure 6. The Concave Case

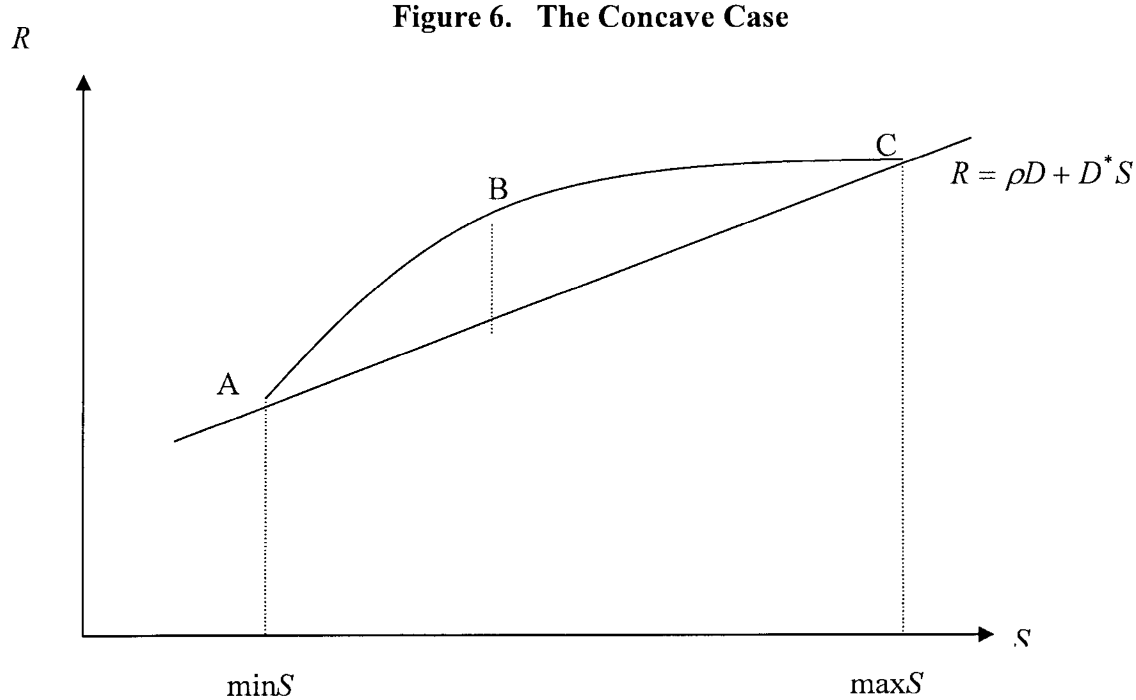
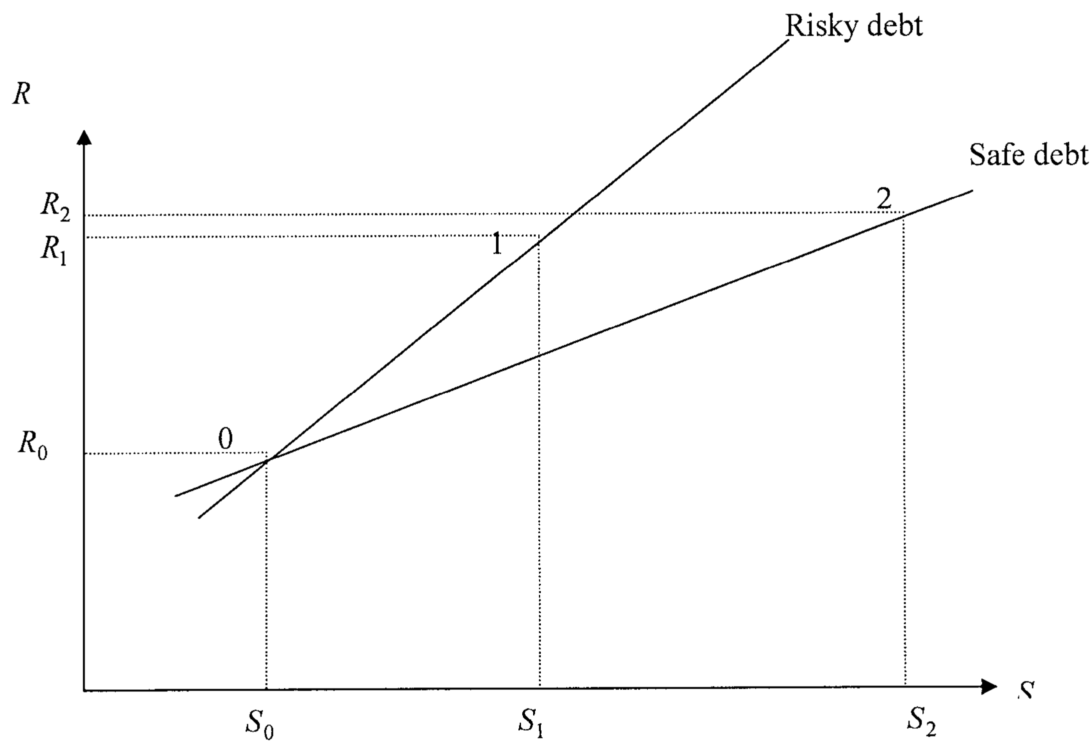


Figure 7. Proof of Proposition 4.



$$\eta = \frac{R_1 - (1-\lambda)R_0 - \lambda R_2}{S_1}$$

Because the problem is concave, if $\hat{V} < I^*$ the entrepreneur must choose between defaulting in state 0 (no devaluation) and defaulting in state 2 (large devaluation). As long as the probability of a devaluation μ is lower than $1/(1+p_2)$, the entrepreneur chooses to default in the large devaluation state. Conditional on this, the debt structure (D, D^*) that maximizes the firm's pledgeable income is achieved when the line $R = D + D^*S$ goes through points 0 and 1. The expected repayment is then given by the project's expected return net of the cost of default in state 3:

$$\widetilde{V} = E\left(\frac{R}{S}\right) - \mu p_2 C^*$$

The firm's maximum pledgeable income is larger under a risky debt structure if the expected default cost is not too large. That is, $\hat{V} > \widetilde{V}$ if and only if

$$p_2 C^* < p_1 \eta$$

a condition that I assume to be satisfied. Then, the proof of Proposition 4 easily follows. The thresholds $\underline{\mu}$ and $\overline{\mu}$ are the values of μ for which $\hat{V}$ and $\widetilde{V}$ are equal to I^* respectively. Let us denote by $\gamma \equiv \mu(R_0/S_0 - p_1R_1/S_1 - p_2R_2/S_2)$ the decrease in the project's dollar return resulting from a devaluation, and by $\beta \equiv R_0/S_0 - I^*$ the net benefit of the project conditional on no devaluation. Then it follows from $E(R/S) = I^* + \beta - \mu\gamma$ that the probability thresholds $\underline{\mu}$ and $\overline{\mu}$ are given by

$$\underline{\mu} = \frac{\beta}{\gamma + p_1\eta}, \quad \overline{\mu} = \frac{\beta}{\gamma + p_2 C}.$$

Burger-Warnock Data (bw)		Hausmann-Panizza data (hp)	
country	acode	country	acode
Argentina	Arg	Brazil	Bra
Austria	Aut	Hong Kong SAR	Hkg
Australia	Aus	Czech Republic	Cze
Belgium	Bel	Egypt	Egy
Brazil	Bra	Greece	Gre
Canada	Can	Hungary	Hun
Switzerland	Swi	India	Ind
Chile	Chi	Israel	Isr
China	Chn	Mexico	Mex
Colombia	Col	Philippines	Phi
Czech	Cze	Poland	Pol
Germany	Ger	Singapore	Sin
Denmark	Den	Slovak Republic	Slo
Spain	Spa	South Africa	Sou
Finland	Fin	Taiwan Province of China	Tai
France	Fra	Thailand	Tha
Greece	Gre		
Hong Kong SAR	Hkg		
Hungary	Hun		
Indonesia	Indo		
Ireland	Ire		
Israel	Isr		
India	Indi		
Italy	Ita		
Japan	Jap		
Korea	Kor		
Luxembourg	Lux		
Morocco	Mor		
Mexico	Mex		
Malaysia	Mal		
Netherlands	Net		
Norway	Nor		
New Zealand	New		
Peru	Per		
Philippines	Phi		
Pakistan	Pak		
Poland	Pol		
Portugal	Por		
Russia	Rus		
Sweden	Swe		
Singapore	Sin		
Thailand	Tha		
Turkey	Tur		
Taiwan Province of China	Tai		
United Kingdom	Ukd		
Venezuela	Ven		
South Africa	Sou		
Iceland	Ice		
United States	Usa		
Uruguay	Uru		

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