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EXCESSIVE LIABILITY DOLLARIZATION IN A SIMPLE SIGNALING MODEL

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EXCESSIVE LIABILITY DOLLARIZATION
IN A SIMPLE SIGNALING MODEL

Damien BESANCENOT and Radu VRANCEANU

ABSTRACT :

If a dollar denominated external debt comes with so many risks, why do emerging economies allow for such an imbalance to accumulate ? The explanation provided in this paper builds on a simple signaling model. By assumption, lenders have no direct possibility to infer a firm's financial stance. Therefore sound firms might want to borrow dollars and bear a high clearance cost, just in order to signal their type. The success of this policy depends on the behavior of bad firms. When dollar borrowing clearance costs are relatively small with respect to the clearance cost of borrowing in the local currency, the whole private sector would opt for liability dollarization. In this case the signaling effect vanishes, while all firms bear high clearance costs.

Key-Words :

- Original sin
- Signaling
- Developing countries
- Liability dollarization
- Perfect Bayesian Equilibrium

RESUME :

L'article propose une explication à l'accumulation des dettes externes libellées en dollars par les PVD, dans le cadre d'un modèle de signalisation. Par hypothèse, les banques n'ont aucun moyen direct de déterminer la situation financière des firmes. Les firmes solides seraient tentées de s'endetter en dollars moyennant des coûts administratifs élevés uniquement pour signaler leur type. Le succès d'une telle politique dépend du comportement des firmes fragiles : si le coût administratif lié à l'emprunt en dollars est faible, le secteur privé dans son ensemble peut choisir la dollarization. Dans ce cas, l'effet de signal disparaît, tandis que toutes les firmes subissent des coûts administratifs élevés.

Mots-clés :

- Péché originaire
- Théorie du signal
- PVD
- Dollarization des dettes
- Equilibre Bayésien parfait

Jel Classification : D82, E44, F34, 016.

1 Introduction

In the early nineties, following the example of developed countries and the advice of main international financial organizations, developing countries gradually removed barriers on international movements of capital. In particular, their private sector was allowed to attract foreign savings. In this context, many countries from Latin America, South-East Asia and Eastern Europe accumulated public and private external debts that often exceed 30% of their GDP. Moreover, essentially all the external debt of non-OECD countries is denominated in a foreign currency (in general, in dollars).[1]

After the wave of financial and exchange rate crises that hurt the developing world in the late years (Mexico, Southeast Asia, Russia and Bulgaria, Argentina, etc.) economists start worrying about risks that incurs a developing country which runs an important dollar debt, an imbalance that is often referred to as the "original sin" so as to emphasize its primordial role (Eichengreen and Hausman, 1999). Various risks may be connected to a significant dollar debt, in particular if the international value of the local currency can slide down. Obviously, the local currency depreciation would put additional strain on the debt service (Rogoff, 1999; Calvo and Reinhart, 2002). Furthermore, when firm or bank assets are denominated in the local currency, currency depreciation erodes their net worth; as a consequence, the corporate sector may put a brake on investment, which in turn depresses global demand and would self-enforce a demand-driven crisis (Krugman, 2000; Aghion et al., 2001; Jeanne and Zettlemeyer, 2002). Besancenot and Vranceanu (2003) have shown that under extreme exchange rate volatility specific to clean floating, the non-tradable sector may be vulnerable to illiquidity crises even if it runs only a small dollar debt.

If dollar debt is so dangerous, why did it spread so much? Caballero and Krishnamurthy (2001) argue that many emerging economies can rely only on foreign investors since their domestic financial system is underdeveloped. In other line of argument, liability dollarization serves as a commitment device. For instance, Calvo (2001) and Cowan and Do (2003) suggest that a government may issue a dollar debt just to reveal its preferences for a stable exchange rate,

[1] Many studies document on this surge in dollar denominated external private debts. See Rogoff (1999), Calvo (2001), Eichengreen and Hausman (1999), Eichengreen et al. (2002), Cowan and Do (2003), Ize and Yeyati (2003), Reinhart et al. (2003).

since any devaluation would impose a cost. The amount of dollar debt may even turn out to be 'excessive' if it prevents the central bank from implementing the first best optimum monetary policy. According to Jeanne (2000), borrowing in foreign currency is more dangerous for local entrepreneurs since it increases the probability of terminating their activity; therefore, those who borrow dollars have a strong incentive to provide a superior level of effort; yet this strategy may be optimal since lenders would agree on a lower interest rate.

The explanation provided in this paper builds on the signaling approach such as pioneered by Spence (1973).[2] We consider an emerging economy where the corporate sector is made up of many firms of two distinct types, called "good" and "bad". Bad firms present a higher probability of default than the good ones. The local currency unit will be denoted "peso", and the foreign currency will be denoted "dollar". For simplicity, it is assumed that the peso/dollar exchange rate is irrevocably fixed; this framework is a workable approximation for situations where the government does not allow the exchange rate to fluctuate too much. As Calvo and Reihnart, (2002) have shown, this "fear of floating" seems to be an ubiquitous characteristic of emerging economies. Firms need to borrow one peso (or one dollar) per period to finance their activity. Banks have no direct mean to find out whether they face a high or low risk firm. This assumption is not irrealistic. If banks face so many difficulties to asses the quality of Western companies (think to typical cases like Enron, WorldCom and Parmalat), it is highly probable that the challenge of determining the quality of a firm located in a developing country is even bigger.[3] Yet all banks have their specific lending procedure (involving file and documents processing, meetings, etc.); complying with these administrative requirements entails a so-called "clearance cost" for the firm. The lending procedure of local banks implies a low clearance cost, which, to keep the problem as simple as possible, is assumed to be identical for all firms, good or bad. In general, dollar borrowing implies a higher clearance cost than peso borrowing. Furthermore, it is assumed

[2] See also Spence (2002) for a comprehensive survey on signaling models.

[3] Newspapers abound in comments on how difficult is the task or rating agencies in the developing countries. For instance, it seems that "international credit rating companies charging into China are operating in such darkness that many investors question the value of their work in the country" and that "faulty accounting, poor corporate governance and a lack of disclosure hamper the raters' efforts" (Joel Bagole, Credit-Rating work in China is Iffy Business, Wall Street Journal, January 6, 2004).

that the dollar clearance cost is higher for the bad firms than for the good ones.

This game presents a Perfect Bayesian Equilibrium in which lenders' beliefs and optimal borrowing strategies of the firms are mutually consistent. Interest rates are endogenous; they reflect the solvency risk perceived by the lenders given the observed debt policy. The nature of the equilibrium depends on the relative size of various clearance costs. We put forward two pooling equilibria in which all firms borrow in the same currency (i.e., either pesos or dollars), a separating equilibrium where good firms borrow dollars and bad firms borrow pesos, and two hybrid equilibria, one where all the bad and some good firms borrow pesos and one where all the good and some bad firms borrow dollars.

In particular, a good firm may bear the higher clearance cost connected to dollar borrowing only to signal its type, and hope to benefit from a lower interest rate. Yet, under certain conditions, bad firms may wish to take advantage of the lower interest rate specific to dollar borrowing and accept bearing a high clearance cost too. This situation of full dollarization of liabilities is clearly inefficient, since the signaling effect is absent, while all firms are subject to higher clearance costs than in the peso pooling case.

The paper is organized as follows. In the next section we introduce the main assumptions and describe the set of strategies and beliefs. Section 3 introduces the main equilibria and the necessary conditions of existence. Conclusions are presented in Section 4.

2 The model

2.1 Basic assumptions

The model features a developing country where local firms finance themselves by borrowing from local or foreign banks. The local currency unit is denoted peso, the foreign currency unit is denoted dollar. For simplicity, it is assumed that one peso is worth one dollar. The exchange rate being irrevocably fixed, there is no exchange rate risk. Continuation of a firm's productive activity for one period requires either one peso, or one dollar (the firm cannot split the credit between two currencies). Local bank lend pesos and foreign bank lend dollars.[4]

[4] Calvo (1999) emphasizes that foreign banks have an institutional requirement to denominate their assets in the same currency as their liabilities.

Firms differ in their risk of default. To further simplify the analysis, is assumed that the set of firms is made up of only two distinct types: the so-called $b - firms$ (for "bad"), present a high probability of default, π^b; the others, called $g - firms$ (for "good"), present a low probability of default π^g, with $\pi^b > \pi^g$. The type t of a firm is therefore defined according to the probability of default, i.e. $t \in \{b, g\}$. The frequency of $b - firms$ is m, thus $1 - m$ is the frequency of $g - firms$.

The lenders (banks) know the distribution of types in the total population of firms, but have no direct mean to determine the probability of default of a potential client. To get a credit, firms should comply with a lending procedure (file processing, formal and informal meetings, providing documents), involving a so-called "clearance cost". This cost depends on the nature of the credit (dollar or peso) and on the type of firm. It is assumed that:

a) borrowing dollars implies a higher clearance cost for a $b - firm$ than for a $g - firm$;

b) borrowing pesos implies the same clearance cost, whatever the type of the firm;

c) the clearance cost related to peso borrowing is lower than the clearance costs related to dollar borrowing.

Let the c_N (the index N stands for national) denote the monetary equivalent of the clearance cost related to peso borrowing and $c_{\$}^t$ the monetary equivalent of the clearance cost related to dollar borrowing of a type t firm. The above mentioned conditions can then be written in the compact form:

$$0 \leq c_N \leq c_{\$}^g < c_{\$}^b. \tag{1}$$

It should be emphasized that the clearance cost is a deadweight loss, whose signaling virtues are only implicit, given the posited relationship between the "quality" of the firm and the costs connected to the grant procedure. Banks may also ask for external certification, financial audit reports and so on. In this model, these actions cannot reveal the firms' type and may be considered as a clearance cost; in other words, a bad firm could provide a good report provided that it spends money and effort to get a false statement.

Assumption (a) is thus crucial for the model. Assumption (b) was made only to keep the model to its simplest form; the structure of the problem would not change if the clearance cost of borrowing pesos were different between b and $g - firms$, i.e. $c_N^g < c_N^b$. Assumption (c) is a plausible conjecture; the opposite situation could be analyzed following the same methodology.

2.2 The strategy of the firm

From the firm's point of view, two debt policies are feasible:

- borrow pessos (from a local bank); this policy is denoted by s_N;

- borrow dollars (from a foreign bank); this policy is denoted by $s_{\$}$.

The set of policies is therefore $\{s_N, s_{\$}\}$.

We define the strategy S of a firm as the choice of the best debt policy contingent upon its type. The best policy minimizes the total borrowing cost.

2.3 Lenders' strategy

Denoting by p (respectively q) the probability that lenders assign to a firm that borrows pesos (respectively dollars) to be "bad", the common set of beliefs can be written:

$$\Theta = \begin{cases} \Pr[t = b|s_N] = p \\ \Pr[t = b|s_{\$}] = q \end{cases}. \tag{2}$$

Let $\rho \geq 0$ denote the risk free international interest rate and let r_i be the interest rate required for the debt policy s_i, with $i = \{\$, N\}$. To simplify calculus, we assume that in case of default, the value of the debt becomes zero; in the context of developing countries, this assumption is not probably very far from reality.

With risk-neutral lenders, the standard zero trade-off condition can be written:

$$(1 + \rho) = (1 + r_i)(1 - \Pr[\text{default } |s_i]), \tag{3}$$

or, in an equivalent form:

$$1 + r_i = \frac{1 + \rho}{1 - \Pr[\text{default } |s_i]}. \tag{4}$$

Lenders who observe a firm choosing s_i will asses the probability of default:

$$\Pr[\text{default } |s_i] = \Pr[\text{default}|t = b] \Pr[t = b|s_i] + \Pr[\text{default}|t = g] \Pr[t = g|s_i]. \tag{5}$$

More specifically, if the firm borrows pesos (s_N), the contingent probability becomes:

$$\Pr[\text{default } |s_N] = \pi^b p + \pi^g (1 - p). \tag{6}$$

The interest rate required by the local bank (r_N) is implicitly defined by:

$$(1 + r_N) = \frac{(1 + \rho)}{1 - \pi^b p - \pi^g (1 - p)}. \tag{7}$$

If the firm borrows dollars ($s_\$$), the probability of default is:

$$\Pr[\text{default } | s_\$] = \pi^b q + \pi^g (1 - q).$$

The interest rate on dollar debt ($r_\$$) is implicitly defined by:

$$(1 + r_\$) = \frac{(1 + \rho)}{1 - \pi^b q - \pi^g (1 - q)}. \tag{8}$$

Given these interest rates, and the existence of clearance costs connected to various forms of borrowing, the overall cost of the debt is:

- $(1 + c_N)(1 + r_N)$, for a firm borrowing pesos;
- $(1 + c_\$^t)(1 + r_\$)$, with $t \in \{b, g\}$, for a firm borrowing dollars.

In other words, firms will borrow not only the one peso (or one dollar) directly related to the productive activity, but also the resources necessary to cover the clearance cost.

3 Equilibria

An equilibrium exists if all firms implement their best policy given lenders' beliefs Θ, and lenders' beliefs are correct given S. This game presents several types of equilibria: separating, pooling and hybrid, depending on whether the type of a firm can or cannot be inferred from the observed debt policy.

3.1 Separating equilibrium

A separating equilibrium occurs if the borrowing policy unambiguously signals the type of the firm. With two types of firms and two policies available, in a separating situation either good firms borrow dollars and bad firms borrow pesos, or the reverse, good firms borrow pesos and bad firms borrow dollars. It can be shown that the second situation is impossible (see Appendix). We study hereafter the first case.

If banks interpret the desire to borrow dollars as a signal that the firm is of the $g - type$ (low probability of default) and conversely, interpret the desire to borrow pesos as a signal that the firm is of the $b - type$ (has a high probability of default), their beliefs can be written as:

$$\Theta = \begin{cases} \Pr[\texttt{t=b} \; |s_N] = p = 1 \\ \Pr[\texttt{t=b} \; |s_{\$}] = q = 0 \end{cases}.$$

We study now under which conditions this system of beliefs is correct, that is under which conditions $s_{\$}$ is the best policy of the $g - firms$ and s_N is the best policy of the $b - firms$.

Interest rates were defined in equations (7) and (8). Given lenders' beliefs, firms borrowing pesos are asked an interest rate:

$$1 + r_N = \frac{1+\rho}{1-\pi^b}. \tag{9}$$

and firms borrowing dollars are required an interest rate:

$$1 + r_{\$} = \frac{1+\rho}{1-\pi^g}. \tag{10}$$

Remark that $r_{\$} < r_N$.

A $b - firm$, borrowing pesos, has no incentive to deviate from the s_N policy if:

$$(1+r_N)(1+c_N) \quad < \quad (1+r_{\$})(1+c^b_{\$}) \Longleftrightarrow \tag{11}$$

$$\frac{(1+c^b_{\$})}{(1+c_N)} \quad > \quad \frac{(1+r_N)}{(1+r_{\$})}. \tag{12}$$

Let us denote by $C^b \equiv \frac{(1+c^b_{\$})}{(1+c_N)}$, with $C^b \geq 1$. Replacing in condition (12) interest rates such as defined in (9) and (10), the condition can be restated as:

$$C^b > \frac{1-\pi^g}{1-\pi^b}. \tag{13}$$

A $g - firm$, borrowing dollars, has no incentive to deviate from $s_{\$}$:

$$(1+r_{\$})(1+c^g_{\$}) \quad < \quad (1+r_N)(1+c_N) \Leftrightarrow \tag{14}$$

$$\frac{(1+c^g_{\$})}{(1+c_N)} \quad < \quad \frac{(1+r_N)}{(1+r_{\$})}. \tag{15}$$

Let us denote by $C^g \equiv \frac{(1+c^g_{\$})}{(1+c_N)} > 1$. Then condition (15) can be written:

$$C^g < \frac{1-\pi^g}{1-\pi^b}. \tag{16}$$

Denoting by $\delta \equiv \dfrac{1-\pi^g}{1-\pi^b}$, where $\delta > 1$, the separating equilibrium is feasible if (13) and (16) jointly hold:

$$C^g < \delta < C^b. \tag{CS}$$

It should be emphasized that under our assumptions about the clearance costs (see Condition 1), it comes out that

$$1 \leq C^g < C^b. \tag{17}$$

3.2 Pooling equilibria

In a pooling situation all firms follow the same strategy, either $s_{\$}$ or s_N; banks cannot infer the firm's type, and ask a single interest rate including an average risk premium.

3.2.1 Pooling Eq.1. All firms borrow dollars (undertake policy $s_{\$}$)

In an undifferentiated situation, if lenders observe a firm which borrows dollars, it can assign a probability m of facing a $b-firm$; we assume that they consider that a firm who borrows peso is a bad firm[5] :

$$\Theta = \begin{cases} \Pr[\texttt{t=b} \; |s_N] = p = 1 \\ \Pr[\texttt{t=b} \; |s_{\$}] = q = m \end{cases}.$$

The peso interest rate is:

$$1 + r_N = \frac{1+\rho}{1-\pi^b} \tag{18}$$

and the dollar interest rate:

$$1 + r_{\$} = \frac{1+\rho}{1-\pi^b m - \pi^g(1-m)}. \tag{19}$$

We study now under which conditions this system of beliefs is correct. A $b-firm$, following policy $s_{\$}$, has no reason to deviate if:

$$(1+r_{\$})(1+c^b_{\$}) \quad < \quad (1+r_N)(1+c_N) \tag{20}$$

$$\Leftrightarrow \quad C^b < \frac{1-\pi^b m - \pi^g(1-m)}{1-\pi^b} \tag{21}$$

A $g-firm$, following $s_{\$}$, will never deviate if:

$$(1+r_{\$})(1+c^g_{\$}) \quad < \quad (1+r_N)(1+c_N) \tag{22}$$

$$\Leftrightarrow \quad C^g < \frac{1-\pi^b m - \pi^g(1-m)}{1-\pi^b}. \tag{23}$$

Given that $C^g < C^b$, and denoting $\theta \equiv \dfrac{1-\pi^b m - \pi^g(1-m)}{1-\pi^b}$, this equilibrium is feasible if:

$$C^b < \theta. \tag{CP\_1}$$

5 It can be shown that the system of beliefs where banks think that a firm that borrows pesos is good cannot be an equilibrium of this game.

3.2.2 Pooling Eq.2. All firms borrow pesos (follow s_N)

In an undifferentiated situation where all firms borrow pesos, lenders' beliefs are:

$$\Theta = \begin{cases} \Pr[\mathsf{t{=}b} \; | s_N] = p = m \\ \Pr[\mathsf{t{=}b} \; | s_{\$}] = q = 0 \end{cases}.$$

A firm that borrows pesos may be bad with probability m, and good with probability $1 - m$. If the firm borrows dollars, the probability that lenders assign to the event that the firm is bad is zero.[6]

Interest rates are:

$$1 + r_N = \frac{1 + \rho}{1 - \pi^b m - \pi^g (1 - m)}. \tag{24}$$

and:

$$1 + r_{\$} = \frac{1 + \rho}{1 - \pi^g}. \tag{25}$$

The system of beliefs is correct under the following conditions. A $b - firm$ which follows s_N will not deviate if:

$$(1 + r_N)(1 + c_N) \quad < \quad (1 + r_{\$})(1 + c^b_{\$}) \Leftrightarrow \tag{26}$$

$$C^b \quad > \quad \frac{1 - \pi^g}{1 - \pi^b m - \pi^g (1 - m)}. \tag{27}$$

The $g - firm$ which follows s_N will not deviate if:

$$(1 + r_N)(1 + c_N) \quad < \quad (1 + r_{\$})(1 + c^g_{\$}) \Leftrightarrow \tag{28}$$

$$C^g \quad > \quad \frac{1 - \pi^g}{1 - \pi^b m - \pi^g (1 - m)}. \tag{29}$$

Denoting by $\sigma \equiv \dfrac{1 - \pi^g}{1 - \pi^b m - \pi^g (1 - m)}$, with $\sigma > 1$, this equilibrium is feasible if:

$$C^g > \sigma \tag{C\_P2}$$

3.3 Hybrid equilibria

3.3.1 Hybrid Eq.1: all $g - firms$ and some $b - firms$ borrow dollars

In one possible hybrid equilibrium, all $g - firms$ borrow dollars; a fraction α of the $b - firms$ borrow pesos (s_N), while $(1 - \alpha)$ of the $b - firms$ borrow dollars as well. In such an equilibrium

[6] It can be shown that the opposite situation (where a firm that borrow dollars must be bad) is not sustainable as an equilibrium.

beliefs are:

$$\Theta = \begin{cases} \Pr[\mathsf{t{=}b}\ |s_N] = 1 \\ \Pr[\mathsf{t{=}b}\ |s_\$] = q \end{cases}.$$

where:

$$q = \Pr[\mathsf{t{=}b}\ |s_\$] = \frac{\Pr[s_\$|\mathsf{t{=}b}]\Pr[\mathsf{t{=}b}]}{\Pr[s_\$|\mathsf{t{=}b}]\Pr[\mathsf{t{=}b}] + \Pr[s_\$|\mathsf{t{=}g}]\Pr[\mathsf{t{=}g}]} \tag{30}$$

$$= \frac{(1-\alpha)m}{(1-\alpha)m + (1-m)} \in [0, m]. \tag{31}$$

We notice that q goes between 0 and m when α goes between 0 and 1.

Like in the previous cases, interest rates are:

$$1 + r_N = \frac{(1+\rho)}{1-\pi^b} \tag{32}$$

and

$$1 + r_\$ = \frac{1+\rho}{1-\pi^b q - \pi^g(1-q)} \tag{33}$$

In equilibrium, $b-firms$ should have no incentive to deviate from their optimal policy; this implies that costs of a $b-firm$ following the s_N policy are identical to costs of a $b-firm$ following the $s_\$$ policy:

$$(1+r_N)(1+c_N) = (1+r_\$)(1+c_\$^b) \tag{34}$$

Given that $C^b = \dfrac{(1+c_\$^b)}{(1+c_N)}$, this is equivalent to:

$$C^b = \frac{(1+r_N)}{(1+r_\$)} = \frac{1-\pi^b q - \pi^g(1-q)}{1-\pi^b} \tag{35}$$

or, for:

$$q = \frac{(1-\pi^g) - C^b\left(1-\pi^b\right)}{(\pi^b - \pi^g)}. \tag{36}$$

The equilibrium exists if $q \in [0, m]$:

$$q > 0 \Leftrightarrow C^b < \frac{(1-\pi^g)}{(1-\pi^b)} = \delta \tag{37}$$

$$q < m \Leftrightarrow C^b > \frac{1-\pi^b m - \pi^g(1-m)}{1-\pi^b} = \theta. \tag{38}$$

Let also check that a $g-firm$ following the $s_\$$ policy has no interest to deviate:

$$(1+r_\$)(1+c_\$^g) < (1+r_N)(1+c_N) \tag{39}$$

$$\Leftrightarrow C^g < \frac{1-\pi^b q - \pi^g(1-q)}{1-\pi^b} = C^b. \tag{40}$$

The latter inequality is always true under our assumptions.

Therefore this equilibrium is possible if:

$$\theta < C^b < \delta. \tag{CH\_1}$$

3.3.2 Hybrid Eq.2: all $b-firms$ and some $g-firms$ borrow pesos

We study now the feasibility of a hybrid equilibrium where all $b-firms$ follow the s_N policy, and where a fraction λ of the $g-firms$ borrow pesos, while the other $(1-\lambda)$ borrow dollars. In this context, beliefs are:

$$\Theta = \begin{cases} \Pr[\mathsf{t{=}b}\ |s_N] = p \\ \Pr[\mathsf{t{=}b}\ |s_\$] = 0 \end{cases}.$$

where:

$$p = \Pr[\mathsf{t{=}b}\ |s_N] = \frac{\Pr[s_N|\mathsf{t{=}b}]\Pr[\mathsf{t{=}b}]}{\Pr[s_N|\mathsf{t{=}b}]\Pr[\mathsf{t{=}b}] + \Pr[s_N|\mathsf{t{=}g}]\Pr[\mathsf{t{=}g}]} \tag{41}$$

$$= \frac{m}{m+\lambda(1-m)} \in [m,1]. \tag{42}$$

Interest rates are then:

$$1 + r_N = \frac{1+\rho}{1-\pi^b p - \pi^g(1-p)}. \tag{43}$$

and:

$$1 + r_\$ = \frac{1+\rho}{1-\pi^g}. \tag{44}$$

In equilibrium $g-firms$ have no incentive to deviate from their policy; this is possible if costs of the $g-firms$ borrowing dollars are identical to costs of the $g-firms$ borrowing pesos:

$$(1+r_N)(1+c_N) = (1+r_\$)(1+c_\$^g),$$

or, in an equivalent form, if:

$$C^g = \frac{(1+r_N)}{(1+r_\$)} = \frac{1-\pi^g}{1-\pi^g - p(\pi^b - \pi^g)}. \tag{45}$$

The probability p is:

$$p = \frac{(1-\pi^g)}{(\pi^b-\pi^g)}\frac{(C^g-1)}{C^g}. \tag{46}$$

An equilibrium can be put forward if $p \in [m, 1]$. This implies:

$$p > m \Longleftrightarrow C^g > \frac{1-\pi^g}{1-\pi^b m - \pi^g(1-m)} = \sigma \tag{47}$$

$$p < 1 \Longleftrightarrow C^g < \frac{1-\pi^g}{1-\pi^b} = \delta. \tag{48}$$

We also check that no $b - firm$ would deviate from the s_N strategy:

$$(1+r_N)(1+c_N) < (1+r_\$)(1+c_\$^b) \tag{49}$$

$$\Leftrightarrow \quad C^b > \frac{1-\pi^g}{1-\pi^g - p(\pi^b - \pi^g)} = C^g. \tag{50}$$

This is always true under the initial assumptions.

Therefore, this equilibrium is feasible if:

$$\sigma < C^g < \delta. \tag{CH_2}$$

4 A synthesis

Depending on the relative clearance costs C^b and C^g, and on parameters δ, σ and θ, one or several of the equilibria may occur. The table here below summarizes the main findings:

Separating	Only $g - firms$ ($b - firms$) borrow dollars (pesos)	$C^g < \delta < C^b$	(CS)
Pooling 1	All firms borrow dollars	$C^b < \theta$	(CP_1)
Pooling 2	All firms borrow pesos	$C^g > \sigma$	(CP_2)
Hybrid 1	Some $b - firms$ also borrow dollars	$\theta < C^b < \delta$	(CH_1)
Hybrid 2	Some $g - firms$ also borrow pesos	$\sigma < C^g < \delta$	(CH_2)

We recall the definition of the critical thersholds:

$$\begin{cases} \delta = \frac{(1-\pi^g)}{(1-\pi^b)} \\ \sigma = \frac{(1-\pi^g)}{1-\pi^b m - \pi^g(1-m)} \\ \theta = \frac{1-\pi^b m - \pi^g(1-m)}{(1-\pi^b)} \end{cases} . \tag{51}$$

It can be easily shown that $\delta > \theta$ and that $\delta > \sigma$. Then, we compare θ and σ :

$$\sigma = \frac{(1-\pi^g)}{1-\pi^b m - \pi^g(1-m)} < \frac{1-\pi^b m - \pi^g(1-m)}{(1-\pi^b)} = \theta \tag{52}$$

$$\Leftrightarrow \quad 0 < (1-\pi^g)(1-2m) + \left(\pi^b - \pi^g\right) m^2. \tag{53}$$

Let us write:

$$f(m) = (1 - \pi^g)(1 - 2m) + (\pi^b - \pi^g)\, m^2. \tag{54}$$

It can be noticed that $f(0) > 0, f(1/2) > 0$ and $f(1) < 0$. Hence, there is a root $\hat{m} \in [0.5, 1]$, so that for $m < \hat{m}$ then $\sigma < \theta$ and for $m > \hat{m}$ then $\sigma > \theta$. We analyze more in depth the situation where $\sigma < \theta$ (which would occur, for instance, if $m = 0.5$).[7] In this case, the three parameters can therefore be ranked:

$$1 < \sigma < \theta < \delta. \tag{55}$$

The regioning is depicted in Figure 1, where C^g (C^b) is represented on the horizontal (vertical) axis. Since $C^b > C^g$, only the region above the 45° line will be considered. Given that $C^g \geq 1$, the origin is set at 1.

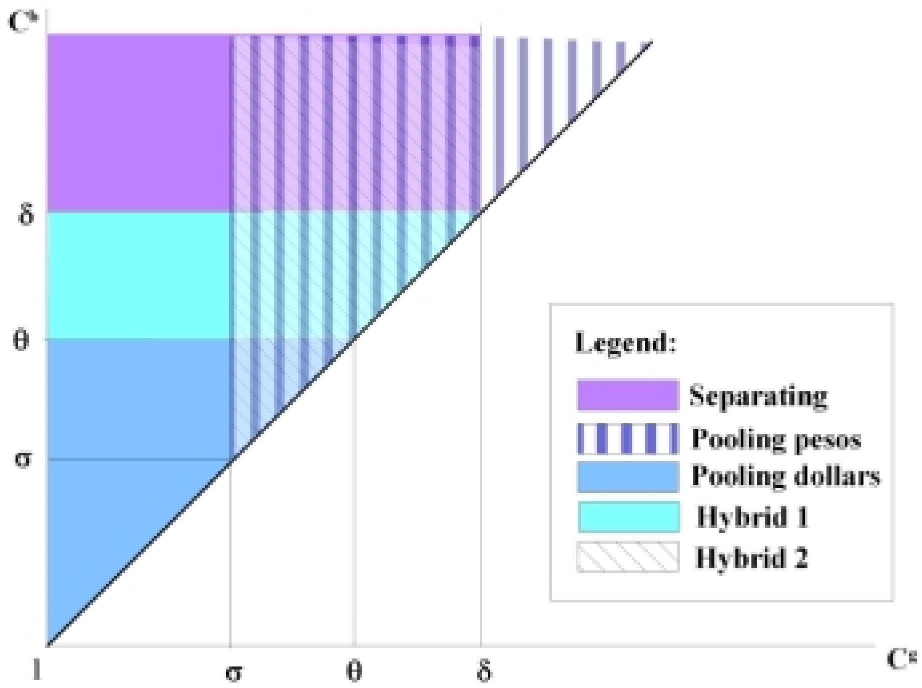

Figure 1: Various equilibria according to cleareance costs

From Figure 1 it comes out that for $C^g \in [\sigma, \delta]$ the game presents multiple equilibria, whatever C^b.

[7] The opposite case leads to rather similar conclusions and will not be developed here.

The dollar pooling equilibrium, where all firms borrow dollars, is the single equilibrium possible when the dollar clearance cost is relatively small compared to the peso clearance cost, i.e., if $C^b \in]1, \sigma[$. This situation has a less trivial interpretation. Consider a small developing country which does not have an open capital market: obviously, all firms finance themselves by borrowing resources from the local banks; the latter cannot differentiate between the good and the bad firms so they consider an average probability of default $[\pi^b m + \pi^g(1-m)]$. Let us suppose that the country opens its capital account, and may freely borrow dollars from abroad. Foreign banks may impose clearance costs related to a firm's type. If these costs are small enough, the economy shifts to complete dollarization of liabilities. Is this outcome efficient? No: at the end of the journey all firms pay the same interest rate as in the case of a closed capital account, but bear now higher clearance costs. In addition, local banks were probably pushed out of the market by foreign banks.

The efficient separating equilibrium can unambiguously occur if the clearance cost of dollar borrowing by bad firms are relatively high and clearance costs of dollar borrowing by the good firms are relatively low, i.e. if both $C^b > \delta$ and $C^g < \sigma$. Yet, risk neutral foreign banks may have no interest in tuning clearance costs so as to achieve this equilibrium: while the average rentability is identical to the dollar pooling case, the volume of credit is smaller.

As expected, if dollar borrowing clearance costs are high enough ($C^b > C^g > \delta$) all firms will borrow only pesos.

5 Conclusion

In the last decade, the mix of external dollar denominated debt, perfect mobility of international capital and sharp currency depreciation provided to be an extremely dangerous combination for the developing world. Several economists who studied the last crises in Latin America and South-east Asia, emphasized the primordial role played by the accumulation of large amounts of dollar denominated external debt.

This paper aims at explaining why in a context of exchange rate stability and perfect mobility of capital, emerging countries are prone to accumulate large dollars debts. The model is set up in a signaling framework. Building on real life observation, it was assumed that banks (or rating agencies) have no direct means to infer information about the quality of a borrowing firm in a developing country. However, borrowing dollars involve higher clearance (administrative) costs than borrowing pesos (i.e., the local currency); in addition, the dollar borrowing clearance cost depends on the financial strength of the firm. In this case, a good firm might borrow dollars only to signal its type: by so doing, it bears higher clearance costs, but would benefit from lower interest rates. Depending on the relative size of these clearance costs, the model presents various equilibria.

If their specific clearance cost is not very large, bad firms will also borrow dollars, so as to take advantage of the lower interest rates. In this equilibrium, the country falls into full liability dollarization, and the signaling effect vanishes. What appeared to be a favorable opportunity for the good firms, turned into a sub-optimal situation for the economy as a whole. Furthermore, if the same country shifts to a more flexible exchange rate regime, it will be subject to additional risks related to a would-be currency depreciation (e.g. a heavier debt burden, an adverse balance sheet effect, illiquidity).

The model also emphasizes the necessary and sufficient conditions for emergence of a separating equilibrium with limited dollarization, where only good firms borrow dollars, while bad firms borrow pesos. Whether this outcome can emerge or not depends on the relative clearance costs, which are probably under the (imperfect) control of the foreign banks. If the latter are risk-neutral, incentives to achieve this equilibrium can only be week.

The model could be generalized by relaxing some of the initial simplifying assumptions; for instance, one may allow for peso clearance costs to vary between firms according to their financial quality, or for peso clearance costs to be higher than dollar clearance costs. The complexity of the problem would increase but without altering the main insights. An interesting development would allow for exchange rate fluctuations. Despite its limitations, the model is interesting since it provides, within a simple framework, an explanation for both the shared enthusiasm about dollar borrowing and the disappointing final outcome.

6 Appendix: the impossibility of another separating equilibrium

We study whether a separating equilibrium where $g - firms$ borrow pesos and $b - firms$ borrow dollars would be feasible. In this context, beliefs would take the form:

$$\Theta = \begin{cases} \Pr[\texttt{t=b} \ |s_N] = p = 0 \\ \Pr[\texttt{t=b} \ |s_\$] = q = 1 \end{cases}$$

This system of beliefs is correct if, in equilibrium, the best policy of $g - firms$ is to borrow pesos ($s_\$$) and the best policy of $b - firms$ is to borrow dollars (s_N). The interest rate on peso credits is:

$$1 + r_N = \frac{1+\rho}{1-\pi^g} \tag{56}$$

and the interest rate on dollar credits is:

$$1 + r_\$ = \frac{1+\rho}{1-\pi^b} \tag{57}$$

A $g - firm$ which implements policy s_N has no interest to deviate if:

$$(1+r_N)(1+c_N) < (1+r_\$)(1+c_\$^g) \Leftrightarrow C^g > \frac{1-\pi^b}{1-\pi^g} \tag{58}$$

A $b - firm$ which borrows dollars has no incentive to deviate if:

$$(1+r_\$)(1+c_\$^b) < (1+r_N)(1+c_N) \Leftrightarrow C^b < \frac{1-\pi^b}{1-\pi^g} \tag{59}$$

In the main text, $\delta \equiv (1-\pi^g)/\left(1-\pi^b\right) > 1$.

This separating equilibrium would be feasible if:

$$C^b < 1/\delta < C^g \tag{60}$$

This is not possible, since $1/\delta < 1$ while $C^b \geq 1$.

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