Dollarization, Bailouts, and the Stability of the Banking System*

Douglas Gale
Department of Economics
New York University
269 Mercer Street
New York, NY 10003

Xavier Vives
Institut d'Anàlisi Econòmica CSIC
Campus UAB
08193 Bellaterra, Barcelona

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Abstract

We examine the trade-offs associated with the move to dollarization from the perspective of the stability of the banking system in a small open economy. Central bank policy suffers from time-inconsistency when facing a banking crisis: A bailout is optimal ex post but ex ante it should be limited to control moral hazard. Dollarization provides a credible commitment not to help at the cost of not helping even when it would be ex ante optimal to do so. It is found that dollarization is good when the costs of establishing a reputation for the central bank are high, monitoring effort by the banker is important in improving returns, and when the cost of liquidating projects is moderate.

Keywords: Moral hazard, banking crisis, lender of lasr resort

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“We would never put ourselves in a position where we envisioned actions that we would take would be of assistance to the rest of the world but to the detriment of the United States, ”Alan Greenspan to a congressional panel in 1999 (IHT, Jan. 19, 2000)

1 Introduction

The aim of this paper is to examine the trade-offs associated with the move to dollarization from the perspective of the stability of the banking system in a small open economy.

It has been argued repeatedly that a major problem in emerging markets is the implicit or explicit guarantee of a bailout in the event of a banking crisis. The anticipation of a bailout deactivates the potential disciplinary action of the market (bank runs, for example) and renders ineffective the threat of closure or restructuring. In emerging markets, moral hazard problems are widespread and the economy relies in an important way on the monitoring effort of bankers who provide finance to entreprenurial projects. It is precisely the fear of bank closure or change of management that makes bankers, who derive benefits from running the bank, cautious and willing to expend effort to monitor projects.[1]

In a monetary economy, the central bank can provide lines of credit when banks are in trouble. This may avoid costly, and inefficient, liquidation of entreprenurial projects. However, central bank policy is typically time-inconsistent. Ex ante, the central bank would like to make a commitment to close the bank if the project returns are very low (and perhaps help the bank if the returns are only moderately low). Such a commitment provides incentives for the bankers to monitor closely the projects they finance. However, ex post, costly liquidation of the projects will not be optimal, so the central bank will not want to carry out its threat. It is worth noticing that providing help ex post is both efficient and welcome by the banker, whose interest is in the continuation of the bank. In short, ex post it always pays to help and this distorts bankers' incentives ex ante.

In summary, the Lender of Last Resort (LOLR) suffers from a problem

[1]See Calomiris (1998), Eichengreen (1999), Fisher (1999) and the ”Symposium on Global Financial Instability” of the *Journal of Economic Perspectives*, 1999, 13 (4), 3-65, for different perspectives on the problem.

of time-inconsistency in the presence of moral hazard in the banking sector (say, the level of effort in monitoring projects). A benevolent LOLR will find it optimal ex post to intervene and help, whenever this salvages the value of the banking industry conditional on the effort level already exerted. Banks, anticipating the help, will tend to exert suboptimal effort.

A commitment to financial discipline can sometimes be maintained if the central bank has a strong incentive to build a reputation. In emerging markets, however, it may be difficult for central banks to build a reputation for disciplining banks, because the central bankers' effective horizon is short due to political instability. A central bank that cannot build a reputation will face a time-inconsistency problem.

How can dollarization alleviate this problem? Dollarization represents a commitment to a limited use of the LOLR facility (understood in a broad sense). Indeed, in a dollarized regime, help to the banking system (bailouts) must be arranged in advance, via insurance funds and/or tax schemes, for example, or pre-contracted in the international market. Dollarization implies that there cannot be recourse to monetary base expansion for bailouts. In the extreme case of a small open economy, dollarization means that banking contracts are written in real (dollar) terms. No recourse to the central bank is possible and market discipline is restored. This benefit comes at a cost, because help is not provided even in those situations in which it would be efficient. Furthermore, unlimited availability of liquidity provision from the central bank is sometimes the only way to avoid a self-fulfilling panic (a coordination problem among investors with short-term debt contracts). This coordination problem is not addressed in this paper.[2]

Another important issue which is not explored in the present paper is the transition to a dollarized system. Indeed, dollarization could bring the banking system down when implemented in a crisis context. To address this issue a dynamic model would be needed.

The tendency towards excessive bailouts may also result from political economy considerations. In countries with weak institutions, central banks may not be able to withstand pressure to help a banking system in trouble, over and above any systemic or efficiency concern. Indeed, generous help may be given even when it is common knowledge that the system is bank-

[2]Papers that address the coordination problem among depositors are, among others, Diamond and Dybvig (1983), Battacharya and Jacklin (1988), and Postlewaite and Vives (1987). Chang and Velasco (1998a and b) introduce the exchange rate regime into consideration.

rupt and the money spent will serve only as a transfer to political friends and strong lobbies.

The paper formalizes the forgoing ideas in a coherent model. The outline of the paper is as follows. Section 2 describes the basic model and builds on Diamond and Dybvig (1983) and Allen and Gale (1998). The classical Diamond and Dybvig model with random investment returns (as in Allen and Gale (1998)) is augmented with an unobservable effort choice by the banker that affects the distribution of returns of the risky project. Section 3 characterizes the incentive-efficient allocation. A main result is that, in order to provide incentives to the banker to exert effort, the investment project has to be liquidated if a leading indicator shows that returns are too low. Section 4 introduces a competitive banking sector and characterizes what can be achieved with banking contracts which promise consumption allocations (that is, contracts written in real terms). Section 5 models the time-inconsistency problem of the central bank policy in a monetary economy. It shows how an appropriate central bank policy implements the incentive-efficient allocation provided the central bank can commit to a monetary policy ex ante. In the absence of commitment, the central bank always helps ex post and this destroys the incentives of the banker to exert effort to monitor the projects. Competitive banking without commitment delivers an efficient outcome *conditional on the banker not exerting effort.* Section 6 considers the costs and benefits of dollarization in a small open economy. It is shown that dollarization is equivalent to restricting banking contracts to be in real terms. The trade offs associated with dollarization are then studied, comparing an economy with real contracts and a monetary economy in which the central bank cannot commit to a monetary policy. In the extreme, dollarization provides a commitment not to help at the cost of not helping at all, not even when it would be ex ante optimal to do so. Dollarization will tend to be good in countries in which there is a moral hazard problem for the banker and:

- the costs of establishing a reputation for the central bank are high (perhaps because of a short effective horizon);
- monitoring effort by the banker is important in improving returns;
- and the cost of liquidating projects is moderate.

Section 7 introduces the possibility of international borrowing. Section 8 considers an alternative (complementary) rationale for dollarization in terms of alleviating incentive problems for the central banker in the presence of political economy considerations. The last section contains concluding remarks and directions for further research and the appendix contains most of the proofs.

2 The Basic Model

The basic structure of the model is drawn from Allen and Gale (1998). There are three dates $t = 0, 1, 2$. At each date, there is a single good that can be used for consumption and investment. There are two kinds of investment technology, a safe, liquid investment and a risky, illiquid investment. The liquid investment is modeled as a storage technology: one unit of the good invested at date t produces one unit of the good at date $t + 1$, for $t = 0, 1$. The illiquid investment should be thought of as a risky project that takes two periods to mature. The returns to the risky project are linear: one unit of the good invested at date 0 yields R units of the good at date 2. The random variable R has a support $[\underline{r}, \bar{r}]$, where $0 \leq \underline{r} < \bar{r} < \infty$. If the project is liquidated prematurely, it yields γR units of the good at date 1 for each unit invested at date 0. Liquidation is costly because $0 < \gamma < 1$. We are assuming that it is impossible to liquidate a fraction of the project; either the entire project must be liquidated at date 1 or the entire project is allowed to continue until date 2.

There is a continuum of ex ante identical agents. Each agent has an endowment of one unit of the good at date 0 and none at dates 1 and 2. Agents are subject to a time-preference shock at date 1. A fraction $0 < \lambda < 1$ of them will become *early consumers*, who only value consumption at date 1 and the remaining fraction $(1 - \lambda)$ will become *late consumers*, who only value consumption at date 2. The parameter λ also represents the typical agent's ex ante probability of becoming an early consumer. Thus, the agent's expected utility can be written as

$$\lambda u(c_1) + (1 - \lambda)u(c_2)$$

where $c_t \geq 0$ is the agent's consumption at date $t = 1, 2$ and $u(\cdot)$ is a neoclassical utility function (increasing, strictly concave, twice continuously differentiable).

At date 0 all agents are ex ante identical and they hold the same beliefs about the returns to investment. All uncertainty is resolved at the beginning of date 1: individual agents learn whether they are early or late consumers and the returns to the risky investment R are revealed. A consumer's type is not observable, so late consumers can always imitate early consumers. Therefore, contracts explicitly contingent on this characteristic are not feasible.

We assume that the risky project requires the supervision of a manager. Precisely, the probability distribution of returns to the risky asset depends on effort undertaken by the manager. For simplicity, we assume that the manager's effort takes two values $e \in \{0, 1\}$ and the random variable R has a probability density function $f(r, e)$ (with support $[\underline{r}, \bar{r}]$) that depends on the value of e chosen at date 0. The cost of effort to the manager is represented by the constant $A > 0$ if he chooses $e = 1$; if he chooses $e = 0$ the cost is 0. The manager also receives a benefit $B > 0$ from continuing the project until date 2. Thus, the manager's payoff is

$$-Ae + qB,$$

where q is the probability that the project is continued at date 1. The manager's effort cannot be observed so his willingness to undertake effort will depend on the relationship between his effort and the probability that the project is continued at date 1.

3 The Incentive-Efficient Solution

Suppose that a planner were given the task of choosing an optimal risk-sharing arrangement. Since all agents are ex ante identical, it is natural for the planner to treat all agents alike and maximize their ex ante expected utility. Let (x, y) denote the portfolio chosen at date 0, where x is the investment in the risky asset and y is the investment in the safe asset, let e denote effort level, and let $q(r)$ denote the probability of continuation at date 1 when the r.v. R takes the value r. The optimal consumption allocation will depend only on the aggregate wealth of the economy. Let $(c_1(r), c_2(r))$ denote the optimal consumption allocation, where $c_t(r)$ is the consumption at date $t = 1, 2$ when $R = r$.

The planner's problem can be solved in stages. First, we suppose that the first-period decisions regarding x and y are given and the value of $R = r$ has been observed. If the project is discontinued, the aggregate wealth available is $\gamma rx + y$ and the problem solved by the planner is

$$\begin{array}{ll} \max_{(c_1(r),c_2(r))} & \lambda u(c_1(r)) + (1-\lambda)u(c_2(r)) \\ \text{s.t.} & \lambda c_1(r) + (1-\lambda)c_2(r) \leq \gamma rx + y \\ & c_1(r) \leq c_2(r). \end{array}$$

The first constraint is the budget constraint at date 1. It requires that the consumption of the early and late consumers be less than or equal to the liquidated value of the portfolio. Although the project is discontinued at date 1, the planner is assumed to pay out the consumption to the late consumers at date 2 using the storage technology. This allows him to take advantage of the fact that early consumers cannot wait and so cannot imitate late consumers. As a result, only one incentive constraint has to be satisfied. The second constraint is the incentive constraint. It requires that late consumers do not benefit from imitating early consumers (a late consumer can pretend to be an early consumer, receive $c_1(r)$ at date 1 and save it until date 2 using the storage technology).

The solution to this problem is

$$c_1(r) = c_2(r) = \gamma rx + y$$

and the maximum utility from discontinuing the project is

$$W(r,x,y) = u(\gamma rx + y).$$

Next, suppose that the project is continued at date 1. Then the planner has y units of the good at date 1 and rx units of the good at date 2 . He chooses a consumption allocation to solve the following problem:

$$\begin{array}{ll} \max_{(c_1(r),c_2(r))} & \lambda u(c_1(r)) + (1-\lambda)u(c_2(r)) \\ \text{s.t.} & \lambda c_1(r) \leq y \\ & (1-\lambda)c_2(r) \leq rx + y - \lambda c_1(r) \\ & c_1(r) \leq c_2(r). \end{array}$$

The first constraint is the budget constraint at date 1, the second constraint is the budget constraint at date 2, and the third constraint is the incentive constraint. The solution to this problem has the form:

$$\begin{aligned} c_1(r) &= \min\{rx + y, y/\lambda\} \\ c_2(r) &= \max\{rx + y, rx/(1-\lambda)\} \end{aligned}$$

and the maximum utility from continuing the project is

$$U(r,x,y) = \lambda u\left(\min\{rx+y, y/\lambda\}\right) + (1-\lambda)u\left(\max\{rx+y, rx/(1-\lambda)\}\right).$$

To check that this is indeed the solution is easy. Here is the gist of the argument. The necessary conditions for optimization require that $u'(c_1(r)) \geq u'(c_2(r))$ with equality if $\lambda c_1(r) < y$. Given concavity of u this means that the incentive constraint $c_1(r) \leq c_2(r)$ is automatically satisfied. Now, if returns are low, $r \leq y(1-\lambda)/x\lambda$, then we are in the case $\lambda c_1(r) < y$ and the consumptions of early and late consumers are equated $c_1(r) = c_2(r) = rx+y$ (for the late consumers $y - \lambda c_1(r)$ of the asset is carried to date 2, which added to rx yields the desired $(1-\lambda)(rx+y)$). If returns are higher, $r > y(1-\lambda)/x\lambda$, then we keep constant the consumption of early withdrawers giving them all the output at date 1, $c_1(r) = y/\lambda$, and we let late consumers profit from the high returns at date 2, $c_2(r) = rx/(1-\lambda)$. Figure 1 below depicts the consumption allocations when the project is continued.

The manager always prefers to continue the project at date 1. Whether the consumers are better off on average continuing the project depends on the parameters of the model. Since we are interested in the problem of time consistency, it makes sense to assume that the consumers are, on average, better off continuing the project ex post. That is,

$$U(r,x,y) \geq W(r,x,y), \forall (x,y,r).$$

For very small values of r, this condition must be satisfied, so it will be satisfied everywhere if $U(r,x,y) - W(r,x,y)$ is increasing in r (see Remark 2 below).

Now suppose that the planner has chosen a portfolio (x,y) at date 0 and consider the choice of effort. If the planner chooses $e=0$, there is no problem implementing this choice. Since the manager prefers not to make an effort, the incentive constraint will automatically satisfied. Further, since it is ex post inefficient to liquidate the project, it is optimal to choose $q(r) = 1$ for all r. In this case the planner solves

$$\max_{(x,y)} \quad \int U(r,x,y) f(r,0) dr.$$

Denote by $V^0(0)$ the value of the program.

The interesting case, therefore, is the implementation of $e=1$. The planner chooses $q(r)$ to solve the problem

$$\begin{array}{ll} \max & \int \{q(r)U(r,x,y) + (1-q(r))W(r,x,y)\} f(r,1) dr \\ \text{s.t.} & \int q(r) B \{f(r,1) - f(r,0)\} dr \geq A. \end{array}$$

The incentive constraint says that taking high effort increases the manager's expected continuation benefit by an amount that is greater than or equal to his cost of effort. In general, the optimal continuation probability $q(r)$ can be quite complicated. Intuition suggests that, if making an effort is optimal, it is because higher effort is associated with higher outcomes for the risky project on average. So we should reward the manager for good outcomes and should punish him for bad outcomes. In certain cases, the optimal continuation probability does have the form of a cutoff rule: continue the project if and only if $r \geq r^0$, for some critical value or cutoff r^0. The next result gives sufficient conditions for the optimal rule to be a cutoff rule.

Proposition 1 *For a given portfolio (x, y), suppose that $U(r, x, y) - W(r, x, y)$ is increasing in r and $f(r, 0)/f(r, 1)$ is decreasing in r. Then the optimal continuation probability $q^0(r)$ has the form of a cutoff rule, that is, for some constant r^0,*

$$q^0(r) = \begin{cases} 1 & r \geq r^0 \\ 0 & r < r^0. \end{cases}$$

Remark 1 *Let $F(r, e)$ denote the cumulative distribution function of R given the effort level e. The monotone likelihood ratio property, $f(r, 0)/f(r, 1)$ decreasing in r, implies that $F(r, 1)$ first order stochastically dominates $F(r, 0)$.*

Remark 2 *A sufficient condition for $U(r, x, y) - W(r, x, y)$ to be increasing in r is that*

$$u'(w) > \gamma u'((1 - \lambda)\gamma w)$$

for any $w > 0$.[3]

Remark 3 *When the cutoff rule is optimal, the incentive constraint simplifies to*

$$B\left(F(r^0, 0) - F(r^0, 1)\right) \geq A.$$

It is possible to implement the high level of effort, then, if and only if $A/B \leq \sup_{\underline{r} \leq r \leq \bar{r}} \{F(r, 0) - F(r, 1)\}$.

[3]If $u(w) = w^{1-a}$ with $0 < a < 1$ the inequality holds if and only if $(1-\lambda)^a > \gamma^{1-a}$. This is true if λ and/or γ are small. However, the inequality does not hold if $a = 1$ (logarithm) or the utility is of the CARA type.

Assuming that it is optimal to induce $e = 1$, the planner must find a portfolio (x, y) and a cutoff point r^0 that solve the following problem:

$$\begin{array}{ll} \max & \int_{r \geq r^0} U(r,x,y) f(r,1) dr + \int_{r<r^0} W(r,x,y) f(r,1) dr \\ \text{s.t.} & x + y \leq 1 \\ & F(r^0, 0) - F(r^0, 1) \geq A/B. \end{array}$$

Denote the solution by (x^0, y^0, r^0). Note that the planner wants to keep r^0 as low as possible. Indeed, if $A = 0$ then a first-best allocation can be achieved and it will be optimal to put $r^0 = \underline{r}$. It follows that the incentive constraint must be binding at an optimum. Otherwise it would be optimal to put $r^0 = \underline{r}$; but this would not satisfy the incentive constraint because $F(\underline{r}, 0) = F(\underline{r}, 1) = 0$ and $A > 0$. Thus, $r^0 > \underline{r}$ is uniquely determined by the incentive constraint: $r^0 = \inf I$,wehre $I = \{r \in [\underline{r}, \bar{r}] : F(r, 0) - F(r, 1) \geq A/B\}$. Note that r^0 will be weakly increasing in A/B. As A/B tends to 0, r^0 will tend to $\underline{r}$. Having determined the value of r^0, we can choose (x, y) to maximize the objective function subject only to the first-period budget constraint. A typical solution is depicted in Figure 1. For low returns, $r \leq r^0$, the project is discontinued and $c_1(r) = c_2(r) = \gamma r x + y$. For higher returns we are in the continuation region and consumptions follow the pattern described above. Under certain regularity conditions[4], the optimal investment in the risky project x^0 is increasing in γ (as it becomes cheaper to liquidate the project). This is always the case if the project is liquidated whenever it loses money, $r^0 < 1$. Let us assume so. Assume also that $r^0 \leq y^0(1 - \lambda)/x^0\lambda$ when $\gamma = 1$. This means that the inequality holds for all γ whenever $y^0 + x^0 = 1$.

Denote by $V^0(1)$ the value of the program when $e = 1$. When effort is irrelevant, $F(r, 0) - F(r, 1) = 0$ for all r, it is impossible to achieve $e = 1$ in an incentive-compatible way and $V^0(1)$ is not defined. Our maintained asumption in the paper is that $V^0(1)$ is defined and that managerial effort is optimal, that is, $V^0(1) > V^0(0)$.

4 Competitive Banking

In this section, we introduce a competitive banking sector. Banks are coalitions of agents. They pool their endowments and hire a manager to monitor

[4] A sufficient condition is that the inverse of the coefficient of relative risk aversion be larger than $r^0 - 1$.

their investment.

Like the planner, banks will maximize the expected utility of the representative member subject to the investment technology and the manager's incentive constraint. Unlike the planner, banks cannot make the consumption allocation directly contingent on the state of nature. Instead, they are forced to use non-contingent deposit contracts. (The consumption allocation will be contingent on r in the event that the bank cannot meet its commitments, of course.) A deposit contract offers the bank members a choice of d units of consumption at date 1 or the residual units of consumption left at date 2.

The bank invests in a portfolio (x, y) at date 0 and the manager chooses effort e. If the bank can afford to pay d to all the agents who want to withdraw at date 1 the bank is solvent and the risky project can continue. Otherwise, the bank is bankrupt and its portfolio must be liquidated and distributed to the agents. The bank will be solvent if it can pay the early consumers what it owes them at date 1 and if the late consumers are willing to wait until date 2 to withdraw. The aggregate consumption of the late consumers is $(1-\lambda)c_2 = rx + y - \lambda d$. Thus, the necessary conditions for solvency are

$$\begin{aligned} \lambda d &\leq y \\ d &\leq \frac{rx + y - \lambda d}{1-\lambda}. \end{aligned}$$

We assume that whenever these inequalities are satisfied, the late consumers are content to withdraw at date 2. Note that this is not the only equilibrium of the depositors' game at date 1. Indeed, there could be an equilibrium in which all depositors withdraw (c.f., Diamond-Dybvig (1983)).

The critical value of r at which the bank can just meet its obligations is denoted by r^* and implicitly defined by

$$d = r^* x + y.$$

For $R \geq r^*$ we have $c_1 = d$ and $c_2 = (rx + y - \lambda d)/(1-\lambda)$. For $R < r^*$ we have $c_1 = c_2 = \gamma rx + y$. So, we can equivalently think of the bank as choosing a portfolio (x, y) and a bankruptcy point r^*. Then, assuming that it is optimal to induce high effort, the bank's decision problem is to choose (x, y, r^*) to maximize the objective

$$\int_{r \geq r^*} \left(\lambda u(d) + (1-\lambda) u \left(\frac{rx + y - \lambda d}{1-\lambda} \right) \right) f(r, 1) dr + \int_{r < r^*} u(\gamma rx + y) f(r, 1) dr,$$

subject to the constraints

$$\begin{aligned} x + y &\leq 1, \\ F(r^*, 0) - F(r^*, 1) &\geq A/B, \end{aligned}$$

where $d \equiv r^*x + y$. Denote by $V^*(1)$ the value of the program.

At the solution we have, obviously, that $r^* \geq r^0$, since the incentive constraint must be satisfied. Assume (reasonably) that the optimal r^* ignoring the incentive constraint has $r^* > \underline{r}$. Then whenever A/B is small $r^* > r^0$ because as A/B tends to 0, r^0 tends to $\underline{r}$. In any case whenever the incentive compatibility constraint is binding an increase in A/B will decrease $V^*(1)$. Note, however, that even if $r^* = r^0$ the expected utility typically attained at the banking contract will be strictly less than at the incentive-efficient solution, $V^0(1)$. This is because the risk sharing provided by the banking contract is sub-optimal, even when the bank is solvent. A typical solution to the banking contract is depicted in Figure 2.

There is a conceivable knife-edge case for which $V^*(1) = V^0(1)$. This would happen if $r^* = r^0 = y^0(1-\lambda)/x^0\lambda$.[5] Furthermore, when liquidation is not costly ($\gamma = 1$) and $y^0(1-\lambda)/x^0\lambda$ is in the incentive compatible range I for r, then $V^*(1) = V^0(1)$. Under these assumptions competitive banking can replicate the incentive-efficient allocation (recall that we have that $r^0 \leq y^0(1-\lambda)/x^0\lambda$). By continuity then, for γ close to 1, $V^*(1)$ will be close to $V^0(1)$. Given that $V^*(1)$ is increasing in γ we will have then that for γ large, $V^*(1) > V^0(0)$ because by assumption $V^0(1) > V^0(0)$.

Remark 4 *There is no role for a liquidity requirement in our context. Indeed, a competitive bank already chooses the optimal investment in the safe asset given the deposit contract.*

5 Banking in a monetary economy and optimal central bank policy

Up to now we have assumed that the banking contract was specified in real terms (in units of consumption). Let us now introduce a central bank that supplies money and therefore makes it possible to write nominal contracts

[5] However, when the distribution of R has a two-point support, $V^*(1) = V^0(1)$ is a robust possibility.

in terms of the domestic currency. The dollar is the reserve currency and serves as the unit of account (one dollar is worth one unit of consumption). The central bank produces the domestic currency at no cost. We imagine that the central bank controls the price level p or, equivalently, the exchange rate, by standing ready to exchange the domestic currency for goods (or dollars) at the specified price level p_t in period t. To avoid arbitrage it is necessary that the return to holding money between dates 1 and 2 be less than or equal to the return to holding the safe asset. This implies that the price level must be non-decreasing ($p_1 \leq p_2$). Since the only function of money, besides its use as a unit of account, is to be a store of value between dates 1 and 2, we assume that it is optimal to hold money, that is, $p_1 = p_2 = p$. The central bank also provides liquidity to the banking firms in the form of zero-interest domestic currency loans.

The deposit contract now promises D units of currency to anyone withdrawing in period 1 and, as before, late withdrawers are residual claimants of whatever is left in the representative bank in the last period.

We assume here that the central bank is benevolent and that it wants to maximize the expected utility of the representative investor. The central bank has available whatever public information there is at any stage. In particular, the central bank observes the realization of R in period 1. A central bank policy is therefore a function which determines the price level $p(r)$ as a function of the realization $R = r$.

We will consider two scenarios. In the first, the central bank can commit to a specific monetary policy at period 0 for the rest of the game. In the second, the central bank is not able to commit to a specific policy at period 0.

In the commitment scenario, there is a simple central policy that implements the incentive-efficient allocation with a banking contract specified in nominal terms. Let $(x^0, y^0, c_1^0(r), c_2^0(r))$ be the incentive-efficient solution. Then the price policy $p(r) = y^0/\lambda c_1^0(r)$ for $r \geq r^0$ and $p(r) = p(r^0)$ for $r < r^0$ induces the representative bank to choose $D = y^0/\lambda$ and implement the planner's allocation. Indeed, the bank can do no better than to offer $D = y^0/\lambda$ and choose (x^0, y^0) and this is feasible. Note that the price level is constant at $p(r) = 1$ for $r \geq (1-\lambda)y^0/\lambda x^0$ in which case $c_1(r) = D = y^0/\lambda$. In the range $r^0 \leq r < (1-\lambda)y^0/\lambda x^0$ the value of the assets in the bank at $t = 2$ is $p(r)(y^0 - \lambda c_1(r) + rx^0)$ where $c_1(r) = rx^0 + y^0$. This yields the required consumption for patient consumers $c_2(r) = rx^0 + y^0$ and they are willing to wait. When $r < r^0$ it is in the interest of late consumes to withdraw at date 1 and the bank faces nominal claims for the total amount of D $(= y^0/\lambda\ )$. The bank cannot meet the claims because by liquidating it has assets with nominal value $p(r^0)\ (\gamma r x^0 + y^0) < p(r^0)\ (r^0 x^0 + y^0) = y^0/\lambda = D$. By inflating the price level in the range $r^0 \leq r < (1-\lambda) y^0/\lambda x^0$, the central bank avoids the inefficient liquidation of the project, reducing the consumption of early consumers. In the range $r < r^0$ the central bank refuses to inflate prices further and the bank must be liquidated.

Alternatively, we could think that the central bank provides help to the bank in the range $r^0 \leq r < (1-\lambda) y^0/\lambda x^0$ in the form of a (zero interest) loan. This help avoids a run that forces the bank to liquidate. Late consumers withdraw at $t = 1$ and they end up holding all the money, which they exchange in period $t = 2$ for goods to consume.

Proposition 2 *If the central bank can commit to a monetary policy ex ante then the incentive-efficient solution is an equilibrium of the banking contract in nominal terms.*

However, the situation is very different if the central bank cannot commit to a monetary policy at period 0. Indeed, the optimal central bank policy is time-inconsistent. The optimal policy calls for costly liquidation of the project when $r < r^0$. Effort by the manager has already been exerted when the decision to continue or discontinue the project has to be made in period 1. In period 1, it is always optimal to let the project continue. The time-consistent central bank policy in period 1 for given (x, y) is: $p(r) = y/\lambda c_1(r)$ for all r, $c_1(r) = \min\{rx + y, y/\lambda\}$ and $c_2(r) = \max\{rx + y, rx/(1-\lambda)\}$. This consumption pattern corresponds to the optimal continuation allocation. Anticipating that the bank will never be closed down, the manager does not exert effort $(e = 0\ )$ and the bank solves the problem

$$\max_{(x,y)} \quad \int U(r, x, y) f(r, 0) dr$$

where

$$U(r, x, y) = \lambda u\left(\min\{rx + y, y/\lambda\}\right) + (1-\lambda) u\left(\max\{rx + y, rx/(1-\lambda)\}\right).$$

This program, indeed, yields the value $V^0(0)$ which obtains when the planner chooses the optimal allocation contingent on $e = 0$. The following proposition summarizes the result.

Proposition 3 *If the central bank cannot commit to a monetary policy ex ante, then the representative bank is never liquidated and the banker does not exert effort. Competitive banking delivers an efficient outcome conditional on the banker not exerting effort* ($V^0(0)$).

6 Banking in a small open economy: The costs and benefits of dollarization

Let us consider now a small open economy in which the safe asset is the dollar and the currency of the country is the peso. The country is small and therefore the only way to affect the exchange rate is by changing the price level. Indeed, the exchange rate is just the peso price of consumption. We assume for the moment that international borrowing is not possible.

If the country has a central bank and an independent monetary policy it can control the price level. However, let us assume, realistically for an LDC or emerging economy, that the central bank has a commitment problem. The costs of establishing a reputation for the central bank may be high because of a short effective horizon or a low discount factor.In this scenario, the value of the banking program (the maximum incentive-feasible expected utility) is $V^0(0)$, because the banker will exert no effort ($e = 0$). There is no costly liquidation, the bank never closes down, but returns are drawn from the bad distribution $F(r, 0)$.

What happens if the country renounces its monetary autonomy and embraces dollarization? The allocation attained is then identical to the one attained under competitive banking with real contracts. Indeed, in this scenario there is no central bank to help and deposits will be held in dollars. The banker will exert effort ($e = 1$) but there will be excessive (costly) liquidation of the project. The value of the banking program is then $V^*(1)$.

It is now clear what are the costs and benefits of dollarization. The benefit of dollarization is that it imposes discipline by avoiding excessive help from the central bank. It is feasible then to induce the banker to exert effort. This solves the time-inconsistency problem of central bank policy at the cost of excessive liquidation of the project (excessive because help is never available, not even when it is ex ante incentive-efficient).

Dollarization will be good ($V^*(1) > V^0(0)$) when:

1. Effort is important to improve returns ($F(r,0)$ is "much worse" than $F(r,1)$ for all r). Indeed, the central bank (with no commitment power) will achieve an efficient allocation when effort makes no difference ($F(r,0) = F(r,1)$ for all r). Furthermore, when returns are normally distributed $R_0 \sim N(\mu_0, \sigma^2)$ and $R_1 \sim N(\mu_1, \sigma^2)$, $V^*(1) > V^0(0)$ if and only if $\mu_1 - \mu_0$ is large enough.

2. The cost of liquidation is not too high (γ is close to 1). When the cost of liquidation is low (γ close to 1) we will then have that $V^*(1)$ will be close to $V^0(1)$. Given that $V^*(1)$ is increasing in γ we will have then that for γ large, $V^*(1) > V^0(0)$ because by assumption $V^0(1) > V^0(0)$.[6]

A necessary condition for dollarization to be good is that a moral hazard problem is present. Indeed, the central bank (with no commitment power) will achieve an efficient allocation when the moral hazard problem of the banker does not exist ($A/B = 0$). Paradoxically perhaps, a severe moral hazard problem of the banker (A/B high) may hurt the chances of dollarization. This is so because, for an increase in A/B when it is already high, the incentive constraint will bind and $V^*(1)$ will decrease. Indeed, when A/B is high it becomes expensive to provide incentives.

Proposition 4 *Dollarization will be welfare improving* ($V^*(1) > V^0(0)$) *when effort is important to increase returns or the cost of liquidation is not too high* (γ *is close to* 1).

Dollarization will tend to be good in countries in which there is a moral hazard problem and

- the costs to establishing a reputation for the central bank are high;
- monitoring effort by the banker is important in improving returns;
- or the cost of liquidating projects is moderate.

[6] When there is no liquidation cost ($\gamma = 1$) the central banker may liquidate the bank in period 1 in the ex ante efficient manner. However, we may also think realistically that in period 1, given that the central banker will be indifferent between liquidating the bank when $r < r^0$ and not liquidating it, he will yield to the pressure of the bank manager and not liquidate it.

Except for the last factor, this depicts the situation of a country with a long way to go in terms of political stability, rule of law, contract enforcement and institutional development, supervision as well as reliance on bank monitoring to make finance available for entreprenurial projects. For politically stable countries with a modern institutional structure and deep financial markets, dollarization is not likely to be a good idea.

The question arises whether a mixture of partial dollarization and central bank intervention could attain the incentive-efficient solution. The idea is to combine the flexibility of domestic-currency contracts with the commitment value of dollarized contracts. In this way incentive-efficiency can be achieved provided that, and this is a big if, partial dollarization is credible. This is how it can be accomplished. As before, let $(x^0, y^0, c_1^0(r), c_2^0(r))$ be the incentive-efficient solution. Suppose that depositors are offered the option of withdrawing D pesos or d dollars at date 1. Choose d so that the bank is insolvent and forced to liquidate when $r = r^0$. That is, let $d = r^0 x^0 + y^0$. For values of $r < r^0$ the bank is liquidated and all depositors share the liquidated value of the assets. For $r > r^0$ the central bank can offer help by lowering the price level (increasing the exchange rate) so that depositors consume the optimal amount $D/p(r) = c_1^0(r) > d$, where $D = y^0/\lambda$. The contract (D, d) would be offered then by a competitive bank. The crucial aspect of the banking contract is the right of depositors to demand d dollars back at date 1.

7 Concluding Remarks

We have provided a preliminary analysis of the costs and benefits of dollarization in controlling moral hazard in the presence of a time inconsistency problem in central bank policy. It would good to check the robustness of the results in the context of a richer model including international borrowing. Furthermore, it would nice also to explore alternative, and complementary, rationales for dollarization in terms of alleviating incentive problems for the central banker because of political economy considerations. Indeed, the tendency towards excessive bailouts may also result from political economy problems. In countries with weak institutions, central banks may not be able to withstand pressure to help a banking system in trouble, over and above any systemic or efficiency concern. Generous help may be given even when it is common knowledge that the system is bankrupt and the money spent will serve only as a transfer to political friends and strong lobbies.

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