HWWA HAMBURG

DISCUSSION PAPER

Dollarization, Bailouts, and the Stability of the Banking System

Douglas Gale
Xavier Vives

HWWA DISCUSSION PAPER

185

Hamburgisches Welt-Wirtschafts-Archiv (HWWA)
Hamburg Institute of International Economics
2002
ISSN 1616-4814

Das HWWA ist Mitglied der:

- Wissenschaftsgemeinschaft Gottfried Wilhelm Leibniz (WGL)
- Arbeitsgemeinschaft deutscher wirtschaftswissenschaftlicher Forschungsinstitute (ARGE)
- Association d‘Instituts Européens de Conjoncture Economique (AIECE)

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

Douglas Gale
Xavier Vives

* We are grateful to participants at the Financial Market Group, London School of Economics lunch seminar, at ESSET 2000, to Ramon Caminal, Elu von Thadden, two anonymous referees as well as an editor of this journal for useful comments. Ana Belmonte provided excellent research assistance. Vives acknowledges the support of DGICYT Project PB98-0696.

The subject of this paper is assigned to the HWWA's research programme "International Financial Markets ".

HWWA DISCUSSION PAPER

Edited by the
PRESIDENTIAL DEPARTMENT

Hamburgisches Welt-Wirtschafts-Archiv (HWWA)
Hamburg Institute of International Economics

Öffentlichkeitsarbeit
Neuer Jungfernstieg 21 – 20347 Hamburg
Telefon: 040/428 34 355
Telefax: 040/428 34 451
e-mail: hwwa@hwwa.de
Internet: http://www.hwwa.de/

Xavier Vives
INSEAD
Boulevard de Constance
77305 Fontainebleau Cedex, France
E-mail: xavier.vives@insead.edu

CONTENTS

DOLLARIZATION, BAILOUTS, AND THE STABILITY OF THE BANKING SYSTEM*

Douglas Gale and Xavier Vives

Revised July 2001

Abstract

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. 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. However, a very severe moral

*We are grateful to participants at the Financial Market Group, London School of Economics lunch seminar, at ESSET 2000, to Ramon Caminal, Elu von Thadden, two anonymous referees as well as an editor of this journal for useful comments. Ana Belmonte provided excellent research assistance. Vives acknowledges the support of DGICYT Project PB98-0696.

hazard problem could make dollarization Undesirable. The results obtained are applied to assess the desirability of dollarization in a range of countries and the potential role of the IMF as International LOLR.

"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.[1]

Dollarization is a reality in several countries and is on the agenda for others. Arrangements short of full dollarization, or adoption of the currency of another country, include currency boards, with a rigid link between domestic currency and foreign reserves[2], and partial dollarization. Dollarization is not very common but gaining ground. Starting with Panama in 1904, Ecuador embraced full dollarization in 2000, after the collapse of its financial system in 1998-99 at the staggering cost up to 22 percent of GDP, and El Salvador very recently in January 2001. Guatemala is also planning to circulate the dollar and Estonia is thinking about "euroization". Currency boards were a more common arrangement in the British colonial past and

[1]Dollarization means that the country adopts the currency of another country (for example, the dollar) as a means of payment and unit of account.

[2]A currency board is typically defined by a legislative commitment to exchange domestic currency for the reserve currency at a fixed rate and by the requirement that (a major proportion of) monetary liabilities be backed by the reserve currency.

presently they are in operation, among others, in Argentina [1991], Hong Kong [1983] and in Lithuania [1994], linked to the dollar, as well as in Bosnia-Herzegovina [1997], Estonia [1992] and Bulgaria [1997], linked to the DM/euro. Turkey moved recently to a quasi currency board arrangement.[3] Furthermore, partial dollarization is prevalent in countries such as Argentina, Bolivia, Peru and Turkey with dollar deposits equal to more than 30 percent of the total.[4]

The adoption of a common currency reduces the transaction costs of trade (see, for example, Rose [2000]) and if the country adopts a stable currency it commits to a stable monetary policy. The latter may be particularly important in emergent economies. However, dollarization has the potential cost of abandoning monetary policy and the exchange rate as policy instruments and compromising the capacity to bail out the domestic banking system. It is worth noting that banking crises can be very costly, with bail out costs up to 10 percent or even 20 percent of GDP.[5] We concentrate attention in this paper on the bailout issue.

When it comes to bailouts, not being able to help may have its benefits. As Grossman and Hart [1982] pointed out, the threat of bankruptcy and loss of private benefits can motivate managers to exert effort and improve the

[3]Estonia considers its currency boards as a step towards joining the European Monetary Union. Lithuania plans to link its currency board to the euro in 2001. Dollar-based currency boards have been established also in Djibouti [1949] and the member countries of the Eastern Caribbean Central Bank [1965]. The one in Brunei Darussalam [1967] is linked to the Singapore dollar. See Santiprabhob [1997] and Ghosh, Gulde and Wolf [2000] for a description of the arrangements in the different currency boards.

[4]See IMF [1999].

[5]See for example Caprio and Klingebiel [1996] and Dziobek and Pazarbasioglu [1997].

performance of the firm. The possibility of a bailout reduces this incentive effect and indirectly encourages managerial shirking and risk taking. 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 (think of Argentina, Mexico or Thailand).[6] 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 entrepreneurial 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.[7]

In a monetary economy, the central bank can bail out distressed banks by extending a line of credit. The optimal central bank policy must balance the costs and benefits of bailouts. On the one hand, a bailout avoids costly and inefficient liquidation of entrepreneurial projects. On the other hand, the prospect of a bailout reduces the banks incentive to monitor. Ex ante, the central bank would like to make a commitment to close the bank in some cases (for example, if the project returns are very low) and to extend credit in others (for example, if the returns are only moderately low). Un-

[6]For example, Calomiris and Powell [2000] state that "the banking sector suffered from ineffective regulation and supervision and repeated, forced government rescues contributed significantly to Argentina's past fiscal and inflationary problems". A related problem (in Argentina, for example) is the lack of legal protection that a supervisor has when attempting to discipline a bank in trouble. Then even if the perceived problem is serious the bank may be allowed to continue or even granted help. See World Bank [1998].

[7]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.

fortunately, the optimal policy suffers from a lack of time-consistency. Ex ante it is optimal for the central bank to commit to a policy of financial discipline. Ex post, it may be optimal to avoid costly liquidation by allowing banks and projects to continue in every case. Note that ex post continuation is both efficient and welcomed by the banker, who derives benefits from running the bank.

To sum up, a time-consistent policy by the central bank may lead to excessive bailouts. Anticipating this lack of financial discipline, bankers will not make sufficient effort to screen and monitor projects. The result will be excessive financing of inferior projects, inadequate monitoring, and poor project performance.

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.[8] A central bank that cannot build a reputation will face the time-inconsistency problem.

How can dollarization alleviate this problem? Dollarization represents a commitment to a limited use of the lender of last resort (LOLR) facility, understood in a broad sense. 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

[8]For example, in Argentina in the 1980s the average term in office for a central bank governor was less than a year despite the fact that the legal term was four years. See Chapter 19 in Cukierman [1992].

in real (dollar) terms. In a dollarized regime, help to the banking system (bailouts) must be arranged in advance, via stabilization funds and/or tax schemes, or pre-contracted in the international market. [9]

Calomiris and Powell (2000) provide some evidence that credible market discipline is being established in Argentina. Namely, that market perceptions of default risk are mean reverting, possibly indicating that banks are market-disciplined and respond to increases in risk perception by being more prudent. Argentina, as well as Estonia, both with a currency board, provide examples of countries where depositors have suffered significant losses following banking crises.[10]

Dollarization is not a panacea, however. Whereas the domestic LOLR may impose too little financial discipline, dollarization may impose too much. By constraining the central bank's role as LOLR, it may be impossible to extend assistance to a distressed bank even in situations where this would be efficient ex ante.

In this paper, we study the costs and benefits of dollarization from the point of view of providing market discipline for the banking sector. The model we use integrates the banking instability model à la Diamond and

[9]For example, in Argentina a contingent liquidity facility with international banks is in place. This is complemented with a liquidity requirement and holdings of excess reserves. The LOLR activity of the Central bank is severely restricted by the Convertibility Law (adoption of a currency board) of 1991 and charter of 1992. See Calomiris and Powell [2000]. Most currency boards have established limited LOLR facilities. The exceptions are Brunei, Darussallam and Djibouti. Note also that a stabilization fund built to provide liquidity when needed can be diverted to other ends (as in the cases of Mexico and Thailand).

[10]See Ghosh, ulde and Wolf [2000].

Dybvig [1983] and the moral hazard view (see Krugman [1998] for example) of crises. In the tradition of Diamond and Dybvig [1983], banks are risk sharing institutions that transform liquid liabilities (demand deposits) into illiquid assets (investments in long-term projects). In Diamond and Dybvig [1983] and much of the following literature, panics are generated by self-fulfilling prophecies. This coordination problem is not addressed in this paper.[11] In our model, which is based on Allen and Gale [1998], crises are the result of exogenous shocks to asset returns.[12] The model is augmented by introducing the possibility of moral hazard. The model may be of independent interest because it combines the two elements (moral hazard and financial crises) that have been studied separately in the literature.

We approach the analysis of optimal policy in three steps. First, as a benchmark in Section 3, we analyze the policy of a planner with full commitment who uses complete contracts to finance risky projects. We characterize the incentive-efficient policy and show, among other things, that the planner chooses the minimum probability of termination (default) that is required to satisfy the incentive constraint (induce the optimal effort from the bank manager).

Secondly, we examine in Section 4 a competitive banking sector in a real economy where banks use (incomplete) demand deposits to finance

[11] Chang and Velasco [1998a and b] introduce the exchange rate regime into consideration in a Diamond-Dybvig type model.

[12] This is consistent with the evidence provided in Gorton [1988] and in Kaminsky and Reinhart [1999]. Bhattacharya and Jacklin [1988], and Postlewaite and Vives [1987] present an information-based view of bank runs which is close to the one developed in the paper.

risky projects. Banks are implicitly assumed to be able to commit to demand deposits. The competitive equilibrium is third-best (worse than the incentive-efficient allocation) for two reasons. First, the probability of default may be too high, leading to excessive costly liquidation. Secondly, even if the probability of default is the same as in the incentive-efficient solution, the allocation of risk sharing may be inefficient because of the restriction to (incomplete) deposit contracts.

Thirdly, we examine in Section 5 a competitive banking sector in a monetary economy. Banks use nominal demand deposits (i.e., demand deposits denominated in domestic currency) to finance risky projects. The central bank, through its control of the money supply, can influence the real value of deposits and hence the probability of default. When project returns are low, extension of credit to the bank allows the depositors to be paid off in depreciated currency. If the central bank can commit to a monetary policy ex ante, the incentive-efficient allocation can be achieved through a competitive banking sector. However, in the absence of full commitment, the central bank always extends credit ex post and the outcome is typically worse than the second best.

Comparison of these scenarios (in Section 6) allows us to weigh the costs and benefits of dollarization. In the case of a small, open economy, dollarization corresponds to the real economy, in which market discpline may be excessive but does support high effort by the bank managers. Full use of the LOLR facility in a non-dollarized economy corresponds to the case of a monetary economy without central bank commitment. Market discipline is too low to support high effort. Neither of these cases is second-best

(incentive-efficient). Which is to be preferred depends on the parameters of the economy. We study also how partial (and credible) dollarization could implement the incentive efficient solution. The main contribution of the paper is to provide a framework in which to analyze the impact of the different parameters on the tradeoff between the benefits of market discipline and the costs of liquidation.

Whether it is better to dollarize from the point of view of banking stability is an empirical question. In a first attempt to measure the costs and benefits of dollarization, in Section 7 we survey a number of countries where dollarization can be beneficial prima facie, suggest some empirical counterparts to the parameters of our model, and identify which countries are the leading candidates for dollarization.

Section 2 presents the model and concluding remarks, including a discussion of the potential role a reformed IMF, close the paper.

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 cost A can be interpreted as the benefit that the manager derives from selecting "bad" projects (like giving loans to friends and family or straight embezzlement). 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. The present formulation is extreme but is the simplest way of presenting the banker's choice of effort and it allows us to focus on the bankruptcy point as the critical variable. Despite this simplification, the characterization of the contracting problem is far from trivial and the model allows for a trade-off between too much and too little discipline.[13]

[13]The modelization is similar to Dewatripont and Tirole [1993, 1994]. Dewatripont and Tirole [1994], in a somewhat more complex model, provide a discussion of the reasons why managers prefer continuation even in the presence of monetary benefits.

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 $\gamma r x + y$ and the problem solved by the planner is

$$\begin{aligned} \max_{(c_1(r),c_2(r))} \quad & \lambda u(c_1(r)) + (1-\lambda)u(c_2(r)) \\ \text{subject to} \quad & \lambda c_1(r) + (1-\lambda)c_2(r) \leq \gamma r x + y \\ & c_1(r) \leq c_2(r). \end{aligned}$$

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:

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

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: $c_1(r) = \min\{rx + y, y/\lambda\}$, $c_2(r) = \max\{rx + y, rx/(1-\lambda)\}$ and the maximum utility from continuing the project is

$$U(r, x, y) = \lambda u\left(\min\{rx + y, y/\lambda\}\right) + (1-\lambda)u\left(\max\{rx + y, rx/(1-\lambda)\}\right).^{14}$$

[14]Here is the gist of the argument to check that this is the solution. 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

Figure I 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.[15] That is,

$$U(r, x, y) \geq W(r, x, y), \text{ for all } (x, y, r).$$

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.[16]

Now suppose that the planner has chosen a portfolio (x, y) at date 0

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, $c_2(r) = rx/(1 - \lambda)$.

Here is the gist of the argument to check that this is the solution. 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, $c_2(r) = rx/(1 - \lambda)$.

[15] Whether the consumers are better off on average continuing the project depends on the parameters of the model. The assumption makes sense because we are interested in the problem of time consistency.

[16] 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 $w > 0$. (See Gale and Vives (2001) for a proof.) If $u(w) = w^{1-a}$

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 be 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. Note that $V^0(0)$ is independent of γ, A and B.

The interesting case, therefore, is the implementation of $e = 1$. The planner chooses $q(r)$ to maximize the expected utility of the representative depositor subject to the incentive compatibility constraint to insure that the bank manager exerts effort. 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. 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. Under natural assumptions, the optimal continuation probability does have the form of a cutoff rule. If $f(r, 0)/f(r, 1)$ is decreasing in r we say that the monotone likelihood ratio property (MLRP) holds. If so, $F(r, 1)$ first order stochastically dominates $F(r, 0)$ where $F(r, e)$ denotes the cumulative distribution function of R given the effort level e. The next result gives

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.

sufficient conditions for the optimal rule to be a cutoff rule (see Gale and Vives (2001) for a proof).

Proposition 1 *For a given portfolio (x, y), suppose that $U(r, x, y) - W(r, x, y)$ is increasing in r and the MLRP holds. Then the optimal continuation probability is, for some constant r^0, given by* $q^0(r) = \begin{array}{ll} 1 & r \geq r^0 \\ 0 & r < r^0 \end{array}$ *and the incentive constraint for the banker is given by*

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

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:

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

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. [17] Thus, $r^0 > \underline{r}$ is uniquely determined by the incentive constraint: $r^0 = \inf \{r \in [\underline{r}, \bar{r}] : F(r, 0) - F(r, 1) \geq A/B\}$. Note that r^0 is weakly increasing in A/B. As A/B tends to 0, r^0 tends 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

[17] 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 $A > 0$.

typical solution is depicted in Figure I. 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[18], 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 $e = 1$.[19] Our maintained assumption in the paper is that to induce managerial effort is optimal, that is, $V^0(1) > V^0(0)$.

4 Competitive Banking

We introduce a competitive banking sector in which banks are coalitions of agents that pool their endowments and hire a manager to monitor 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

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

[19] 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.

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 $\lambda d \leq y$ and $d \leq \frac{rx+y-\lambda d}{1-\lambda}$. We assume that whenever these inequalities are satisfied, the late consumers are content to withdraw at date 2.[20]

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

[20]This is not the only equilibrium of the depositors' game at date 1. Indeed, there could be a panic equilibrium in which all depositors withdraw. This can be avoided with suspension of convertibility (c.f., Diamond and Dybvig [1983]).

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

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

where $d\equiv r^*x+y$. Denote by $V^*(1)$ the value of the program. $V^*(1)$ is increasing in γ and nonincreasing in A/B. Whenever the incentive compatibility constraint for the banker is binding an increase in A/B will decrease $V^*(1)$.

At the solution we have, obviously, $r^*\geq r^0$, since the incentive constraint must be satisfied. The banking solution will tend to have $r^*>r^0$ and, consequently, a higher probability of failure. The reason is that the incentive-efficient solution chooses the smallest r^0 compatible with preserving incentives for the banker while at the banking solution the selection of the cutoff r^* determines also the level of $d(=r^*x+y)$ for a given portfolio choice (see Figure II). A low r^* may imply then an excessively low consumption d for early consumers from the point of view of risk sharing. Indeed, the value of r^0 is determined by the distribution $F(r,e)$ and the ratio A/B independently of the choice of (x^0,y^0). One can make r^0 arbitrarily small without affecting the value of r^*. For example, note that as A/B tends to 0, r^0 tends to $\underline{r}$. Provided (reasonably) that the optimal r^* ignoring the incentive constraint has $r^*>\underline{r}$ then whenever A/B is small, $r^*>r^0$. It is interesting to see under what conditions r^* is likely to be high. To illustrate, suppose that $\gamma=1$ so there is no cost to default per se.

Then a competitive bank will choose the same portfolio and consumption allocation as the incentive-efficient solution (the second best).[21] However, to implement this consumption allocation with a deposit contract, it will be necessary to choose $d = y/\lambda$. If the variance of r is "high", one expects the amount of the safe asset to be "high" and this makes it likely that $r^0 x + y < y/\lambda = d = r^* x + y$.

It is worth remarking that the (third-best) banking equilibrium is not the same as the second-best, even if $\gamma = 1$. If the probability of continuing is lower in the third best, the bank manager will be strictly worse off than in the second best, even though the depositors are indifferent. Of course, the costs of financial distress may also be felt in the non-financial sector of the economy [Bernanke and Gertler 1989]. If so, then the gap between $r^*$and r^0 will have consequences far more serious than the effect on the manager's utility (private benefits) of discontinuing the project. The assumption that $\gamma < 1$ is just a cheap way of capturing the idea that financial fragility has real costs.

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 II.

[21] This assumes that $y^0(1-\lambda)/x^0\lambda$ is in the incentive compatible range for r. Recall also that we have that $r^0 \leq y^0(1-\lambda)/x^0\lambda$.

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 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 nondecreasing ($p_1 \leq p_2$). 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, $p_1 = p_2 = p$ (if $p_1 < p_2$ then banks would be willing to store goods only).

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 $R = r$. [22]

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.

The commitment scenario can be studied by analyzing the subgame perfect equilibria (SPE) of the following "extensive form game".

- Stage 1: The central bank (CB) chooses a strategy $p(\cdot)$ that commits it to a price level $p(r)$ conditional on the asset return $R = r$. The policy $p(\cdot)$ is chosen to maximize the expected utility of the typical depositor, taking account of the optimal reactions of the banks and their managers.

- Stage 2: Individual banks take the function $p(\cdot)$ as given and choose the portfolio (x, y) and the nominal contract D (similarly to the last section).

- Stage 3: Bank managers choose high ($e = 1$) or low ($e = 0$) effort to maximize their own utility.

- Stage 4: All uncertainty is resolved and the price level $p(r)$ is implemented. Banks will always choose to continue unless the bank is insolvent, in which case default is unavoidable. The consumption al-

[22] We are thinking therefore of open market operations of liquidity control to help, possibly, a banking system in trouble and not of helping individual institutions.

location is determined by the choice of (x, y, D), the price level $p(r)$, and whether the bank continues or not.

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 consumers 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.[23]

[23]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) domestic currency 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

Proposition 2 *If the central bank can commit to a monetary policy ex ante then the incentive-efficient solution can be implemented with a banking contract in nominal terms. This is accomplished with the following central bank price policy:* $p(r) = y^0/\lambda c_1^0(r)$ *for* $r \geq r^0$ *and* $p(r) = p(r^0)$ *for* $r < r^0$, *where* $(x^0, y^0, c_1^0(r))$ *is the incentive-efficient solution.*

The fact that these actions result in the incentive-efficient allocation proves that they are optimal for each of the players in equilibrium. It is optimal that banks default only when necessary; the incentive constraint ensures that the manager's effort choice is optimal; the bank's choice of (x, y, D) is optimal by definition, given the function $p(\cdot)$, and the CB cannot do better than the incentive compatible allocation.[24]

The situation is very different if the central bank cannot commit to a monetary policy at period 0. The no-commitment scenario is represented by the following " extensive form game".

- Stage 1: Individual banks choose the the portfolio (x, y) and deposit D.

consume.

[24]The players' actions are, of course, functions of the information set at which they are chosen. Thus, strategies are decision rules that map the history of the game into the available action sets. Since there is a large number of banks, there is a large number of possible information sets. For simplicity, we only consider information sets in which almost all banks and managers have made the same choices. Further, note that in our context individual players have no effect on subsequent play of the game. To complete the proof that the incentive-efficient allocation is the outcome of a SPE, we should specify optimal actions for every possible subgame (which we won't bother to do here).

- Stage 2: Given the choices of the individual banks, bank managers decide whether to exert high or low effort.
- Stage 3: Uncertainty is resolved and the CB chooses a price level $p(r)$ conditional on the asset return $R = r$.
- Stage 4: As before.

We have also that, at each stage of the "game", strategies are functions of the actions chosen at the earlier stages. The incentive-efficient policy calls for costly liquidation of the project when $r < r^0$, but the incentive-efficient CB policy is time-inconsistent. Effort by the manager has already been exerted when the decision to continue or discontinue the project has to be made in period 1 (Stage 3). Indeed, then it is always optimal to let the project continue. In any SPE, the CB maximizes the utility of the average depositor by choosing $p(r) = y/\lambda c_1(r)$ at Stage 3 and the banks choose to continue at Stage 4. This implies that $c_1(r) = \min\{rx + y, y/\lambda\}$ and $c_2(r) = \max\{rx + y, rx/(1-\lambda)\}$. This consumption pattern maximizes the utility of the average depositor. Anticipating that the bank will never be closed down, the manager does not exert effort ($e = 0$) and the bank solves the problem that 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

We develop now the idea that dollarization may help alleviate the commitment problem faced by a central bank in a small open economy.

Dollarization represents a commitment precisely because it is costly to reverse. Indeed, once domestic currency has been replaced by the dollar to go back to a domestic currency may be very costly. Typically a currency board (where the domestic currency is backed by dollar reserves) is established by a law of the Parliament (like in Argentina) and therefore to repeal it would need a legislative change. Authorities cannot then react to a crisis with a sudden devaluation.[25]

By the same token dollarization may be costly to adopt. The important issue of the transition to a dollarized system is not considered in the pa-

[25]However, a currency board is ultimately the creation of the government, which can indeed change the law under which it operates or even abolish it altogether. The cost of doing so does not seem to explain the commitment to an extremely costly policy in states of nature where the incentive to adjust is very strong. One explanation may be that the act of abandoning the currency board is very obvious, so the government's policy change is recognized immediately and the benefits are consequently short-lived. A discretionary monetary policy, by contrast, allows the government to adjust interest rates, exchange rates, and price levels in response to privately observed shocks, so it is less clear when there has been a fundamental change in policy. It is possible to sustain cooperative outcomes of a repeated game between the government and foreign investors with the help of a currency board (which makes the moves of the government visible) that avoid dominated outcomes (which are the only possible if the government's moves are not observable). (See Gale and Vives [2001] for a sketch of a model.)

per but might prove crucial. Indeed, dollarization could bring the banking system down when implemented in a crisis context. The tough recent experience of Ecuador comes to mind. To address this issue a dynamic model would be needed.

Our analysis builds on the fact that dollarization represents a commitment to a limited used of a LOLR facility. With dollarization a certain amount of help can be pre-arranged. This typically is not sufficient to deal with a major banking crisis. This may be a problem because in case of crisis the pressure to abolish a currency board, for example, may be enormous. At the same time a limited capacity to help is fortunate because otherwise, most likely it would be misused. What institutional arrangements may be appropriate to establish a credible LOLR? In a country in which institutions have a hard time building a reputation the commitment not to help has to be external. The Federal Reserve will not play a role (it is certainly credible but not willing to help if there is any potential cost to the operation).[26] Another obvious mechanism would be to form a monetary union with other countries and establish an independent central bank. There are several issues with this approach, which involves relinquishing political sovereignty. The first is that the countries should form an optimal currency area. The second is that it is problematic to build an independent central bank for the monetary union of countries whose central banks have problematic reputations. For example, the European Monetary Union (EMU) would probably not have arisen if the Bundesbank had not had such strong anti-inflationary credentials. The third is that the organization of

[26]The Fed may face a cost in terms of confounding its monetary policy.

the LOLR in a monetary union with no central political authority is likely to be contentious. The experience of EMU points to the difficulties that advanced economies with well developed institutions face in establishing a common central bank.[27] At the present stage in Latin America the avenue of monetary union does not seem realistic. A similar argument applies to countries in Eastern Europe or Turkey whose aim is to join the European Union and be members of a euro zone if they can not join EMU.

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 in a first pass that international borrowing is not possible. We will consider two scenarios. First we consider full dollarization and then partial dollarization.

6.1 Full dollarization

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

[27] See Vives [2001] for a discussion of financial architecture in Europe.

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).

A necessary condition for dollarization to be good is that a moral hazard problem for the banker 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. We know that $V^*(1)$ is nonincreasing (decreasing) in A/B (when the incentive constraint binds) while $V^0(0)$ is independent of A/B. When A/B is high it becomes expensive to provide incentives and it may be that $V^*(1) < V^0(0)$.

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). For example, 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.[28]

2. The cost of liquidation is not too high (γ is close to 1). When liquidation is not costly ($\gamma = 1$) we have seen that competitive banking can replicate the incentive-efficient allocation and we get $V^*(1) = V^0(1)$.[29] 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 (and $V^0(0)$ independent of γ) we will have then that for γ large, $V^*(1) > V^0(0)$ because by assumption $V^0(1) > V^0(0)$.[30]

Proposition 4 *Dollarization will be welfare improving* ($V^*(1) > V^0(0)$), *in the presence of a moral hazard problem for the banker, when effort is important to increase returns or the cost of liquidation is not too high* (γ *is close to* 1). *However, a severe moral hazard problem (A/B high) may*

[28]Note that, contrary to our assumption, we have an unbounded support for R with the normal distribution.

[29]When there is no liquidation cost ($\gamma = 1$) the central bank 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.

[30]Furthermore, there is a conceivable knife-edge case for which $V^*(1) = V^0(1)$. This would happen if $r^* = r^0 = y^0(1-\lambda)/x^0\lambda$. However, when the distribution of R has a two-point support, $V^*(1) = V^0(1)$ is a robust possibility.

induce $V^*(1) < V^0(0)$.

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 not very high.

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, and supervision as well as a country which relies on bank monitoring to make finance available for entrepreneurial projects. For politically stable countries with a modern institutional structure and deep financial markets, dollarization is not likely to be a good idea. However, we have seen also that if the moral hazard problem is very severe dollarization may be welfare reducing. For dollarization to be good the moral hazard problem cannot be hopeless and incentive provision cannot be extremely costly. This points at an intermediate range of countries with a weak institutional structure but without an extreme agency problem.

Our results should be contrasted with those on the time consistency of monetary policy (Kydland and Prescott [1977] and Barro and Gordon [1983]). In those models the absence of commitment leads central banks to choose excessive inflation. The benefits of dollarization (adopting a stable currency) then increase monotonically with the inflation bias present in

the country [Alesina and Barro 2000b]. In our paper the net benefits of dollarization (from the perspective of the stability of the banking system) are not monotone in the severity of the moral hazard problem.

6.2 Partial dollarization

The question arises whether a mixture of partial dollarization and central bank intervention (without assuming commitment) 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. (See Figure III.) 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.[31] For $r > r^0$ the central bank can offer help by inflating and increasing the price level (depreciating the currency) 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

[31] It is worth noting that when $r < r^0$ to demand D is not an equilibrium. If all depositors demand D and the central bank adjusts $p(r)$ so that the bank is solvent, then an individual thinks he can obtain $d > D/p(r)$. This is so because a single individual cannot affect the solvency of the bank (and therefore he compares the value of the two options d and $p(r)$ assuming the bank is solvent.

aspect of the banking contract is the right of depositors to demand d dollars back at date 1.

This is only one of the many ways to implement the incentive-efficient allocation with partial dollarization. Indeed, any scheme which allows depositors to maintain a percentage $\alpha \in (0,1)$ of their endowment in dollars to obtain, at date 1, $(1-\alpha)D$ in pesos and αd in dollars with $\alpha d = r^0 x^0 + y^0$ and $(1-\alpha)D = y^0/\lambda - (r^0 x^0 + y^0)$ will implement the incentive-efficient allocation with an appropriate central bank policy. As before, for $r < r^0$ the bank is liquidated and all depositors share the liquidated value of the assets; for $(1-\lambda)y^0/\lambda x^0 > r \geq r^0$ the central bank offers help by inflating so that depositors consume the optimal amount $\alpha d + (1-\alpha)D/p(r) = c_1^0(r)$, with $c_1^0(r) = rx^0 + y^0$.

Partial dollarization presents two problems. The first problem is credibility. Indeed, partial dollarization is easier to reverse that full dollarization. For example, whenever $r < r^0$ the banker may insist to the central bank that dollar convertibility be suspended and the bank saved. The argument is powerful: It is ex post efficient to do so. With civil servants and politicians with short horizons the incentive consequences of the help are not internalized. The second problem is of a dynamic nature and cannot be captured by our model. Once banks accept dollar deposits they are likely to make dollar denominated loans to domestic residents to avoid exchange rate risk and because they have a comparative advantage serving domestic customers.[32] In this case central bank help inflating may imply a devaluation of the currency and may bankrupt dollar indebted households. We

[32]See Calvo [2000].

would then have the result that access to the peso printing press may magnify the banking stability problem. The problem may be compounded by self-fulfilling expectations of a banking crisis. Households anticipate that in case of crisis the money supply will be expanded, inflation will accelerate and households will demand high nominal interest rates which will translate into high real rates (this is the "peso problem"). The result is a further weakening of the banking system. This may have happened in the recent banking crisis in Ecuador.

These considerations point at the potential instability of partial dollarization without external help providing credibility to the program.

7 From theory to measurement and policy

We have identified a series of theoretical forces that go for and against dollarization. The question arises about how to measure them: What observable variables can we look at to check whether for a particular country dollarization is a good idea from the point of view of banking stability? In this section we put the model to work by

- establishing a link between the parameters in our model and observable country variables;
- assessing what countries would benefit most with dollarization; and
- studying the role of the IMF as International LOLR.

7.1 Where is it good to dollarize?

We will consider a universe of countries where dollarization may be an issue and from which we have been able to gather some data. We concentrate attention on Latin America and South East Asia although we consider also Turkey in the periphery of Europe. Those countries are: Argentina, Brazil, Chile, Colombia, Ecuador, Mexico, Peru, Uruguay and Venezuela in Latin America; Hong Kong, Indonesia, Malaysia, Philippines, Singapore, South Korea, Taiwan and Thailand in East Asia; and Turkey.

In the following we discuss possible, of necessity crude, measures of the determinants of the welfare analysis of dollarization: credibility of the central bank, moral hazard, importance of effort for returns, and cost of liquidation of projects.

Credibility of the central bank. To assess the overall credibility/reputation of a central bank is not easy. We will use here the ranking on central bank independence of 46 countries during the 1980s elaborated by Cukierman [1992] and based on a combined index of legal independence, actual turnover of the governors and a response by experts to a questionnaire. [33] Among the countries we consider in this section, at the bottom of the ranking appear Argentina, Brazil, Chile, Turkey, Venezuela, Mexico, Peru, Uruguay, South Korea and Indonesia. Above those we have the Philippines and Thailand.[34] If we look only at the actual turnover of governors (for the

[33] This ranking is inflation-based and weights the three indexes according to their relative contribution in explaining the variations in the rate of depreciation of the value of the currency.

[34] See Table 21.1 in Cukierman [1992].

period 1950-1989) as an index of credibility, the picture is not very different with the highest average turnover rates per annum for Argentina, Uruguay, South Korea, Turkey, Chile, Singapore, Peru and Venezuela. Thailand, Colombia, Mexico, the Philippines and Malaysia have more moderate rates (from .20 to .13).[35]

Except perhaps for the Philippines and Thailand the indicators point to an important credibility problem for the central bank. In any case, note that the Philippines have the same level of overall central bank independence than Kenya, and Thailand than Greece. It must be pointed out however that developments in the 1990s may qualify the picture for some countries (for example, in Chile).

Moral hazard. The severity of the moral hazard problem, indexed in our model by A/B, could be proxied by the battery of legal indicators reflecting the rule of law in different countries of La Porta, Lopez-de-Silanes,Shleifer and Vishny [1998]. Those include indicators of the efficiency of the judiciary system, rule of law proper ("law and order tradition" of the country), corruption, risk of expropriation and risk of contract repudiation by the government, as well as a rating on accounting standards. Low marks on these indicators would suggest a severe moral hazard problem for the banker. For example, in countries with poorly defined or poorly defended property rights, some of the bank's marginal returns will be captured by others, which increases the marginal cost A of ensuring high returns. We

[35]See Table 19.4 in Cukierman [1992]. While the legal or institutional indexes of central bank independence do not appear to be correlated with inflation in LDCs, the turnover rate of governors is (see Cukierman, Webb and Neyapti [1992]; the results are confirmed by Fry [1998]).

classify the marks given in La Porta, Lopez-de-Silanes,Shleifer and Vishny (1998) into low, medium and high (Table I).[36]

We summarize in Table II the results of aggregating country performance according to the different indicators in three levels of the moral hazard problem: severe, significant, and moderate. Peru, Indonesia and Philippines have a severe moral hazard problem (with 3 or 4 low marks). Argentina, Brazil, Chile, Colombia, Ecuador, Mexico, South Korea, Taiwan, Thailand, Turkey, and Uruguay have a significant but not extreme moral hazard problem (with at most one low mark). Venezuela (with two low marks) and Uruguay (at the boundary of the Low region of Table I, with 5 points, in Rule of Law and Corruption) are boundary cases between the "severe" and "significant" regions. Hong Kong, Malaysia, and Singapore receive high marks and have a moderate moral hazard problem.

The importance of effort. The importance of effort by bank managers for project returns can be proxied by the relevance of banks in the financial system. This can be measured by the amount of bank assets to total financial assets. In the countries of our sample only South Korea is below .50 (with no data for Hong Kong, Indonesia and Singapore). For Argentina, Brazil, Ecuador, Peru, the Philippines and Taiwan is above .80. [37]

Note that there is a link between the (indirect) moral hazard indicators given before (related to the rule of law and accounting standards) and the importance of effort by the banking manager to obtain returns. In countries with a severe or significant moral hazard problem with the firms in the

[36]Data on accounting standards is not available for Ecuador.

[37]Source: Financial Structure and Development Database of the World Bank with data from 1997.

private sector, suggested by low marks in the rule of law indexes, effort by the bank manager will also be important. This means that, perhaps with exception of Hong Kong, Malaysia and Singapore, effort to obtain returns is bound to be important in our set of countries.

Cost of liquidation. The cost of liquidation of projects is somewhat more difficult to proxy. One approximation is to think that high creditors rights are linked with a lower cost of liquidation of projects. In this respect we have that Colombia, Mexico, Peru and the Philippines have low rights; Argentina, Brazil, Chile, Turkey, Uruguay, Taiwan and Venezuela have medium rights; and Ecuador, Hong Kong, Singapore, Malaysia, Thailand, South Korea, and Indonesia have high rights. [38]

A complementary indicator of the liquidation cost is the level of development of the financial system. Indeed we may think that more developed financial systems can cope better with adverse selection problems at the root of costly liquidation. A crude proxy for the level of financial development is the amount of credit to the private sector over GDP.[39] In 1998 Argentina, Mexico, Peru, Turkey and Venezuela were no more than .25; Brazil, Colombia and Uruguay close to .35; Ecuador, Indonesia, and the Philippines close to .50; Chile and South Korea in the .60-.75 range; and Hong Kong, Malaysia, Singapore and Thailand above 1.[40] Of the countries

[38]It is worth noting that creditor rights tend to be stronger in poorer countries (possibly to facilitate secured lending where there are no other financing opportunities). In the score system of La Porta, Lopez-de-Silanes,Shleifer and Vishny [1998, Table 4] for a maximum of 4 points we consider low rights 0, medium 1-2 and high 3-4 points, respectively.

[39]See Rajan and Zingales [1998] for related indicators.

[40]Source: World Development Indicators of the World Bank. Taiwan is not in the database.

considered Argentina, Colombia, Ecuador, Peru, Turkey, Uruguay, South Korea and Venezuela were below the .25 threshold for stock market capitalization over GDP in 1997. Brazil, Mexico and Indonesia were at about .30, Thailand around .40, the Philippines at .70 and Hong Kong, Malaysia, Singapore and Taiwan above 1 (with Chile close).[41] In terms of accounting standards (Table I), another indicator of financial development, Peru, Uruguay and Venezuela obtain low marks.[42]

We summarize the level of financial development in three categories: low if both the amount of credit to the private sector over GDP and stock market capitalization over GDP are below 25 percent and if accounting standards are low; high if the amount of credit to the private sector over GDP is above (or not far from) 50 percent and stock market capitalization over GDP is above 40 percent; and medium otherwise. With this aggregation procedure we find that Peru, Uruguay, and Venezuela are in the low category; Argentina, Brazil, Colombia, Ecuador, Mexico, South Korea, Turkey, and Indonesia in the medium one; and Chile, Hong Kong, Singapore, Malaysia, the Philippines, Thailand, and Taiwan in the high one.

Putting together the two sets of indicators we arrive at an estimate of the cost of liquidation provided in Table III. We will say that the cost of liquidation is high if the country obtains a low mark in both indicators; medium-high if the country obtains medium-medium or medium-low marks; medium-low if the country obtains at least one high mark: and low if the country obtains two high marks.

[41] Source: Financial Structure and Development Database of the World Bank.

[42] Although Venezuela gets 40 points, at the boundary of the Medium region in Table 1.

Altogether we may suspect therefore a high cost of liquidation of projects in Peru; important for Argentina, Brazil, Colombia, Mexico, Uruguay, Venezuela, and Turkey; moderate for Ecuador, Chile, Philippines, South Korea, Taiwan, and Indonesia; and low for, Hong Kong, Singapore, Malaysia, and Thailand. It is interesting to note the regional difference between Latin America and East Asia.[43]

Assessment. These indicators, taken together, point to a middle range of countries where dollarization can be a good idea from the point of view of banking stability. Those countries are at the intersection of significant or moderate levels of the moral hazard problem (Table II) with medium or low levels of the cost of liquidation (Table III). Among them we can highlight some Latin American countries, like Argentina, Brazil, Chile, Colombia, Ecuador and Mexico (but not Peru and both Venezuela and Uruguay are borderline), as well as some East Asian tigers, like Hong Kong, Malaysia, South Korea, Singapore, Taiwan and Thailand (but not Indonesia and the Philippines), and Turkey. Peru, Indonesia and the Philippines (and perhaps Venezuela and even Uruguay) are discarded because of the extreme severity of the moral hazard problem to which a potentially large cost of project liquidation is added for Peru, Uruguay, and Venezuela. The benefits of dollarization to Hong Kong, Malaysia, and Singapore are moderated by the relative lessened importance of monitoring effort to improve returns in those economies.

Despite this the costs of dollarization (in terms of costly liquidation of

[43]This would be consistent with the better-than-expected recovery of South East Asia from the recent financial crisis.

assets) are not uniform with the East Asia tigers, Ecuador and Chile being on the light side, while the costs will be more stiff for Argentina, Mexico and Turkey as well as for Brazil and Colombia.

It would be interesting to compare the results obtained with the implications of the theory of optimal currency areas for individual countries. The countries that should tend to abandon their currency are those that have a history of high and variable inflation (lack of domestic commitment ability); a large volume of international trade (particularly with the anchor country); a cycle that co-moves with the anchor; and stable relative prices with the anchor [Alesina and Barro 2000a]. According to these criteria the yen does not look appealing as a potential anchor, except perhaps for Indonesia. For Central America, Mexico and Ecuador the US dollar is the best anchor. Same is true for Canada, the Philippines, Hong Kong and Singapore. For South America, the choice of anchor is not so clear. For example, for Argentina the euro could work also. For Western and Eastern Europe as well as most of Africa the euro is the candidate anchor.

8 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.

The basic results point to a middle range of countries where to dollarize is a good idea from the point of view of the stability of the banking system. This includes some Latin American countries, like Argentina, Brazil, Chile,

Colombia, Ecuador, and Mexico (but not Peru, and Uruguay and Venezuela are doubtful), as well as some East Asian tigers, like Hong Kong, Malaysia, South Korea, Singapore, and Taiwan (but not Indonesia and the Philippines), and Turkey. However, the costs of dollarization are not equal for all countries with the East Asia tigers, Ecuador and Chile on the light side, while the costs can be much higher for Argentina, Brazil, Colombia, Mexico and Turkey. It is interesting to notice that, according to our analysis, Ecuador would qualify for dollarization from the perspective of the stability of the banking system. Meanwhile IMF officials were openly skeptical about the process. Dollarization is not good for countries where the moral hazard problem is extreme.

We should warn the reader however that our model can be used only as a first screening device to assess the costs and benefits of dollarization for the stability of the banking system. A country by country deeper study should be conducted to reach a more definitive policy conclusion.

Given that dollarization has costs in terms of excessive liquidation welfare could be improved either with a partial and credible dollarization or with the intervention of an international LOLR like a reformed IMF. Let us explore the potential role of the IMF.

The central problem of implementing the incentive-efficient solution is how to provide help without losing the commitment capacity to avoid helping when ex ante efficiency requires it. An independent IMF may be just what is needed. This is how it could be done. The IMF could provide a loan only when the country has enough collateral (more than $r^0x^0 + y^0$ in terms of our model). The IMF should provide help in the range r^0

$\leq r < (1-\lambda)y^0/\lambda x^0$. Obviously to determine the minimum required amount of collateral (and the range where help has to be provided) a supervisory knowledge of the (relevant parameters of the) economy is needed and therefore the IMF should have supervisory capacity. What is interesting is that the reason why a minimum amount of collateral is needed for help is not to secure the loan but to impose a threshold below which help is not given. Although the IMF can ask for collateral it rarely does so.[44] Instead the IMF requires "policy conditionality" for the loan.[45] However, according to our analysis, what makes sense is conditionality in terms of rule of law and accounting standards because it avoids lending to countries where the moral hazard problem is hopeless.

This requires an IMF with a statute which provides independence (along the lines, for example, of De Gregorio, Eichengreen, Ito, T. and Wyplosz [1998]). This is crucial to avoid granting help when it is not ex ante efficient to do so and therefore contributing to moral hazard. In summary, a reformed IMF would need to be independent, lend on the basis of collateral and require a minimal institutional infrastructure for the country.

To be sure another line of argument would insist that with dollarization the domestic banking system will fall into foreign hands anyway and therefore bailouts could be provided by strong international banks super-

[44]The reason is that the IMF is seen as preferred creditor and therefore not repaying the IMF means essentially being denied access to the international capital market [Fischer 1999].

[45]Including, among other things, that the country meets, or move in the direction of meeting, international standards (in information provision in particular, Special Data Dissemination Standards).

vised abroad and supported by their respective central banks. Indeed, local banks are being bought in Latin America by strong international banks (with solid collateral).. This solution has been successful in a country like Panama where there is no LOLR facility except for, seemingly, a large US bank.[46] However, it is doubtful that international banking can be the sole answer to the problem. This is because the private incentives of the international banks and those of foreign LOLR and supervisors are not in line with local interests. Indeed, neither a private bank nor a foreign supervisor will take into account the consequences (systemic or not) for domestic residents of a restructuring of a local branch or subsidiary.[47] At the same time the headquarters of foreign banks may want to limit the exposure to a country which may face a currency crisis, tightening therefore liquidity provision to the branches of the bank in the country in question.

The market failure that the IMF is addressing is derived from the lack of commitment capacity of domestic institutions. The view [Chari and Kehoe 1998] that an International LOLR is not needed because the joint action of the Fed, the ECB and the BoJ can take care of any international liquidity problem does not take into account problems that may be systemic in small dollarized countries but non systemic worldwide. We believe therefore that there is room for an International LOLR.

NEW YORK UNIVERSITY

INSEAD and INSTITUT D'ANÀLISI ECONÒMICA, CSIC

[46]See Chapman [1999] and Moreno-Villalaz [1999].

[47]See Vives [2001] for an analysis of similar problems in the European context.

9 References

Alesina, Alberto and Robert J. Barro "Dollarization" (2000a) forthcoming in *American Economic Review.*

_____ and _____, "Currency Unions," NBER Working paper 7927, forthcoming in the *Quarterly Journal of Economics* (2000b).

Allen, Franklin and Douglas Gale, "Optimal Financial Crisis," *Journal of Finance*,LIII (1998), 1245-1284.

Barro, Robert J. and David Gordon, "Rules, Discretion, and Reputation in a Model of Monetary Policy,", *Journal of Monetary Economics*,XII (1983), 101-121.

Bernanke, Ben and Mark Gertler "Agency Costs, Net Worth, and Business Fluctuations," *American Economic Review*, LXXIX (1989), 14-31.

Bhattacharya, Sudipto and Charles Jacklin. "Distinguishing panics and information-based bank runs: Welfare and policy implications," *Journal of Political Economy* XCVI (1988), 568-592.

Calomiris, Charles, "The IMF's Imprudent role as Lender of Last Resort," *Cato Journal*, XVII (1998), 275-294.

_____, "Blueprints for a New Global Financial Architecture," mimeo, Columbia Business School, New York, (1998).

Calomiris, Charles and Andrew Powell, "Can Emerging Bank Regulators Establish Credible Discipline? The case of Argentina, 1992-1999," World Bank 2000 ABCDE Conference, (2000).

Calvo, Gillermo, "Argentina's Dollarization Project: A Primer," mimeo (available at http://www.bsos.umd.edu/econ/ciecpn.htm) (1999).

_____, "Capital Markets and the Exchange Rate. With Special Reference to the Dollarization Debate in Latin America," mimeo, (2000).

_____,. (2000), "Brief Analytical Chronicle of Dollarization," (available at http://www.bsos.umd.edu/econ/ciecpn.htm)(2000).

Caprio, Gerard Jr. and Daniella Klingebiel, "Bank Insolvency: Cross-Country Experience", World Bank Policy Research Paper 1620. Washington, D.C., The World Bank (1996) .

Chang Roberto and Andres Velasco, "Financial Fragility and the Exchange Rate Regime," working paper, New York University, (1998a).

_____ and _____ , "Financial Crises in Emerging Markets. A Canonical Model," working paper, New York University (1998b).

Chapman, Gary, "La Experiencia de Dolarización en Panama", paper presented at the conference on *Opciones Cambiarias para la Región,"* sponsored by the IADB, July 23-24, Panama City, Panama (1999).

Chari, V. and Patrick Kehoe" Asking the Right Questions about the IMF," *Public Affairs*, XIII (1998), 3-26.

Cukierman, Alex, *Central Bank Strategy, Credibility and Independence. Theory and Evidence*, MIT Press, Cambridge: Massachussetts (1992).

Cukierman,Alex, Steven B. Webb and Bilin Neyapti, "Measuring the Independence of Central Banks and its Effects on Policy Outcomes," World Bank Economic Review, VI (1992), 353-98.

De Gregorio, José, Eichengreen, Barry, Ito, Takatoshi and Charles Wyplosz, "An Independent and Accountable IMF: Geneva reports on the World Economy 1," ICMB Centre for Economic Policy Research, (1998).

Dewatripont, Mathias and Jean Tirole, "Efficient Governance Structure:

Implications for Banking Regulation„ in *Capital Markets and Financial Intermediation*, C. Mayer and X. Vives (eds), CUP, Cambridge: UK (1993).

_____ and _____ "A Theory of Debt and Equity: Diversity of Securities and Manager-Shareholder Congruence," *Quarterly Journal of Economics*, CIX (1994), 1027-54.

Diamond, Douglas and Philip Dybvig, "Bank Runs, Deposit Insurance, and Liquidity, ", Journal of Political Economy, XCI (1983), 401-419.

Dziobek, Claudia and Ceyla Pazarbasioglu, "Lessons from Systemic Bank Restructuring: A Survey of 24 Countries," IMF Working Paper 97/61 (1997).

Eichengreen, Barry, *Toward a new International Financial Architecture: A Practical Post-Asia Agenda*, Institute for International Economics (1999).

Fisher, Stanley, "On the Need for an International Lender of Last Resort," *The Journal of Economic Perspectives*, XIII (1999), 85-104.

Fry, Maxwell J., "Assessing Central Bank Independence in developing countries: Do Actions Speak Louder than Words?," *Oxford Economic Papers*, L (1998), 512-529.

Gale, Douglas and Xavier Vives, "Technical Appendix to Dollarization", mimeo (2001) (available at http://www.nyu.eddu/econ/user/galed and at http://www.iae.csic.es/en/personal/vives2.htm)

Ghosh, Atish R., Anne Marie Gulde and Holger Wolf , "Currency Boards: More Than a Quick Fix?," *Economic Policy*, XXXI (2000), 269-335.

Gorton, Gary , "Banking Panics and Busines Cycles," *Oxford Economic*

Papers, XL (1988), 751-781.

Grossman, Stanford and Oliver Hart, "Corporate Financial Structure and Managerial Incentives," in J. McCall (ed.) *The Economics of Information and Uncertainty*, 107 - 137. Chicago: University of Chicago Press, (1982).

IMF, *Monetary Policy in Dollarized Economies*, Occasional Paper No.171, (1999).

Kaminsky, Graciela and Carmen Reinhart, "The Twin Crises: The Causes of Banking and Balance-of-Payments Problems," *American Economic Review*, LXXXIX(1999), 473-500.

Krugman, Paul, "What Happened to Asia?, mimeo, Massachussetts Institute of Technology, (1998).

Kydland, Finn and Edward Prescott, "Rules Rather than Discretion: The Inconsistency of Optimal Plans," , Journal of Political Economy, LXXXV (1977), 473-492.

La Porta, Rafael, Florenci Lopez-de-Silanes, Andrei Shleifer and Rrbert W. Vishny, "Law and Finance," *Journal of Political Economy*, CVI (1998), 1113-1155.

Moreno-Villalaz, Juan Luis, "Lessons from the Monetary Experience of Panama: A Dollarized Economy with Financial Integration", *CATO Journal*, Winter (1999), 421-439.

Postlewaite, Andrew and Xavier Vives , "Banks Runs as an Equilibrium Phenomenon", *Journal of Political Economy*, IXV (1987), 484-491.

Rajan, Raghuram and Luigi Zingales, "Financial Dependence and Growth", *American Economic Review*, LXXXVIII (1998), 559-86.

Rodrik, Dani and Andrés Velasco, "Short-Term Capital Flows", World Bank 1999 ABCDE Conference (1999).

Rose, Andrew, " One Money, One Market: Estimating the Effect of Common Currency on Trade," *Economic Policy*, XXX (2000), 7-46.

Santiprabhob, Veerathai, "Bank Soundness and Currency Board Arrangements: Issues and Experience" IMF, PPAA/97/11, December (1997).

Vives, Xavier, "Restructuring Financial Regulation in the European Monetary Union", *Journal of Financial Services Research,* XIX (2001), 57-82.

World Bank, "Argentine Financial Sector Review," September (Report No. 17864-AR) World Bank, Washington DC, (1998).

TABLE II

MORAL HAZARD PROBLEM

Severe	Peru, Indonesia, Philippines
	Venezuela, Uruguay
Significant	Argentina, Brasil, Chile, Colombia, Ecuador, Mexico
	South Korea, Taiwan, Thailand, Turkey, Uruguay
Moderate	Hong Kong, Malaysia, Singapore

Classification of countries in three categories according to the level of moral hazard obtained by aggregating a battery of legal indicators plus accounting standards. (Venezuela and Uruguay are borderline between the Severe and the Siginificant regions.)

TABLE III

COST OF LIQUIDATION

High	Peru
Medium-high	Argentina, Colombia, Brazil, Mexico, Uruguay, Venezuela, Turkey
Medium-low	Ecuador, Chile, Philippines, South Korea, Taiwan, Indonesia
Low	Hong Kong, Singapore, Malaysia, Thailand

Classification of countries in four categories according to the level of the cost of liquidation of projects obtained by aggregating indicators of creditors rights and of the level of development of the financial system.