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5 Welfare, Banks, and Capital Mobility in Steady State: The Case of Predetermined Exchange Rates

Guillermo A. Calvo

5.1 Introduction

This paper explores a kind of "minimum framework" with which the role of banks, and particularly their welfare implications, can be examined. This topic of study is of undoubtedly great importance for modern economies, given the worldwide tendency to pursue relatively free banking, a phenomenon that has been unfolding perhaps more in response to the increase in the inflation rate of the leading currencies over the past decade—more by "economic necessity," as it were—than in response to the thoughtful design of influential economists (see, however, McKinnon 1973, Sargent and Wallace 1981).

The need to develop criteria to judge the different responses is particularly salient in countries in which the movement toward a freer banking system has been associated with serious economic disruptions; examples of these are Argentina and Chile in recent years (see Díaz-Alejandro 1985). The relationship here is not necessarily one of cause and effect, but the fact that the two events went together represents for all practical purposes a political indictment of free banking. An unwinding of this road, if at all desirable, will therefore require a deep and persuasive intellectual effort.

The investigation that follows is based on a small-country, overlapping-generations model in which the monetary authority announces a particular path for the exchange rate. Since the analysis concentrates on steady states, the rate of devaluation will be closely related to the rate

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of inflation. Thus, the first research question asked is what is the optimal rate of inflation in the absence of banks, where the criterion of optimality is the population's steady-state expected utility at birth. Contrary to models examining identical individuals, like the ones emphasized in Friedman (1969), the model employed here shows that when there are no distortions in the capital market, the optimal rate of inflation is zero, and, more significantly (because of the greater robustness of the finding), that as a general rule there is no presumption that the optimal nominal interest rate be equal to zero (the condition of "full liquidity"). This latter result is obtained even when the existence of lump-sum taxes and subsidies, as in Friedman (1969), is allowed.

The model presented here is such that if there were no money to speak of, it would be optimal to allow for free international capital mobility. Thus, a natural question is whether the introduction of money implies some optimal intervention in the capital market if the authority could simultaneously control the rate of inflation. The answer is, again, in the negative: the optimum is attained with no control on capital mobility and zero inflation.

The next step in the analysis is to introduce banks as intermediaries that can issue deposits, hold cash, and buy securities. The banks are assumed competitive but may be subject to a minimum cash/deposits ratio. Again, the nonintervention, zero inflation results appear in this case. In addition, the results show that a lowering of the cash/deposits ratio is always welfare improving if capital mobility is perfect and inflation is set at its optimal level. Whether such a movement toward banking liberalization is welfare-enhancing in the presence of distortions is less clear; however, the analysis does indicate that when cash and deposits are perfect substitutes and the government is constrained to collect a given amount of revenue using distortionary taxation, a lower cash/deposit ratio is welfare increasing, despite the fact that as a general rule it will call for a larger, and permanent, rate of inflation.

The discussion so far is covered in more detail in section 5.2 and in the appendix. Section 5.3 examines some extensions of the model, such as imperfect subtitutability between cash and bank deposits and the existence of nontradable goods. The "liberal" message is, on the whole, sustained, although it has to be qualified in the presence of government revenue constraints and imperfect cash-deposits substitutability. The section also contains a brief description of the underlying microeconomics of banking.

The above scenarios are very "open" in the sense that trade in both goods and securities is allowed. Up to this point in the paper, however, the implicit assumption is that foreigners have no interest in the small country's "money," and neither does that country in theirs. This assumption is relaxed in section 5.4, where a foreign demand for domestic money is assumed to exist. The reason for emphasizing this aspect of the currencies markets—and not, for instance, the demand for foreign money by domestic residents—is the perception in countries having problems associated with a banking liberalization process that the latter are partly related to the high volatility of "foreign" funds, originally attracted by the relatively high interest rates on domestic bank deposits.

The presence of a foreign demand for domestic money or deposits may call for a drastic departure from the optimum of the currency-isolated economy; this is shown to be particularly the case if, in order to attract foreign funds for this purpose, the central bank is obliged to acquire highly liquid assets as some kind of insurance against, say, a run against the domestic currency. Optimal intervention may require making home deposits much less attractive than under the optimum in the currency-isolated economy. But the analysis presented here also shows that to the extent that cash and deposits are perfect substitutes, it is always welfare improving to lower the cash/reserve ratio and to increase the rate of inflation. In this sense, therefore, the presence of foreigners in the domestic currency market does not necessarily call for a tighter control on the banking system.

Section 5.4 closes with a discussion of alternative ways to reduce the cost of attracting foreign funds. Following the summary in section 5.5, the appendix presents another way of proving the first-best optimality propositions of the text and some discussion of the optimal inflation (rate of devaluation) problem.

5.2 Inflation and Banks in Deterministic Steady State

This section will explore some of the simple economics of optimal inflation and banking in the context of an overlapping-generations model. I will confine my attention to deterministic steady states. Furthermore, to minimize the confounding effects of phenomena that would be extraneous to the discussion, I will assume that net taxes are given back to the public in the form of lump-sum subsidies.

Consider an economy in which the residents live for two periods in a paradisaic steady state with constant population. Assume that, except for their date of birth, all residents are alike. Also assume that this economy is floating along in molecular oblivion, surrounded by a sea of other countries all producing the same output, where the law of large numbers dictates a constant one-period (international) rate of interest, r^*.

As a warm-up exercise let us first examine the nonmonetary equilibrium. The typical consumer's utility function is indicated by $U(c^1, c^2)$, where $c^i (i = 1, 2)$ denotes consumption when young and old, respectively. Marginal utilities are positive, and $U(., .)$ is strictly quasi-concave. Let b denote the output value of bonds held by residents, and let r indicate the domestic real interest rate. Assume that the central authorities are in a position to create a wedge between r and r^*. But since, as indicated above, these authorities are assumed to consume nothing by themselves, we postulate that:

$$(r^* - r)b = g, \tag{1}$$

where g is government lump-sum transfers to the private sector (measured in terms of output.) In words, equation (1) states that the difference between the international and domestic values of the service account (of the balance of payments), is given back to the public in the form of lump-sum transfers.

Let us consider, in particular, the case in which g is given to the old; and to economize on notation, also assume that there is only one individual in each generation. The budget constraints of that individual are defined as follows:

$$y^1 = c^1 + b \tag{2}$$

$$y^2 + b(1 + r) + g = c^2. \tag{3}$$

Equation (2) simply states that income in period 1, y^1, is to be allocated between consumption in period 1 and the bond; equation (2), on the other hand, states that output in period 2, y^2, plus the gross revenue from the bond, $b(1 + r)$, plus government transfers, g, must equal second-period consumption.

Let us now turn to the impact on steady-state utility[1] of a change in r, the domestic interest rate. By equations (2) and (3):

$$c^2 = y^2 + (1 + r)(y^1 - c^1) + g. \tag{4}$$

Thus, if the original solution is interior (an assumption that will be maintained throughout), and if the "envelope theorem" (see Takayama 1974) is applied:

$$\begin{aligned} dU/dr &= (\partial U/\partial c^2)[\partial c^2/\partial r + (\partial c^2/\partial g)(dg/dr)] \\ &= (\partial U/\partial c^2)(r^* - r)db/dr, \end{aligned} \tag{5}$$

where the partial derivatives involving c^2 are supposed to be taken in equation (4); and dg/dr is the total change of g (as defined by equation [1]) when r is increased. More intuitively, the change in U is being evaluated by calculating the increase in welfare that would occur if the entire adjustment fell on c^2. This calculation yields the true variation in U, because the individual is assumed to optimize, taking into account his budget constraint; and the implication is that the marginal utility of the last unit of money spent on any good should be equalized across goods. Notice that db/dr stands for the optimal response of b to both the change in r and the associated change in g.

In the "normal" case in which $db/dr > 0$,[2] maximum steady-state utility is attained, by equation (5), at the point at which $r = r^*$, that is, when there is no control on international capital mobility and, therefore, when the international and domestic interest rates are equalized.

As can easily be shown the above result is not robust to changes in the allocation of g between the young and the old. Nevertheless, the assumption that transfers are given only to the old is interesting, because it implies that in the absence of money and other imperfections, there should not be any interference with international capital mobility. The following discussion will bring money and banks into the picture in an examination of questions about optimal inflation and bank controls and then, in a framework comparable to the above, in an examination of the question about controls on capital mobility.

Assume that (expected) utility at birth is also a function of real monetary balances, m,[3] thus making it possible to write $U(c^1, c^2, m)$. For concreteness, the marginal utility of money is assumed to be positive, and function U is assumed to be strictly quasi-concave in its three arguments. The representative individual's budget constraints are therefore:

(6) $$y^1 = c^1 + b + m$$

(7) $$y^2 + b(1 + r) + m(1 + \pi)^{-1} + g = c^2,$$

where π is the steady-state, one-period rate of inflation. Unlike in equations (2) and (3), the individual is now allowed to hold money in period 1 and to use it in period 2; the output value of m in period 2 is thus $m(1 + \pi)^{-1}$.

Let M_t stand for the nominal stock of money and P_t stand for the price level, both at time t. Seigniorage from money creation in terms of output then equals:[4]

(8) $$(M_{t+1} - M_t)/P_{t+1} = m\pi/(1 + \pi).$$

The budget constraint for the government therefore implies (recall equation [1]):

(9) $$(r^* - r)b + m\pi/(1 + \pi) = g.$$

Again, if we assume interior solutions, the changes in expected utility caused by changes in π and r are, by equations (6) through (9):

(10a) $$dU/dr = (r^* - r)db/dr + \pi(1 + \pi)^{-1}dm/dr$$

(10b) $$dU/d\pi = (r^* - r)db/d\pi + \pi(1 + \pi)^{-1}dm/d\pi,$$

where, without losing generality, $\partial U/\partial c^2$ is set equal to one (this normalization will be used for all the following "dU" exercises). In addition, the following "normality" assumptions are made:

(11a) $db/dr > 0$ (11b) $db/d\pi \geqslant 0$

(11c) $dm/dr < 0$ (11d) $dm/d\pi < 0$.

It follows from (10) and (11) that if $\pi = 0$, it would be optimal to set $r = r^*$, as in the nonmonetary case. On the other hand, if $r = r^*$, then it is optimal to set π equal to zero. There is therefore a prima facie case for expecting $r = r^*$ and $\pi = 0$ to yield a global maximum. (See the appendix for a formal proof of the latter, $\pi = 0$, that does not even rely on (11).)

A point of considerable theoretical interest is that there is no presumption here that the optimal rate of inflation should, as in Friedman's rule (see Friedman 1969), be related to the market real rate of interest. The example here makes that absolutely clear, since as pointed out before, when there is no interest tax—which Friedman also assumes—optimal inflation is zero.[5] Another important finding of the analysis is that the mere existence of money does not call for controls on capital mobility if the quantity of money is set optimally. If, however, $\pi > 0$, it would not be optimal by (10a), to set r greater than or equal to r^*. As a result, with positive inflation it is optimal to subsidize capital inflows and to tax capital outflows. In other words, in the realistic case in which inflation is a positive number, net borrowing from abroad should be stimulated by subsidizing the rate of interest. This result may be more appealing if the reader notices that positive inflation in this model implies that individuals are receiving the inflation tax in the form of a positive lump-sum transfer during old age. Setting r slightly less than r^* results in a negligible welfare cost because of the change in b (because r is very close to r^*); but since the analysis started at a point at which m was significantly distant from the optimum, the associated increase in m (which was brought about by the lowering of r) has a significant positive effect on welfare. Thus, the subsidy of the interest rate is optimal because of its positive effect on the demand for money; if money demand were totally interest inelastic, for example, the optimal domestic interest rate would equal the international interest rate.

A more difficult question is the optimal policy mix when the government is committed to set g (government transfers) at a given positive level. The answer depends very strongly on the underlying structural parameters; and unfortunately, no generally valid policy rule emerges from the analytical apparatus employed here.

I will now expand the model to analyze the effects of banking. To simplify the exposition, we will assume that there exists only one bank which, however, behaves in a competitive manner (further extensions are discussed in the section 5.3). This bank takes (demand) deposits from individuals and buys bonds yielding the domestic interest rate. Since we assume the costs of operating the bank are nil (or, if you wish, negligible), and since the bank earns zero (pure) profits, we can conclude that if the bank holds a cash/deposits ratio equal to δ, where $0 \leq \delta \leq 1$, the gross return of deposits in terms of output, η, satisfies:

$$\eta = (1 + r)(1 - \delta) + (1 + \pi)^{-1}\delta. \tag{12}$$

The first term on the right-hand side of the equation represents the yield of bonds held per unit of deposit, while the second term is the yield of cash reserves per unit of deposit. Since the bank is a profit maximizer and there is no uncertainty, it will hold all of its assets in only one form, unless the rates of return of the two assets are equal (something that happens only by accident in the present model), or unless it is regulated by, for example, minimum reserve requirements. If we assume the latter here, as long as $(1 + r) > (1 + \pi)^{-1}$—that is, as long as the return on the bond exceeds the return on cash—a profit-maximizing bank will set δ equal to the legal cash/deposits ratio.

Let us now consider the depositors' side. For simplicity of exposition, make the strong assumption that bank deposits are perfect substitutes for cash (extensions to allow for imperfect substitutability are discussed in the section 5.3). Since, by equation (12) and the previous considerations, $\eta \geqslant (1 + \pi)^{-1}$, individuals will find it to their advantage to hold no cash and to maintain all of their liquidity in the form of bank deposits.[6] Thus, in the utility function m will be identified with (real) bank deposits in the discussion that follows.

The budget constraint for the representative individual is now (recall equations [6], [7], and [12]):

$$y^1 = c^1 + b + m \tag{13}$$

$$y^2 + b(1 + r) + m\eta + g = c^2. \tag{14}$$

Furthermore, recalling equation (8) and that in the present case the bank is the only holder of cash, we find:

$$(r^* - r)[b + (1 - \delta)m] + \delta m\pi/(1 + \pi) = g. \tag{15}$$

A comparison of equations (15) and (9) shows that one innovation is that there are now two types of bond holders: individuals (as before), and the bank. The demand for bonds by the bank just equals the share of total deposits that is not kept in the form of cash balances, that is, $(1 - \delta)m$. Another innovation is that the bank is now the only holder of cash, the demand for which thus equals δm.

Let us again study the welfare implications of changing π and r. By methods similar to those used to specify equation (10), it can be verified that, as in the no-banks situation, optimal inflation is zero if $r = r^*$ (that is, if there is no tax on interest). Furthermore:

$$(16)\quad dU/dr = (r^* - r)[(1 - \delta)dm/dr + db/dr] + \delta\pi(1 + \pi)^{-1}dm/dr.$$

Hence, if $\pi = 0$ and if:

$$(17)\quad (1 - \delta)dm/dr + db/dr > 0,$$

then it is optimal to set $r = r^*$. To understand this result better, notice that $(1 - \delta)m$ is the demand for bonds by the bank, and equation (17) therefore requires that the *aggregate* demand for bonds increases with the rate of interest. Moreover, this proposition is the natural extension of the one proved for the no-banks case, since when $\delta = 1$, that is, when the bank holds 100 percent reserves, equation (17) reduces to (11a).[7]

Of even greater interest is to study the impact of changing the minimum cash/deposits ratio at the bank. Suppose that $(1 + \pi)^{-1} < (1 + r)$ so that cash yields a smaller return than bonds. As argued above, δ will therefore be set at the legal minimum. Using similar methods as before, we find that if $\pi = 0$ and $r = r^*$:

$$(18)\quad dU/d\delta = -mr,$$

which is a negative number if the international real interest rate is positive (which will be assumed in what follows). Under these circumstances a lower cash/deposits ratio is therefore always welfare improving. If there is no technical lower limit on δ, (18) implies that welfare is maximized in a "pure credit" regime according to which high-powered money is eliminated and bank deposits have a 100 percent backing in terms of bonds (or securities).

Suppose now that the government is constrained to raise a given amount of revenue. In this case is there an optimal combination of inflation and a minimum cash/deposits ratio? To answer this question, consider an experiment in which δ and π are changed such that η remains constant; clearly, by equation (12):

$$(19)\quad [(1 + \pi)^{-1} - (1 + r)]d\delta - \delta(1 + \pi)^{-2}d\pi = 0.$$

Recalling equations (13) and (14), we can see that a change in π and δ that keeps g and η constant—and where, therefore, equation (19) holds—leaves the individual with exactly the same budget constraint. Obviously, this experiment will not result in any change of expected utility.

What about government revenue? By equations (15) and (19):

$$(20)\quad dg = -mr^*d\delta.$$

Hence, if δ is lowered—and, thus, by (19), π is raised—to keep the return on deposits, η, constant, total government revenue will tend to increase. Since when part of the extra revenue is given back to the public, expected utility will obviously increase, a rather remarkable proposition results, namely, *it is possible to lower the cash/deposits ratio in such a way that expected utility and government revenue are both increased, even when the economy will have to suffer a permanently higher rate of inflation*. Notice that this proposition, contrary to most of the previous ones, does not depend on the sign of any total derivative, and that it holds independent of the initial values of π and r.

This proposition is a local one. We cannot infer from it that δ should be set equal to zero; when $r = r^*$, for example, $\delta = 0$ implies, by equation (15), that the revenue would also be zero. In general, there will be a (possibly positive) lower bound on δ, below (and normally also *at*) which the revenue constraint cannot be satisfied.[8] The proposition suggests setting δ as close as possible to that lower bound.

As an important extension of the above result, it is now possible to prove that the above type of experiment may yield even higher welfare when $\pi \geqslant 0$ if the extra revenue is used to bring r closer to r^*, that is, if the extra revenue is accompanied by a reduction (in absolute value) of the interest-rate tax. To prove the proposition, assume equation (17) holds and examine the region in which the revenue from the tax on interest, $(r^* - \text{r})\,[b + (1 - \delta)m]$, is an increasing function of the tax, $(r^* - r)$, or, equivalently, the region in which:

$$(21) \qquad d\{(r^* - r)[b + (1 - \delta)m]\}/dr < 0.$$

This condition would necessarily hold for some neighborhood of r^* if the aggregate demand for bonds is positive—a highly plausible assumption, since bond holdings represent the net financial wealth of this economy outside of high-powered money.

Suppose that associated with the constraint on g, there is an optimal choice of r given π and δ; now, lower δ and increase π as in the previous experiment, momentarily returning the extra revenue to the public. By the previous analysis, this results in larger welfare and government revenue than before; thus, the constraint on g would not be binding. The change in welfare when the constraint on g is not binding is given by equation (16). Hence, if $r > r^*$ we have—recalling equations (16) and (17) and that, by assumption, $\pi \geqslant 0$—$dU/dr < 0$, so that the optimal r will shift down toward r^*. Suppose now that $r < r^*$; then, by equations (11c), (15), and (21), $dg/dr < 0$. Since the original choice of r is assumed to have been optimal (given r, π, and the constraint on g), it follows that $dU/dr \geqslant 0$; for if contrariwise ($dU/dr < 0$), the expected utility and revenue could be made larger by further lowering r, contradicting optimality. It would therefore be optimal—or more accurately, given the "weak" inequality above, it would not be inoptimal—(once the constraint on g is relaxed) to increase r toward r^*, proving the proposition.

The intuition surrounding this statement is as follows. The local analysis strongly suggests the possibility that the global optimum, when there are no constraints on government revenue, calls for setting $r = r^*$ (the global proof is in the appendix). This equality, of course, would not hold in general when g is subject to a constraint; however, it is quite clear that as the revenue constraint is relaxed, welfare increases and, for some nonnegligible regions, r should move toward r^* (since it has to be equal to r^* when the g constraint is removed.) One way of relaxing the constraint is, as argued before, by a lowering of δ accompanied by an appropriate increase in π. Hence, by the previous reasoning, there should be nonnegligible regions in which the proposition is true. The proposition also gives a set of plausible sufficient conditions for the optimal r necessarily to move toward r^*, although the intuitive justification for those conditions is less obvious.

In sum, this analysis has shown that the presence of a banking system does not, in principle, imply a modification in the optimal values of inflation and interest rate; moreover, when $\pi = 0$ and $r = r^*$, liberalization of the system (a lowering of δ) is always welfare increasing. This is also true if the government is committed to raising a particular amount of revenue, for, as has been shown, within certain bounds a lower δ, accompanied by an appropriately higher π, will result in higher expected utility and government revenue. Furthermore, under plausible conditions even higher welfare would be attained if the tax on interest (in absolute value) were simultaneously reduced. In other words, the present framework strongly suggests that the emergence of a competitive banking system may call for a further *increase* of the degree of free capital mobility.

5.3 Deterministic Steady State: Further Discussion and Extensions

To contribute to the reader's understanding of, and comfort in using, the previous models as analytical tools, it will be useful to check that certain basic relations hold as they should. For instance, by equations (12) through (15) it can be shown that:

$$y^1 + y^2 + r^*[b + (1 - \delta)m] = c^1 + c^2. \tag{22}$$

The left-hand side of the equation represents the GNP, because it is the sum of total domestic output plus the balance in the service account (in the brackets b denotes private bond holdings, while $(1 - \delta)m$ denotes the bonds demanded by the bank). The right-hand side denotes domestic absorption; equation (22) therefore states that the GNP equals domestic absorption, a relation that necessarily has to hold in a no-growth steady state.

In the earlier, molecular scenario, the speck of land that constituted the country produced only purely tradable goods. An easy extension of that scenario is to introduce nontradables by, for example, letting "leisure" be a factor in the utility function and by assuming that total output is produced by labor alone. Leisure would then stand for the nontradables, and none of the comparative statics formulas is changed, implying, of course, that all the earlier results carry over to this case. The industrious reader may want to pursue the analysis further by studying the impact of the different policies on the "real exchange rate," which could be defined as the inverse of the "real wage," that is, the wage rate in terms tradables.

A blatantly unrealistic assumption of the analysis to this point has been the perfect substitutability between cash and bank deposits. Fortunately, there is easy remedy for that. First, notice that the analysis does not depend on whether b, bond holdings, is an argument in the utility function; the results thus hold whether bonds are "liquid" or not. Now, consider the extreme case in which the legal cash/deposits ratio is zero and it is technically feasible for the bank to hold no cash. As long as cash is a less attractive asset than bonds, the profit-maximizing bank will then set δ equal to zero, and by equation (12), the gross rate of return on deposits, η, will be $(1 + r)$, thus making deposits and bonds equally attractive. Without losing generality, it can then be assumed that individuals hold no bonds, and in the no-banks version of the model (primarily equations [6], [7], and [9]), b can be redefined as deposits, and m as real *high-powered* money. With this reinterpretation, the no-banks model can be applied to examine optimal policy in the context of a perfectly competitive banking system (one with zero cash reserves), but one in which deposits are imperfect substitutes for cash. Recalling the discussion in section 5.2, we can see that if there is no constraint on government revenue, it is possible to make a plausible case for zero inflation and no tax on interest. As a matter of fact, that case can be extended to cases in which δ is exogenous; and in addition, one can show, as in section 5.2, that if $\pi = 0$ and $r = r^*$, welfare improves as δ is lowered.

With imperfect cash-deposits substitutability, it is no longer true that when there is a constraint on government revenue, it is always welfare increasing to lower the cash/deposits ratio at the cost of higher inflation. This is so because, although such an experiment could be done in such a way as not to lower the "quality" of bank money (by the arguments given in the previous section), there is here an additional welfare loss caused by the associated quality loss of cash, which is provoked by higher inflation. It should be pointed out, however, that the degree of substitutability between deposits and currency would normally be a function of government regulations. Thus, a challenging open question is whether it would be optimal to ease the substitutability between these two types of monetary instruments, taking into account the government budget constraint. Such an effort would probably require a more detailed model, one in which the role of money is explicitly stated and liquid assets are not introduced simply as factors in the utility function.

In connection with the last point, it is worth indicating that essentially all of the arguments made so far could be shown in terms of a model that does not include money in the utility function. One can, for instance, assume that money (cash or bank money) is the only savings instrument available in the very short run. A case could be made that individuals do not know their tastes when they make the bond-holding decision (presumably because the bond market is not open at all times), and as a result they carry some purchasing power into the first period of their life without exactly knowing their preferences. When their tastes are revealed (during the first period, say), those who desire to transfer unspent purchasing power to their second period are forced to hold money. Given the return on money, some may prefer to save something extra for next period, thus generating a (precautionary) demand for money. If preferences are "shocked" by identically distributed random variables that are mutually independent across individuals, the result could be a stable demand for money that would be indistinguishable from the one derived in section 5.2 (for details on this model, see Calvo 1984).

An obvious advantage of a more explicit model is that it allows a better understanding of the role of the banking system. In the context of the case just mentioned, for example, banks would be in a position to take advantage of the law of large numbers; by the stochastic assumptions, the bank (again, if we assume there is only one bank) would be in a position to know exactly the sums that will be kept in the form of deposits if it has a very large set of customers. The bank could therefore use those sums (more accurately, what is left of those sums after accounting for the required reserves against deposits) to buy bonds, thus generating a type of money that would dominate cash (in the realistic case in which $[1 + r] > [1 + \pi]^{-1}$).

The model can easily be extended to allow for the existence of more than one bank. In this case the amount of deposits at any given bank will be a random variable, but the interbank loan system may come into play to help replicate the solution that would be attained by one large competitive bank.

In closing this section, I should point out that I have completely abstracted from the stock seigniorage from money creation emphasized by Auernheimer (1974). Nonetheless, the analysis can be extended in that direction with no significant qualitative changes in the results. The next section will take account of the stock seigniorage in connection with the foreign demand for domestic money.

5.4 Foreign Demand for Domestic Money

This section presents a discussion of the possibility that a competitive banking system may not be optimal because it creates a potential for the emergence of a demand for domestic money by foreigners. It will thus be useful to begin by examining some of the mechanics associated with such a demand for money in the simplest case, one with no banks.

Assume that the central bank announces a path of the exchange rate with a constant rate of devaluation and is committed (to the maximum extent of its capabilities) to guaranteeing full currency convertibility at the ruling exchange rate. Let z indicate the demand for real domestic monetary balances by foreigners. Assume now that z was zero up to time zero and $\bar{z}$ thereafter (unless a collapse of the fixed-rates system is expected, as will be explained below). In the kind of scenario discussed in the previous section, with a nonstochastic aggregate demand for domestic money, the central bank would be able to guarantee 100 percent backing for foreign deposits, increase social welfare by buying z units of bonds, and distribute the return on the government's bonds back to the public. There is a potential source of time inconsistency here (see Calvo 1978). Suppose, for instance, that $\bar{z}$ is foreigners' demand for domestic money when the expected rate of devaluation equals π. A way for the government to collect extra revenue would be to announce a surprise devaluation, followed by a renewed promise that the rate of devaluation would henceforth be set equal to π. If the policy was credible, the government would succeed in accumulating more bonds, thus increasing the amount of the transfer to domestic residents. This is not the type of problem I wish to emphasize here, however. To eliminate such "temptations" on the part of the monetary authorities, I will instead assume that the government compensates (taxes) foreigners for any depreciation (appreciation) in the value of their real monetary balances that is caused by a surprise policy change.

Let us now introduce the banking sector, as in section 5.2. There is thus a single domestic bank that is the only holder of domestic currency (or high-powered money).[9] Let Z denote the nominal value of foreign holdings of domestic money (deposits, in this case). The flow of seigniorage based on devaluation that accrues to the government is then given by (recall equation [8]):

$$\delta(Z_{t+1} - Z_t)/P_{t+1} = \delta z\pi/(1 + \pi), \tag{23}$$

where $z = Z/P$. In addition, the government can collect a return (the rate of which is assumed to be equal to r^*) on the (net) bonds that had to be surrendered by foreigners when they acquired the domestic deposits, that is, $\delta z r^*$. Finally, an additional source of revenue is the interest tax on the bonds that the bank acquired with foreigners' deposits, or $(r^* - r)(1 - \delta)z$. Thus, the flow of government revenue (in terms of output) associated with the presence of foreigners in the money market, g^*, satisfies the following:

$$g^* = [(r^* - r)(1 - \delta) + \delta(r^* + \pi/(1 + \pi)]z. \tag{24}$$

It readily follows from equations (12) and (24) that:

$$g^* = (1 + r^* - \eta)z, \tag{25}$$

which states that the government's revenue associated with the presence of foreigners in the money market is just equal to the difference between the return on those deposits if they were entirely invested in the international bond market, $(1 + r^*)z$, and the return that accrues to foreigners as depositors, $z\eta$.

Now make the plausible assumption that (given the rates of return on all the other international assets) foreigners' demand for domestic deposits is an increasing function of the rate of return of domestic deposits, η. That demand can be indicated by:

$$z = f(\eta), \qquad f' > 0. \tag{26}$$

It is interesting to note that the present assumptions (a key one being that reserves at the central bank can be kept in terms of the international bond—see below for further discussion) imply that g^* is a function only the rate of return on deposits, η. Given η, the value of g^* is completely independent of r, π, and δ. This feature will be exploited in the analyses to follow.

Revenue from domestic sources still satisfies equation (15), and the gross return on deposits is given by equation (12). Total government revenue, G, therefore satisfies the following:

$$G = g + g^*. \tag{27}$$

The budget constraints for the representative individual are now given by:

$$y^1 = c^1 + b + m \tag{28}$$

$$y^2 + b(1 + r) + m\eta + G = c^2. \tag{29}$$

In section 5.2 I suggested very strongly (the formal proof is in the appendix) that in the absence of constraints on government revenue, an optimal policy would be to set δ equal to zero and r equal to r^*. By equation (12) this implies $\eta = 1 + r^*$, a consequence of which is, by equation (25), that revenue from foreigners would be zero. But, by (25) and (26), at $\eta = 1 + r^*$:

$$(30) \qquad dg^*/d\eta = -f(1 + r^*) < 0.$$

Hence, revenue from foreigners would necessarily increase if η is set at slightly less than the social optimum when there is no foreign demand for domestic deposits. But since taking into account only the domestic variables (everything but g^*), when $\delta = 0$ and $r = r^*$, we have $dU/d\eta = 0$ (the first-order condition for maximum), it follows, by equations (28) through (30), that when there is a positive foreign demand for domestic deposits, it is optimal to set $\eta < 1 + r^*$.

Let $\bar{\eta} < 1 + r^*$ be the optimum level of η. A reasoning similar to the one given in section 5.2 (particularly the discussion around equation [20]) shows that if $\delta > 0$, that is, if there is a nonzero minimum cash/deposits ratio, and if $\pi < \infty$, welfare and government revenue are increased by lowering δ and increasing the rate of devaluation (or rate of inflation, π) in such a way as to keep $\eta = \bar{\eta}$. The previous reasoning can be applied directly because, by equations (26) and (27), the revenue from foreign holdings of domestic deposits is not being changed by this experiment.

Consequently, the presence of a stable foreign demand for domestic deposits offers no new reason against banking liberalization. This is an interesting result because it might appear natural to think that a significantly positive cash/deposits ratio would be the optimal way to collect the seigniorage from foreigners. The analysis has instead shown that the country is always in a better position by collecting the same amount of revenue from foreigners by lowering δ, while at the same time increasing the rate of devaluation (equal to the rate of inflation.) It can easily be shown that the same qualitative result holds even when there is a constraint on government revenue.

Up to this point, the analysis has completely ignored the presence of aggregate random shocks. This assumption will now be relaxed with respect to z, namely, foreigners' demand for domestic money. The main objective here is to gain some insight into situations in which the demand for domestic money that originates abroad is significantly more volatile than that generated by domestic residents. This may be the case, in particular, when foreigners consider the home country's domestic money to be essentially like any other (almost) pure asset, while the country's residents, because they use domestic money for transaction purposes, are more appreciative of the "liquidity services" that domestic money provides. By the law-of-large-numbers argument given in the previous section, one could argue that domestic demand for money is relatively stable and unaffected by random shocks on the rate of return of competing assets.

Consider, first, the case without banks. If the central bank could invest the equivalent of z in the form of international bonds and still maintain the liquidity necessary in case of a random reduction of z, then all that was found in the previous cases applies here as well. But the central bank should normally be subject to transactions constraints. If, as in the scenario in the previous section, individuals have a positive demand for domestic money because, say, the bond market was not open at all times; under these circumstances, it seems quite natural to assume that somewhat similar constraints also apply to the central bank and that it therefore will normally be led to keep some liquid funds (yielding an interest rate less than r^*) as insurance against a random shrinkage of z. I am not interested here in providing a complete theory about the optimal insurance of this type; it is clear, however, that to the extent that the government does not intend to default with a probability of one, it will keep some funds in liquid form. This implies that the rate of return on z realized by the central bank is likely to be smaller than the previous analysis would indicate.

Whether this scenario calls for a higher or lower optimal rate of inflation cannot be answered in general. Thus, to sharpen our intuition, let us assume that no foreign demand for domestic money will arise unless the central bank holds its reserves in the form of assets yielding a zero rate of return, in which case z would become nonrandom, as before. In this case the seigniorage associated with foreign demand is πz and not $(r^* + \pi)z$, as before. If the domestic economy could be isolated from the π that applies to foreigners, and if we examine the region in which the foreign demand for domestic money has an elasticity smaller than one, then the optimal π will tend to be larger than before (that is, when the central bank invested these funds in terms of international bonds, yielding $r^* > 0$[10]). When this fact is combined with domestic considerations, it is likely that the unconstrained optimal rate of devaluation will be larger than before, while the optimal r might be smaller than before. Since a higher π means that smaller amounts of foreign funds will be channeled to the home country, the end result of the policy will tend to be a *smaller inflow of foreign capital in search of domestic money*.

The presence of the banking system may help improve welfare even further if deposits by foreigners can be distinguished from those by residents. In the case in which deposits are perfect substitutes for cash, it can easily be shown that maximum welfare could be achieved by disallowing foreigners to hold domestic deposits and by setting up a perfectly competitive banking system (with a zero cash/deposits ratio).

The rate of devaluation (equal to the rate of inflation) would then be set at the point at which πz is maximized (remember that to be able to attract z the central bank is assumed to be forced to hold assets yielding a zero rate of return).

This separation of domestic residents and foreigners for the purpose of collecting an inflation tax is, however, not very likely to be feasible in practice, given the various ways that individuals can find to hide their identities. Hence, it is interesting to examine the opposite case, one in which foreigners *qua* depositors are indistinguishable from domestic residents. Let us study the case in which the domestic banking system is completely free (that is, $\delta = 0$ and $r = r^*$) and there is therefore no demand for the domestic currency. Suppose, again, that z units of foreign deposits are attracted by the domestic banking system, and that in order to make their deposits at the bank, foreigners first have to exchange foreign currency for domestic currency and second have to make the deposit at the bank. The bank, not having any need or desire to hold domestic currency, takes the domestic currency back to the central bank, exchanges it for foreign currency, and buys bonds yielding a rate of return equal to r^*. The country realizes no gain or loss by this sequence of operations; but the above-mentioned operation is simply infeasible because foreigners are assumed to require that the institution whose liabilities they hold should have equally valued reserves in terms of some zero-interest asset. If the bank makes it perfectly clear that it is not going to acquire any zero-interest assets, no foreigner will want to deposit at the bank, that is, z will be zero. In this case, the banking system would be incompatible with this type of international capital mobility, even when that mobility is unfettered by any form of regulation.

On the other hand, if the central bank would like to attract foreign funds while keeping a perfectly free banking system, it will be forced to offer some kind of deposit insurance. Suppose that deposits are fully insured by the central bank. For z to be positive, the central bank would clearly have to hold an amount z of zero-interest bonds. This would represent a revenue loss of r^*z; and since domestic currency would not be held (directly or indirectly) by foreigners, the result of this operation could not be anything but a welfare loss. An implication of this analysis is that to extract positive seigniorage from foreigners when their identities are totally unknown, the central bank must introduce distortions in the domestic banking system.

In general, when δ is not constrained to be zero, as above, and when $r \neq r^*$ (recall equation [25]):

$$g^* = (1 - \eta)z, \qquad (31)$$

where r^*z has been subtracted from the right-hand side of equation (25) to account for the revenue lost in order to be able to offer 100 percent backing. It thus follows from (31) that *a necessary condition for foreign deposits to improve welfare is that the (net) real rate of return on deposits* ($\eta - 1$) *be negative*. Notice that in the extreme case in which the banking system is totally free—that is, the case examined in the previous paragraph—$g^* = -r^*z < 0$, as argued before.

An important point to keep in mind is that with no foreign participation in the banking system of the type discussed above, we have found strong indications that the optimal solution would be free banking and no interference with international capital mobility, implying $\eta = 1 + r^*$ (which was assumed to be greater than unity). On the other hand, with deposit insurance and 100 percent backing with zero-interest bonds, foreign holding of deposits will be welfare-increasing only if $\eta - 1 < 0$, *independent of how small* z (> 0) *happens to be*. It is therefore quite clear that *under these circumstances it could only be optimal to allow foreigners to hold domestic deposits if it were possible to attract sufficiently large sums for this purpose*, that is, if z were sufficiently large. And, in any case, the business of attracting z-type funds would call for a possibly substantial departure from the policy that would be first best if $z = 0$.

It is interesting to note that since, by equations (26) and (31), g^* depends only on η, welfare again is improved by a lowering of δ accompanied by an increase of π that leaves η unchanged (again here, however, the limit at which $\pi = \infty$ is not well defined.) Thus, although the presence of unidentifiable foreign depositors may call for a major interference with the banking system, it is still true that a lower cash/deposits ratio will improve welfare even when it may call for a substantial increase in the rate of inflation.

At a deeper level, it is still necessary to explain the rationale for the 100 percent backing requirement that was assumed in the above discussion. Although it is not my purpose to give a full coverage of this issue here, some pertinent remarks may be in order. In a more realistic situation, z is likely to be stochastic; the backing of foreigners' deposits would therefore be a way of guaranteeing the international value of deposits. We can think of the case discussed above as one in which foreigners are "maximiners" who think only of the worst possible event and one in which all foreign investors would decide to withdraw their funds from the country at the same time, leading to a total loss of value if there were no 100 percent backing. Thus, if there were no "true" stochastic shocks on z, such a backing would remove the foreign investors' anxieties and the economy would be able peacefully to write its own history along a nonstochastic steady state (as in the case examined above).

From the point of view of the foreign investor, it does not really matter who holds the necessary liquid assets in case of an eventual fall of z. We have assumed that someone in the tiny economy should pay for the resulting liquidity cost (if any foreign investor is going to be attracted), but there are other options. A very obvious one is for the central bank to become a member of some international banking system having the power to issue "international" money. Thus, if the small country's currency is pegged to, say, the U.S. dollar, a way to attract foreign investment would be for the central bank (more accurately, the local banking system) to become a member of the Federal Reserve System and the Federal Deposit Insurance Corporation (FDIC). In situations like these, the backing would be automatically provided by the international system. This kind of arrangement is not necessarily costless, however; the local banking system would now be subject to the regulations applying to the international one.

Another way to reduce the cost of backing the currency would be to allow "international" banks to operate in the home country. This would reduce the need for explicit backing if it is well understood by the public that in case of, for example, a bank run, the subsidiaries of "international" banks will be bailed out by their respective headquarters.

5.5 Summary

The basic argument made in this paper has been that the presence of a stable foreign demand for domestic money is not a reason to dismiss efforts to liberalize the banking system. On the other hand, if foreigners' demand for domestic money is either random or a function of the liquidity of, for example, the central bank's assets, the cost of attracting foreign funds into a relatively liberalized banking system may be significant. Thus, an optimal arrangement may call for an important reduction of the rate of return of bank deposits. The analysis presented here has also suggested that a possible way to reduce the costs of foreign demand for domestic money is to have the domestic banking system become a member of some international system or to allow international banks to operate in the home country.

Appendix

This appendix will demonstrate that the first-best global optimality results can be obtained in a rather general and direct way. This alternative proof will also help illuminate the reason for not associating the optimal rate of inflation with a zero nominal interest rate, as in Friedman (1969).

Consider the most general model discussed in the text, in which there is no foreign demand for domestic money, namely, the model described in equations (12) to (15). Let us examine the position of a planner who wishes to maximize expected utility (at birth) subject to the constraints mentioned in the text. After some simple manipulations, the following planner's constraints can be derived:

$$y^2 - c^2 + (y^1 - c^1)(1 + r^*) - \delta m r^* = 0. \tag{A1}$$

On the other hand, by equations (12) to (14), the budget constraint for the individual can be expressed as follows:

$$y^2 - c^2 + (y^1 - c^1)(1 + r) + \delta m[(1 + \pi)^{-1} - (1 + r)] + g = 0. \tag{A2}$$

Consequently, given δ, the first-order conditions for the planner and for the representative individual will be the same if $r = r^*$ and $\pi = 0$. In addition, the value of g that is incorporated in the planner's constraint (A1) is given by equation (15), which is exactly the same expression as that which determines g in (A2). A result of that equivalence is that the optimum for the planner is on the budget constraint of the representative individual, and furthermore, when $r = r^*$ and $\pi = 0$, it satisfies the representative individual's first-order conditions. Given the strict quasi-concavity of the utility function, the planner's optimum is therefore unique and decentralizable by choosing $r = r^*$ and $\pi = 0$. In addition, it is quite clear from equation (A1) that expected utility (at birth) increases as δ decreases, that is, as the minimum cash/deposit ratio is being decreased. These are in essence the first-best propositions derived in the text.

To understand more clearly the reason for the novel result for the optimal quantity of money found here, let us examine the simple no-bank case, which is equivalent to setting δ equal to one. It follows from (A1) that the marginal cost in terms of second-period consumption, c^2, of an extra unit of real monetary balances is r^*. Thus, to the extent that $r^* \neq 0$, it will not be optimal to set $\partial U/\partial m$ equal to zero, the "full liquidity" or Friedman's point. This is so because although the representative individual is being compensated for the inflation tax, there are not mechanisms in the model through which he could be compensated for the interest income lost when he accumulates an extra unit of real monetary balances.[11]

One can now readily understand why banks can improve welfare over the level attained without banks: they are a device by which bonds become more "liquid," or more like money, and in addition, *the extra liquidity produced in that way does not have an opportunity cost for the representative individual.*

Obviously, in this simple world the central authorities can generate the same welfare as in the pure credit situation (that is, when $\delta = 0$), for example, by "monetizing" bonds—allowing them to be used as a means of exchange. In more realistic situations, however, ones in which ascertaining the "quality" of bonds requires specialized skills, bond monetization would imply some kind of intermediation. Thus, in the final analysis the central authorities would be operating very much like a regular banking system.

Of greater interest is to examine the implications of paying interest on bank reserves.[12] Imagine the bank scenario of section 5.2, except now the central bank pays a nominal interest i on bank reserves (remember that in such a world all cash is held in banks' vaults.) One can easily verify that equations (12) and (15) are now transformed into:

$$\eta = (1 + r)(1 - \delta) + \delta(1 + i)/(1 + \pi) \tag{A3}$$

$$g = (r^* - r)[b + (1 - \delta)m] + \delta m(\pi - i)/(1 + \pi) \tag{A4}$$

Hence, by equations (13), (14), (A3), and (A4), the budget constraint faced by the planner is still given by (A1). The global optimum therefore remains the same, implying that there cannot be a welfare gain over the situation, discussed earlier, in which no interest is paid on reserves.

It is, however, of some interest to explore the additional possibilities opened by the existence of i. This can be done, as before, by obtaining the expression corresponding to (A2), when (A3), instead of (12), holds, such that:

$$y^2 - c^2 + (y^1 - c^1)(1 + r) + \delta m[(1 + i)/(1 + \pi) - (1 + r)] + g = 0. \tag{A5}$$

It is now quite straightforward to argue that the optimum can be decentralized by setting r equal to r^* and i equal to π. Paying interest on banks' reserves could therefore be useful in situations in which, for reasons outside the model, it is not possible to set π equal to zero.

Notes

1. Focusing on steady-state utility, of course, abstracts completely from the transitional aspects of policy. This is one reason why "time inconsistency" will not be a problem here.
2. As a matter of fact, the sign of this derivative is necessarily positive because in the present context it is a pure substitution effect.
3. This is a shortcut; for a more satisfactory way of modeling money that bears the flavor of the present approach, see Calvo (1984).
4. The following expression assumes equilibrium in the money market and that foreigners do not demand domestic money. That they do not is another reason why "time

inconsistency" is not of concern here (see Calvo 1978). Extensions of the model to cover this case are discussed in section 5.4.

5. There is some superficial resemblance between this result and those in, for example, Phelps (1974) and Helpman and Sadka (1979); however, their "anti-Friedman" propositions, unlike the ones here, depend on the assumption that lump-sum taxation is unavailable. See the appendix for a further clarification of this issue.

6. When $\eta = (1 + \pi)^{-1}$, individuals are indifferent to the choice between deposits and cash. To simplify the exposition, assume that they still prefer deposits to cash.

7. See the appendix for a global proof that does not rely on equations (11) and (17).

8. Revenue at the lower bound for δ could very well be smaller than that required by the g constraint, in which case there is, technically speaking, no solution to the maximum welfare problem. Nonetheless, maximum welfare can be approached as closely as desired by setting δ sufficiently close to the lower bound.

9. See Mundell (1972) for an early example along the following lines.

10. For a related result see Auernheimer (1974).

11. Related examples are in Woodford (1983), Abel (1984), and Calvo (1984). A forerunner in this literature was Weiss (1980)—a paper unknown to me until the final stages of this paper—in which the zero-inflation proposition is proved for the case of the utility function being separable in its three arguments. Except for my earlier paper (Calvo 1984), however, no other research seems to have introduced banks into this kind of scenario.

12. The following was inspired by a question posed by Pentti Kouri.

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Comment Mario I. Blejer

I find this paper a valuable addition to the by now quite extensive literature on the macroeconomic effects of predetermined or preannounced exchange rates. The main contribution of the paper is to extend the preannouncement model to consider the role played by financial intermediaries and, more important, to analyze the optimality of a number of policies when some constraints are imposed on the system.

The formal analysis is very carefully elaborated and the conclusions reached are strong, given the assumptions made. I do think, however, that some of the assumptions, as well as the nature of the framework adopted, are rather limiting for the purpose of evaluating the implications of preannouncing the exchange rate path or of liberalizing capital flows. I will mention some of the issues that could be considered to shed light on additional aspects of the topic, although, clearly, they will tend to complicate the structure of the model.

In the first place, I think that a clear limitation of the paper is the absence of any direct consideration of the role of risk in the model. An interesting discussion is provided about the need to hold "liquid reserves" in order to assure that the liabilities of the banks and the home country would indeed be honored, but one misses a direct treatment of risk factors in the determination of the rates of returns. The author, for example, that in the absence of controls on international capital mobility, domestic and foreign interest rates are fully equalized.

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But endogenous risk factors clearly tend to introduce a wedge between those rates, a fact that may change some of the subsequent conclusions.

In addition to risk factors, domestic and foreign rates may also differ if, even in the absence of capital controls, foreign banks are not allowed to operate in the domestic markets and if there are technological differences in the operations of financial institutions across countries (a factor observed to prevail in many circumstances). In such cases, the real return to capital in the financial sector will differ, and the absence of capital controls will not necessarily lead to interest rate equalization. Calvo suggests that allowing the entry of foreign banks may reduce the need for "liquidity backing" of foreign depositors. I would think that preventing their entry would actually result in less than perfect capital mobility and that some of the results may not emerge in the same form. In general, the concept of liberalization used is quite narrow, allowing for no capital controls or reserve requirements. Still, many regulatory elements may remain that will tend to prevent full capital market integration.

An additional subject that is not considered is the role of expectations in the specification of some of the central functions of the model. After all, the justification for the use of predetermined exchange rates was not only to attract foreign deposits and gain seignorage, but also to stabilize expectations and help in the process of integrating domestic and foreign markets. In general, the omission of a detailed treatment of risk and expectations, though making the model neat, raises other types of questions, such as what is the mechanism preventing infinite capital flows.

On a rather specific point, I would think that a more symmetrical treatment calls for allowing domestic residents to hold foreign deposits (since foreigners are allowed to hold domestic deposits). Having a richer menu of assets entering the portfolios of domestic residents would result in less restrictive signs for the partial derivative in equations (11a) through (11d). For example, (11b) implies that the demand for real bonds increases with the rate of inflation ($[\partial b/\partial \pi] \geq 0$). That is not a necessary result, since there are many considerations that would lead to the opposite outcome. It all depends on the nature of the bonds and on the other assets available.

These considerations aside, I think the paper is certainly very useful to evaluate the welfare implications of alternative sets of liberalization and exchange rate rules.