Dollarization: Analytical Issues

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1 Introduction

Dollarization would involve benefits as well as costs for a developing country. The identification of those costs and benefits, as well as the measurement of their relative importance, is the subject of a currently heated debate. To aid in the discussion, this chapter presents and summarizes main analytical considerations related to dollarization.

The usefulness of theory in evaluating dollarization cannot be overemphasized. There are very few observed cases of dollarization, and hence history provides little guidance as to its consequences. One must then resort to theoretical analysis for conjectures about how dollarization may work. Unfortunately, received theory has some important gaps, some of which will become apparent below. However, there are also several points of agreement; we shall emphasize those, as well as some observations that have been relatively ignored in the current debate.

Our discussion is organized around a very simple model of a small open economy with a government that must decide whether to dollarize. We start by discussing the implications of dollarization for macroeconomic policy; this is because much of the debate has been concerned with precisely this issue. In our framework we show that, as emphasized in the literature, dollarization would prevent the implementation of an optimal policy. This is because the exchange rate would no longer serve as an adjustment tool and, in this respect, dollarization resembles an irrevocably fixed exchange rate system. However, dollarization implies a further loss, namely that the stock of domestic base money would have to be retired from circulation and exchanged for dollars. In other words, the so called (stock) seigniorage would accrue to the US Federal Reserve. The welfare costs of dollarization, relative to the

optimal policy, are due to both the fixity of exchange rates and the loss of seigniorage. The magnitude of the costs are shown to depend on the variability of the exogenous shocks hitting the economy, a finding that is reminiscent of Mundell's (1961) optimal currency area approach.

The costs just identified are only relevant if the optimal policy is, in fact, implemented by the government. But this may not be the case, in particular if the government has the inability to commit, at the beginning of time, to date-state contingent policies. In that case, the analysis of the determination of policy, and hence the cost of dollarization, must take into account the possibility of time inconsistency or lack of credibility, and how dollarization may help ameliorating those problems.

We discuss the possibility that dollarization may act as a commitment device, and thus reduce the distortion associated with policy incredibility. It follows from the discussion, however, that whether dollarization is desirable under such circumstances is, at the end, an empirical matter. Dollarization buys credibility at the expense of a suboptimal response to shocks, and may or may not be worth it.

We also emphasize that, when there is a policy credibility problem, the interpretation of the seigniorage lost with dollarization is delicate. In particular, the measured dollar loss of seigniorage may be associated with an increase in social welfare. The implication is that computed seigniorage losses can only be unambiguously interpreted as "real losses" to the economy if policy credibility problems are assumed away, a point that seemes to have been missed in the debate. A similar caveat applies, although perhaps not as starkly, to the Mundellian criteria.

The possibility of financial panics and exchange rate crises has provided a fundamental impetus to calls for dollarization. Hence we discuss the role of dollarization in generating or preventing crises within our simple model. We show that dollarization would prevent the domestic central bank from acting as a lender of last resort which, as in Chang and Velasco (2000a, 2000b), may exacerbate financial fragility and the possibility of crises. However, we also argue that there are solutions to that shortcoming, such as Argentina's policy of contracting contingent lines of credit with foreign banks, that may be inexpensive.

In addition to analyzing the lender of last resort issue, we tackle the contention that dollarization can be hoped to reduce the severity of the shocks hitting the economy or reduce the cost of foreign credit. We argue that both contentions are unwarranted and, in fact, we describe examples in which

exactly the opposite would be true. In particular, if dollarization indeed increased the possibility of crises relative to a domestic currency regime, rational expectations imply that country risk would increase, reflecting a compensation to foreign creditors for defaults during crises.

Finally, we identify some putative consequences of dollarization that, at least so far, resist an analytical treatment. An example is the contention that dollarization would reduce market incompleteness.

The rest of this chapter is organized as follows. Section 2 presents the economic environment. Section 3 discusses optimal macroeconomic policy and the effect that dollarization would have on it. The effects of dollarization on the credibility of government policy are analyzed in Section 4. Section 5 discusses how dollarization affects the availability of a lender of last resort. Section 6 considers a number of issues not included in our formal discussion. Section 7 concludes.

2 The Economic Environment

In this section we describe the model that will serve as the focal point of our discussion. We should emphasize that below we impose a number of exceedingly strong and seemingly ad hoc assumptions. However, this is only for expositional purposes and because we hope that, in this way, the essential elements of our discussion will be most transparent. Indeed, most of the assumptions below can be substantially relaxed, and hence our results can be extended to much more realistic setups.

Consider a small home economy that is part of a much larger world and lasts for only two periods, indexed by $t = 1, 2$.[1] In each period there is a single, perishable consumption good, which is fully traded and has a fixed price, normalized to one, in terms of a world currency (the dollar).

The home economy is inhabited by a large number of identical individuals and a government. The representative agent is endowed with some amount $e > 0$ of the consumption good in period 1. In period 2 he has no endowment of goods, but he can produce l units of consumption by working l hours, $0 \leq l \leq 1$.

The representative individual enjoys consumption and dislikes labor effort. In addition, he is assumed to derive utility from holding the currency

[1] This economy is a version of that in Persson and Tabellini (1990, chapter 6).

that circulates in the home economy. Which currency circulates at home is a government decision. Under a dollarization plan, that currency is the dollar. However, the government may also impose the use of a domestic currency, called peso, which can be costlessly created and destroyed by a domestic central bank.

For simplicity, we assume that home residents can only save by holding currency. Hence the preferences of the representative agent are given by

$$u(c_1) + v(m_1) + E[c_2 + v(m_2) - H(l)] \tag{1}$$

where $E[.]$ is the expectation operator; u, v, and H are continuously differentiable, strictly increasing and strictly concave functions; c_t denotes consumption in period t; and m_t is the real value of currency holdings at the end of period t. Note that, under dollarization, m_t denotes a holding of dollars, while in a domestic currency regime, $m_t = M_t/P_t$, where M_t denotes the holding of pesos and P_t is the peso price of consumption. In the latter case, and because the Law of One Price holds, P_t must also equal the exchange rate, the price of dollars in terms of pesos.

The presence of the expectation operator $E[.]$ in (1) allows for the inclusion of uncertainty in the model. To be concrete, we shall assume that one of S possible states is realized in period 2. The realization of one of these states determines a number of macroeconomic variables, two of which are of concern to the representative agent: the rate of a tax on labor income and, in a peso regime, the exchange rate.

All of these assumptions imply that, under dollarization, the budget constraints of the representative agent can be written as

$$c_1 + m_1 \leq e \tag{2}$$

$$m_{2s} + c_{2s} \leq (1 - \tau_s)l_s + m_1, \;\; s = 1, 2, .., S \tag{3}$$

where τ denotes the tax rate in labor income and, in 3 and the rest of this chapter, a subscript s refers to a value that is contingent on the realization of state s.

In contrast, the budget constraints in a regime of domestic currency are given by

$$P_1 c_1 + M_1 \leq P_1 e \tag{4}$$

$$M_{2s} + P_{2s} c_{2s} \leq (1 - \tau_s) P_{2s} c_{2s} + M_1, \text{ all } s \tag{5}$$

However, note that, after dividing both sides by P_1, 4 reduces to 2. Also, 5 can be rewritten as

$$m_{2s} + c_{2s} \leq (1 - \tau_s) l_s + m_1 (1 - \pi_s) \tag{6}$$

which is the same as 3, except for the presence of the term $(1 - \pi_s) = P_1/P_{2s}$. The term $\pi_s = (P_{2s} - P_1)/P_{2s}$ reflects the "inflation tax" in state s, and is obviously absent in 3 because the dollar price of consumption is assumed to be constant.

Now we turn to the specification of government finance. The home government inherits a debt of d dollars to foreigners which, for the time being, is assumed to be due at the end of period 2. At that time, the government will have some additional and exogenous need of g_s units of consumption, which is contingent on the state of nature; this is the only source of exogenous uncertainty that we consider.

In order to finance its expenditures, the government has two potential sources of revenue: the proceeds from the labor tax and, in a peso regime, the revenue from creating pesos or seigniorage. In the latter case, we assume that the seigniorage collected in period 1 can be saved in the world market at a zero interest rate. More precisely, if in a peso regime the government issues M_1^* pesos in period 1, it then collects $M_1^*/P_1 = m_1^*$ units of consumption, worth m_1^* dollars, that can be effectively stored until period 2.

In equilibrium, the supply of pesos M_t^* must equal the demand M_t. It follows that, in a peso regime, the government's budget constraint in period 2 can be written as

$$P_{2s}(g_s + d) \leq \tau_s P_{2s} l_s + (M_{2s} - M_1) + P_{2s} m_1$$

or, after dividing by P_{2s} and rearranging,

$$g_s + d \leq \tau_s l_s + m_{2s} + \pi_s m_1 \tag{7}$$

The interpretation is obvious: the final government revenue requirements, given by the LHS, must be met by labor taxes ($\tau_s l_s$) or by seigniorage. Seigniorage is, in turn, the sum of a flow inflation tax ($\pi_s m_1$) plus a stock component, m_{2s}, as emphasized in Fischer (1982).

Under dollarization, in contrast, there is no peso creation, and the government flow constraint is simply

$$g_s + d \leq \tau_s l_s \tag{8}$$

In other words, dollarization implies that the government loses seigniorage as a source of real revenue. But the significance of the seigniorage loss cannot be evaluated independently of the determination of government policy. This is because the seigniorage lost, $m_{2s} + \pi_s m_1$, depends on policy, both through the rate of the inflation tax and through the effect of policy on peso demand. This is a straightforward but important observation to which we shall return.

This completes the description of the economic environment. Of the assumptions of the model, the way we have described the difference between a dollarized regime and a peso regime deserves special comment. Imposing that the government can choose between one or the other is crude but seems to be reasonable, given historical experience. But we have gone beyond that by imposing that dollars and pesos enter in exactly the same way in the representative agent's utility function v. Our justification is that one typically thinks of v as capturing the extent of the ignorance regarding transactions costs, payments arrangements, and the like, that are reduced with the use of a fiat currency. Naturally, one may conjecture tha, if the relevant fiat currency changes, v may itself change. However, existing monetary theory provides essentially no guidance as to how v would change with dollarization. And, in the dollarization debate, some have indeed argued that dollars would provide for a "better" currency than existing national currencies while others have argued exactly the opposite.[2] We prefer to be agnostic here. Given the absence of better microfoundations, it is probably best to impose an assumption that does not bias the desirability of dollarization in one way or another.

3 Dollarization and Optimal Policies

As already emphasized, the outcomes of the model, and how they are affected by dollarization, depend on government policy and how it is chosen. Even if, as we shall assume, the government is benevolent and chooses policy to maximize the welfare of its representative citizen, the model yields different outcomes according to when and how strongly the government can commit to its decisions. In this section, we assume that the government commits perfectly to the policies it chooses at the beginning of time. In this ideal and unrealistic situation, dollarization implies a number of costs that we will discuss.

[2] See, for instance, Hanke and Schuler (1999).

Consider first the situation with a national currency. Given perfect commitment, the goverment's problem is to choose a policy and an associated macroeconomic allocation in order to maximize the domestic agent's expected welfare subject to the constraints imposed by competitive equilibrium. The latter include not only the government budget constraint but also the optimality conditions for the representative agent, that are summarized by the first order conditions:[3]

$$u'(e - m_1) = v'(m_1) + E[(1 - \pi)] \tag{9}$$

$$H'(l_s) = 1 - \tau_s \tag{10}$$

$$v'(m_{2s}) = 1 \tag{11}$$

Formally, then, the government's problem (sometimes called the Ramsey problem) is to choose a policy, that is, a contingent set of labor tax rates τ_s and inflation tax rates π_s, and an aggregate allocation summarized by m_1, m_{2s}, and l_s, in order to maximize the utility function 1 subject to 7 and 9-11.

Assuming an interior solution, optimal policy must satisfy the following version of the Ramsey rule:

$$\frac{1 - H'(l_s)}{1 - H'(l_s) - l_s H''(l_s)} = \frac{1 - [v'(m_1) - u'(e - m_1)]}{1 - [v'(m_1) - u'(e - m_1)] + m_1[u''(e - m_1) + v''(m_1)]} \tag{12}$$

for $s = 1, ..., S$.

The Ramsey rule has an intuitive interpretation. Each numerator is the distortionary effect of a tax. If, for example, the labor tax rate were zero in state s, labor supply would satisfy $H'(l_s) = 1$. Hence the difference $1 - H'(l_s)$ is a measure of the distortion caused by τ_s. In turn, each denominator can be shown to be proportional to the revenue raised by a marginal increase in the respective tax rate. So the Ramsey rule equalizes the marginal distortion of each tax, relative to revenue raised.

There are a number of important implications for our discussion. As long as the government has no access to a lump sum tax, optimal policy requires recourse to the inflation tax to at least some degree. This is a very general

[3]We shall assume that the individual's solution is always interior, which may be guaranteed by assumptions of the Inada type on utility.

conclusion known at least since Phelps (1973) and implies that, in our model, it is in general optimal for the exchange rate to change in a forecastable way over time.

In fact, in the context of the present model, there is a much stronger implication. Since 12 must apply to **all** states, and the RHS is not state contingent, that l_s cannot be state contingent and, by 10, τ_{2s} cannot either. Hence, the revenue from labor taxation must be independent of the state of nature and, hence, any unexpected shock to the government revenue needs is best financed via a devaluation. This result, which was developed in a much more general model by Calvo and Guidotti (1993), is a consequence of the fact that only **anticipated** devaluation has distortionary effects: 9 implies that only expected inflation affects peso demand decisions. But **ex post**, that is, once m_1 is determined, unanticipated inflation acts as a lump sum tax. Hence, as long as possible, any unanticipated government need should be met by unexpected inflation.

As inflation and devaluation coincide in this simple model, the implication for the exchange rate regime is clear. An optimal policy calls for exchange rates that are highly sensitive to exogenous shocks to the environment, in this case shocks to g. Naturally, this means that curbing the needed flexibility would imply a welfare loss.

One set of restrictions is given by a regime of **fixed** exchange rates. Suppose that the government solves the same problem as before, but is commited to keep the exchange rate fixed between periods. That restriction obviously requires that $P_1 = P_{2s}$, or that $\pi_s = 0$, all s. The resulting government's problem is the same as the Ramsey problem except for this additional constraint, and social welfare must fall in general. The loss would reflect the elimination of both anticipated inflation, as predicted by Phelps (1973), and unanticipated inflation, as implied by Calvo and Guidotti (1993).

Under fixed exchange rates, there is no **flow** seigniorage: the term $\pi_s m_1$ in the government budget constraint 7 is zero. However, since $m_2 > 0$ and the government creates pesos at no cost, the government still collects the stock seigniorage revenue given by m_2 in 7. This is because, even if there is no inflation, the government creates pesos worth m_1 dollars in the first period and $(m_2 - m_1)$ dollars in the second period.

The effects of a switch to dollarization are now easy to trace. In this model, dollarization has two important effects. The first is that inflation must be zero as in the rest of the world: hence there is no flow seigniorage. The implications of this effect are exactly the same as imposing fixed ex-

change rates. The second effect is that the government does no longer collect the stock seigniorage: the budget constraint of the government is 8, which excludes m_2.

The government policy problem under dollarization is straightforward to tackle directly, but it is easy and illuminating to analyze it in a slightly different way. Note that the real demand for money in the last period, under either a peso regime or a dollarized regime, is given by 11, and hence m_{2s} must equal some noncontingent quantity $\hat{m}_2$, all s. Then rewrite the dollarized budget constraint as

$$g_s + d + \hat{m}_2 = \hat{g}_s + d = \hat{m}_2 + \tau_s l_s$$

where $\hat{g}_s = g_s + \hat{m}_2$. Then a moment's thought reveals that the government's problem is the same as in a peso regime with fixed exchange rates, except that the government revenue needs are increased from g_s to $\hat{g}_s$, that is, by the amount of stock seigniorage.

Hence, under perfect government commitment, dollarization implies a further welfare loss relative to a peso regime with fixed exchange rates. Such a cost is due to the loss of stock seigniorage.

Given our analysis, it is straightforward to calculate the dollar value of the seigniorage that would be colected in a peso regime, either under the optimal policy or fixed exchange rates. Since seigniorage is zero with dollarization, such a quantity would be a measure of the dollar cost of dollarization in terms of lost seigniorage. But it may be more meaningful to derive an expression for the seigniorage cost in terms of welfare.

Starting from a dollarized economy, suppose that the government were able to print and market a quantity of pesos equal to a unit worth of consumption. As we have discussed, this is equivalent, in welfare terms, to a decrease of one unit in g_s in all states, whose effect on expected utility is

$$E\left[\frac{1 - H'(l_2^*)}{1 - H'(l_2^*) - l_2^* H''(l_2^*)}\right]$$

where l_2^* denotes the (state contingent) labor effort required to finance government expenditures under dollarization (that is, for each s, l_2^* solves 8 and 10). In words, the (marginal) welfare cost associated with the stock seigniorage lost under dollarization is equal to the expected distortionary effect of the required labor taxes. The implication is that the measured loss of seigniorage due to dollarization indeed reflects a welfare cost for the domestic economy.

More generally, it is clear that dollarization imposes a cost to the domestic economy. The extent of these costs depends on the parameters of the model. In particular, it should be obvious that the cost increases with the variability of the government revenue needs. In this sense, our analysis is reminiscent of the optimal currency area arguments first proposed by Mundell (1961). Mundell focused on the costs of irrevocably fixing the exchange rate between two countries when nominal rigidities are present. He pointed out that such costs would be larger the less correlated were the economic shocks hitting the two economies. This is, loosely speaking, because exchange rate changes are more valuable as adjustment tools if the fundamentals of the two different countries are less synchronized.

While our analysis yields a similar conclusion, it departs from Mundell's in several ways. Mundell emphasized the role of nominal rigidities in the analysis, while here we have emphasized public finance aspects. The two perspectives are clearly complementary. Also, Mundell focused on the distinction between flexible and fixed exchange rates without discussing the choice of currencies. Our analysis highlights that there is a clear difference between fixed exchange rates and dollarization. Stock seigniorage is lost in the latter but not in the former.

We derived the results of this section under the maintained assumption that the government has perfect commitment power. If such an assumption is dropped, our results need to be severely qualified, as we shall now see.

4 Dollarization and Policy Credibility

The assumption that the government commits once and for all to a policy choice is obviously unrealistic. In practice, governments makes policy choices over time, although they may promise that they will take some particular actions in the future. The sequential nature of policymaking then leads to the possibility that the government's promises may not be believed. This may be the case since, when the time comes, the government's incentives may have changed so as to make it profitable to renege. This problem was first recognized by Kydland and Prescott (1977) and Calvo (1978), and has been since the subject of a huge literature on time inconsistency, credibility, and commitment.

To illustrate the time inconsistency problem with our model, return to the case of a peso regime with flexible exchange rates, and assume that the

government can change policy in period 2, just after g_s has been realized. At that point, c_1 has already been consumed, and m_1 is given by previous decisions. Hence, the government's problem is effectively to choose the labor tax rate τ_s and a devaluation rate in order to maximize

$$c_{2s} + v(m_{2s}) - H(l_s)$$

subject to its budget constraint 7 and the consumer's optimality conditions 10 and 11. Crucially, 9 is irrelevant at this point, although it determined the choice m_1 in the previous period.

For simplicity, assume that τ_s must belong to the unit interval. The analysis is easy once it is noted that, because m_1 is given by history, the inflation tax involves no further distortion. On the other hand, the labor tax is associated with deadweight losses. It follows that the inflation tax should be used as much as possible; the government's choice will be either

$$\tau_s = 0 \text{ and } \pi_s m_1 = g_s + d - \hat{m}_2 \tag{13}$$

or

$$\pi_s = 1 \text{ and } g_s + d - m_1 - \hat{m}_2 = \tau_s l_s \tag{14}$$

where l_s is determined by 10 and $\hat{m}_2$ by 10.

Clearly, this solution departs from the Ramsey rule. This is clear if 13 holds, that is, if the revenue from the inflation tax is enough by itself to cover the government needs in state s. In that case, labor taxes will be zero if the government can reoptimize in period 2, but the Ramsey rule and, therefore, the optimal policy under commitment stipulate that labor taxes be positive in all states. Obviously, the departure from the optimal policy is even greater if 14 holds, as the inflation rate is infinite. This is interpretable as a total repudiation of the pesos issued in period 1.

Assuming rational expectations, the representative agent will understand that, in the absence of government commitment, the inflation tax in period 2 will be given by 13-14 no matter what the government announces in the first period. And, accordingly, this will affect period 1 money demand, as given by 9. Clearly, m_1 will be smaller than under commitment, since inflationary revenues must be larger. But then π_s must be even larger than if m_1 had been chosen on the basis of expectations that the optimal policy would be followed. The outcome will be given by the simultaneous solution of the money demand equation 9 and the government's optimality conditions 13-14. This, of course,

tends to lead to a particularly bad outcome. The worst outcome happens if 14 holds for all s. Then, money demand in period 1 satisfies $u'(e-m_1) = v'(m_1)$. If this implies a small m_1, the revenue from the labor tax must be relatively large. The public's anticipation of hyperinflation then may reduce money demand to such an extent that not only the hyperinflation happens, but also distortionary labor taxation must increase relative to the commitment case.

Note that the government would like to make the public believe that it will implement the Ramsey policy. However, the absence of commitment implies that any announcement to that effect will be incredible. In this sense, the time inconsistency problem is one possible way to model a government with a "credibility problem."

This perspective may also help understand institutions and rules that one observes in practice: they may be designed to alleviate a government's credibility problem or, in our context, act as commitment devices. The general idea is that, while the government may not be able to commit to complicated date and state contingent Ramsey policies, it may commit to simpler rules such as zero inflation or pegged exchange rates.

To illustrate, suppose that the government can commit to a fixed exchange rate or, in our context, to a fixed price level. Such a commitment means that $\pi_s = 0$, all s. Then, the money demand equation 9, with $\pi = 0$, determines m_1. In addition, even if the government is able to reoptimize in period 2, the labor tax rate in period s is determined by 7, with $\pi_s = 0$, 10, and 11. But these are the exact conditions that determine the outcome of the commitment case with fixed exchange rates. In other words, if the government can indeed make an irrevocable commitment to fixing the exchange rate, the credibility problem ceases to be relevant.

On the other hand, as we saw in the preceding subsection, fixing the exchange rate involves a welfare loss relative to the Ramsey policy. So, in the absence of commitment, expected welfare under fixed exchange rates may or may not improve. There is a tradeoff between credibility and flexibility, and the better choice depends on model parameters.

When available, the option to dollarize the economy may be valuable if even a limited commitment to fixed exchange rates is impossible. This may be the case, for instance, if the government in period 1 is able to promise not to devalue, but only if it stays in power. If there is a positive probability that the government will be replaced in period 2, and even if the new government is itself benevolent, a credibility problem remains. In contrast, by dollarizing the economy, the period 1 government in effect would change the taxation

technology so as to take away the inflation tax from any successor.

Clearly, if the economy is dollarized, the credibility problem goes away, and the outcome is the same as that of a dollarized economy under commitment. This means that dollarization involves its own costs. In particular, stock seigniorage is lost; this means that dollarization may or may not be preferable to keeping a national currency, even if the latter option involves living with a policy credibility problem.

Our analysis thus yield several implications that are relevant for the current debate on dollarization. The first is that, as we have just established, even if a government suffers from poor credibility, and even if dollarization would improve credibility, it is not necessarily the case that dollarization is desirable. Whether dollarization is preferable to flexible rates in such a situation has to be demonstrated empirically.

A second noteworthy implication concerns the interpretation of the seigniorage that would be lost with dollarization. In a peso regime, and in the absence of commitment, one would observe that the government is collecting a nonzero seigniorage revenue. That revenue, which is straightforward to calculate, would be lost with dollarization. However, this would not mean that the loss of seigniorage, however big, is costly for the economy. Indeed, it would be quite possible for expected welfare to improve with dollarization, in whose case the elimination of seigniorage would be good for the economy.

The lesson is that the numerous calculations of the seigniorage that would be lost with dollarization are meaningful only in conjunction with some explicit or implicit assumption about the policymaking process and, in particular, of the credibility problem that may be affecting policy. Only in the absence of such credibility problems one can assert unambiguously that the loss of seigniorage would, in fact, be a loss. If there is a credibility problem, the interpretation is much more problematic and, as we have argued, the loss of seigniorage may in fact be beneficial in welfare terms. This point seems to have been missed by even advocates of dollarization, which in general concede that the loss of seigniorage should be counted as one price to pay. At the same time, this observation has a bearing on the debate about how much seigniorage should be "rebated" by the U.S. Federal Reserve to a dollarizing country. For, if eliminating seigniorage is already good for that country's residents, why should the U.S. taxpayers give them back the value of seigniorage in addition?

A similar observation applies to "optimal currency area arguments." Under commitment, an increase of the variability of exogenous shocks unambigu-

ously raises the value of flexibility and increases the welfare loss associated with dollarization. However, this is not necessarily the case in the absence of commitment: since the equilibrium policy in a peso regime is suboptimal, there is no presumption that increased uncertainty will raise its value relative to that of dollarization. Hence, the calculation of "Mundellian" criteria to evaluate the welfare cost of dollarization requires a further justification unless one assumes away policy credibility problems.

We close this subsection with two remarks. Once the economy is dollarized, there would remain a strong incentive for the government to reintroduce a national currency. Consider again the possibility that the original government is replaced by a new one in period 2. Even if the first government had dollarized the economy, the new government would benefit from reintroducing the peso and collect the stock seigniorage $\hat{m}_2$. While a more sophisticated analysis of a possible "dedollarization" would require a model with more periods, it should be noted that it is an open problem in the absence of policy commitments, and that there is a temptation to go back that can be measured by the stock of domestic base money (Fischer 1982).

Secondly, it must be noted that there may be other solutions to the policy credibility problem that do not involve fixed exchange rates, dollarization, and the like. Particularly, if the economy and its government are both long lived, the government's temptation to depart from Ramsey policies may be tempered by the adverse effect of the deviation on the public's expectations about future policies. This implies that the Ramsey outcome may be self sustaining as an equilibrium, even if the government must choose its actions sequentially (Barro and Gordon 1983).

5 Dollarization and the Lender of Last Resort

The recent crises in emerging markets have underscored a crucial question: what is the role of exchange rate policy in the generation and/or prevention of those crises? Arguably, it is this issue that has provided the main impetus for dollarization proposals in developing countries. And, paradoxically, consideration of the same question has led to calls for the exact opposite, flexible exchange rates.

The debate has been colored by some prominent aspects of observed

crises. In them, the financial system, and particularly domestic banks, played a key role. Exchange rate pegs often collapsed as the central bank was attempting to bail out the domestic financial system in the midst of a panic.[4] The panic was possible, in turn, because the countries that went into crises were in a state of international illiquidity: their short term potential liabilities, measured in international currency, clearly exceeded the value of the assets they could have access to on short notice.[5]

In this context, it has been argued that dollarization would make crises more likely by preventing the domestic central bank from acting as a domestic lender of last resort. Loosely speaking, a lender of last resort is an institution that stands ready to provide credit to banks in the event that they experience a sudden demand for liquidity, as when bank runs occur. Such an institution is crucial in a system of banks with fractional reserves in order to reassure bank depositors and short-term creditors that their claims on the banks will always be honored if they attempt to liquidate them. This may help prevent confidence crises and associated bank runs.

In most countries, the role of lender of last resort has traditionally been played by central banks. This role is natural because the central bank can create credit quickly and at a negligible cost simply by issuing domestic currency. But the ability to print currency would disappear under dollarization, and hence the central bank would no longer be able to serve as the lender of last resort.

Making full justice to this issue would require a proper modeling of financial institutions, as in Chang and Velasco (2000b). However, a relatively minor amendment of our model here hopefully suffices to give a flavor of the argument, as well as help evaluating its significance.

So far the debt d of the government has played a negligible role, and in fact we have treated it just as another revenue requirement due at the end of period 2. Let us suppose now that the debt d is of short maturity, in the sense that it is due for repayment at the beginning of period 2, after g_s is realized by before markets open.

To be concrete, assume that d is owed by the home government to a continuum of identical foreigners. If the continuum is assumed to have measure one, the representative creditor is owed d dollars at the beginning of period

[4] That this association was systematic was convincingly shown by Kaminsky and Reinhart (1999).

[5] See Chang and Velasco (2000a) for a more detailed discussion and analysis of the evidence.

2. The problem is that, at that time, the government may not have d dollars to repay its obligations due. The only way the government may cope with early requests for repayments is by printing pesos.

Let us suppose that each foreigner decides, simultaneously, whether or not to demand repayment of his share. If he does not, his share is rolled over until the end of the period with no interest. But if he does, he is entitled to early repayment from the government.

Finally, we assume that early withdrawals are costly for the government: the government's revenue needs at the end of the period increase with early repayments. In particular, if all creditors demand early repayment, the revenue needs changes from g_s to $g_s + \chi$, for some $\chi > 0$.

We are ready to analyze the outcomes of alternative exchange rate regimes. For simplicity, suppose that the government has perfect commitment power, and consider fixed exchange rates. In particular, for each state s, the government budget constraint 7 (with $\pi_s = 0$) holds; note that d still denotes the initial debt, but now it is interpreted as a short term debt. This implies that, if all creditors agree to roll over their debt holdings, it is individually optimal for each of them to do so. This is because, if all of the debt is rolled over, the government will have enough resources to honor it in full. Hence, each creditor is guaranteed that its debt will be repaid if rolled over. In other words, it is an equilibrium outcome for the creditors not to run.

However, suppose that also

$$T + \hat{m}_2 < g_s + d + \chi \tag{15}$$

where T denotes the maximum revenue from labor taxes (that is, the maximum value of $\tau_s l_s$ subject to 10). Then, if all creditors panic and demand early repayment, there is no feasible combination of labor taxation and money creation that allows the government to both meet its revenue requirements and its debt obligations. Under plausible auxiliary assumptions,[6] there will be default on the foreign debt, which makes it optimal for the foreign creditors to demand early repayment. In other words, a panic is also an equilibrium.

The commitment to a fixed exchange rate is at least partly to blame for

[6] In particular, suppose that at the end of the period the government must pay for its exogenous revenue needs before it can pay any creditors left. Then, under 15, if a run occurs then the government will not have enough money to pay any debt rolled over. This means that it is optimal for each individual creditor to demand early repayment, as he would not collect anything if he agreed to roll over his claim.

the possibility of runs. To see this, assume that, in addition,

$$g_{\mathsf{s}} + d + \chi < T + \hat{m}_{\mathsf{2}} + m_{\mathsf{1}} \tag{16}$$

Then, if the commitment to a fixed rate is dropped, there is a government policy such that a run cannot take place in any equilibrium. Suppose that all foreign creditors demand early repayment. Then the government can offer to cancel its debt by paying $L = P_{\mathsf{2s}}d$ pesos to each creditor, where P_{2s} is the exchange rate (and the price level) that is (rationally) anticipated to prevail at the end of period 2. If so, each lender would be happy to take the L pesos as repayment of his claim, as he anticipated that he will be able to exchange them for d dollars before the end of the day. Alternatively, it can be assumed that the government prints L pesos to purchase consumption goods from home agents, and then sells the consumption goods for the d dollars it needs.

It can be now checked that the condition 16 guarantees that there is a labor tax rate, a final supply of pesos, and a price P_{2s} such that the government will also be able to finance its final revenue requirement $g_{\mathsf{s}} + \chi$ with a combination of labor taxes and money issue. But then, there is no reason for foreigners to demand early repayment or, on other words, a run cannot happen in equilibrium.

Two remarks are in order. The first is that, if the run condition 15 holds, preventing runs is not consistent with a fixed exchange rate: out of equilibrium, the inflation tax must be used. In that sense, exchange rate flexibility plays a useful role.

Second, the reader may find little resemblance between the scenario just described and the common meaning of "last resort lending." But this objection may be more apparent than real. When the government prints pesos to face early withdrawals, it is in effect creating credit to lend to itself. More vividly, suppose that the government is composed of a Treasury, which is the initial debtor, collects the labor tax, and pays for government purchases, and a central bank which prints pesos and collects seigniorage. Then the same results would obtain and, at the same time, with flexible exchange rates one can think of the pesos issued in a run as an emergency loan from the central bank to the Treasury.

The shortcomings of fixed exchange rates are shared by dollarization. In fact, the situation is even worse, since the condition for runs to be possible becomes

$$T < g_{\mathsf{s}} + d + \chi \tag{17}$$

since dollarization implies that stock seigniorage is not available to the home government. In fact, it is possible that for 15 to fail and 17 to hold; in such a case, crises are not possible in a peso regime, even one of fixed exchange rates, but they may occur with dollarization.

Advocates of dollarization admit that it would prevent the central bank from acting as a domestic lender of last resort, but that this may not be too difficult to deal with. One way to cope with the possibility of financial panics, which Argentina actually implemented, would be to secure foreign lines of short term credit to be drawn upon in the event of a run. It should be clear that such a strategy would succeed in eliminating equilibrium runs in our model. Take the dollarized case, and assume that the home government had the right to borrow, at the beginning of period 2, at least $g_s + d + \chi - T$ from some foreign agent or institution, at a zero interest rate. Then it is obvious that there cannot be a run in equilibrium.

This suggests that the welfare impact of losing the central bank's ability to be the lender of last resort can be measured by the cost of a contingent line of credit large enough to prevent runs. What "large enough" means is debatable. In light of our model, and recalling the meaning of international illiquidity, the size of the credit line should be at least as large as the gap between the potential short run liabilities and assets of the financial system, which can be substantial. In particular, the Argentinean credit lines are unlikely to have met this criterion. On the other hand, the "commitment rate" at which the Argentinean lines were secured were small enough that the total cost of the strategy would have been relatively small even if the credit line had to increase severalfold.[7]

Note that, as in many models that deliver multiple equilibria, we have not specified which equilibrium obtains when several exist. This is not too difficult to deal with, and in the literature it is often assumed that one of the equilibria is selected by some otherwise irrelevant random device, such

[7]Here is a very rough calculation of the cost of the Argentinean strategy. In 1996 the Argentinean private line of credit reached U.S. $6.1 billion, at a cost of about U.S. $18 million a year-about 0.3 percent. Assuming that this rate remains the same, the total cost of the strategy would depend on how large a credit line is "enough." At the end of 1999, Argentina's M2 (the sum of its banking system monetary and quasimonetary liabilities) was U.S. $88.2 billion. Since it had U.S. $26.5 in international reserves, the banking system's net liquid liabilities were arguably as large as U.S. $88.2 - U.S. $26.5 = U.S. $51.7 billion. At 0.3 percent a year, a line of credit large enough to cover that amount in whole would cost somewhat more than U.S. $150 million per year. While this is not a negligible figure, it is only a small fraction of Argentina's GDP.

as animal spirits or sunspots.[8] Such a selection mechanism would have the noteworthy implication that, observationally, it may seem that a change from a peso regime to dollarization exacerbates the role of exogenous uncertainty. This would be the case if the economy was immune to runs in the peso regime but subject to runs under dollarization. This is an important observation insofar as some have claimed that one of the advantages of dollarization is that it would reduce the severity of exogenous shocks. Our analysis implies exactly the opposite.

In the same scenario, the contractural interest rate on loans to the home country would be higher than the world interest rate in cases in which runs occured with nonzero probability. This risk premium would compensate foreign creditors for the probability of debt default. But the implication is that, in this model, dollarization may well be associated with an increase in the dollar interest rate applicable to the home country. This is in contrast with claims that dollarization would reduce the cost of foreign credit.

6 Some Arguments in Need of a Theory

There are a number of arguments related to the dollarization debate that, to date, have not been formalized with the tools of modern economic theory. Many of these arguments sound plausible, but their relative importance will remain unknown unless more progress is made in formulating them adequately.

The first contention is that dollarization would be beneficial by reducing transactions costs, such as the costs of calculating dollar equivalents of national currency quantities. In principle, one can hardly disagree with this claim. However, measuring its significance is much trickier. For one thing, the transactions costs relevant for the argument are likely to be very small. Also, including them into economic models has proven to be much harder than expected, and no satisfactory and tractable procedure has emerged. As a consequence, measures of the quantitative importance of transactions costs have played little role in the debate. Finally, the transactions costs in question are likely to be already negligible in a system of irrevocably fixed exchange rates, and hence the marginal savings that dollarization would bring along this dimension are arguably insignificant.

[8] See Chang and Velasco (2000c) for a formalization of this idea in the financial panics context.

A second argument, this one voiced by some opponents of dollarization, is that currencies are national symbols, and hence their elimination would be costly in terms of national pride, identity, and the like. Such an argument is sometimes politically effective and, in spite of its being quickly dismissed by many economists, may have some validity. However, how to formalize it or assess its economic importance is competely unknown.

A third claim is that dollarization would reduce market incompleteness. For example, Hausmann (1999) stated that "[Dollarization] would expand the menu of financial options open to emerging-market governments and firms and, in so doing, would increase financial stability." Again, this is not an implausible claim, but is one that cannot be analyzed in the context of standard models. This is because standard models take the degree of market completeness as a given. To our knowledge, there is no theory dealing with how dollarization would "expand the menu of financial options," let alone what implications such an expansion would have on allocations and welfare.

Finally, consider the claim that official dollarization is presumably beneficial because it would legalize the spontaneous dollarization that is already observed in several countries. At one level, our analysis can be amended in a straightforward manner to deal with such an argument. One may suppose that, before dollarization is imposed by policy, the home agent derives utility not only from holding pesos but also from holding dollars. This can be formalized by making v depend on some aggregate of the real value of pesos and dollars, a modeling device that has been employed in the literature on currency substitution. The resulting extension is likely to yield essentially the same lessons as the original model and, in that sense, the observation of currency substitution by itself does not provide independent support for dollarization.

We admit, though, that the fact that dollarization is already taking place in many countries may reflect the effect of some fundamentals about which we know little or nothing; such an effect is buried in the specification of the v function in our model. Given this, it may be not implausible to conjecture that the way such fundamentals work may change, in a favorable way, if dollarization was made official. However, such a conjecture needs to be made explicit and cast in terms of modern economic theory if it is to become more than wishful thinking.

7 Final Remarks

We have conducted a fairly thorough, although surely not exhaustive, discussion of the theoretical issues associated with dollarization. Our analysis has been organized around a simple, single framework, that can be extended in many directions. We emphasize that the study of a single framework is useful for at least two reasons. It gives readers an idea of how the different aspects of the dollarization debate are related to each other. And such a modelling stratgey provides the foundation for a satisfactory quantitative comparison of the associated costs and benefits.

We have borrowed from previous literature, and we have also provided new observations, for and against dollarization. Among the former, we noted that calculations of seigniorage loss should no longer be automatically taken as a con of dollarization. Among the latter, we emphasized that there is no presumption that dollarization should reduce interest rates.

Perhaps most importantly, we have identified some arguments that are lacking satisfactory theoretical foundations. Given the interest on dollarization, these arguments remain fertile ground for future research.

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