CURRENCY BOARDS, CREDIBILIDAD Y CRISIS CAMBIARIAS

MARCELLA MULINO

RESUMEN:

Este trabajo pone en duda la creencia de que los sistemas de *currency board* son una solución para evitar las crisis cambiarias. Basándose en un modelo "de segunda generación", el presente estudio muestra que, en presencia de desempleo duradero, un sistema de *currency board* también puede ser vulnerable a una crisis cambiaria. El modelo analiza el papel que desempeñan en el estallido de esas crisis tanto las expectativas sobre el tipo de cambio como la evolución de las variables fundamentales de la economía. La persistencia del desempleo repercute sobre las expectativas de períodos posteriores, lo que hace que la credibilidad del sistema de *currency board* pueda reducirse con el paso del tiempo, provocando una crisis cambiaria.

PALABRAS CLAVE: *currency board,* crisis cambiarias, credibilidad.

CURRENCY BOARDS, CREDIBILITY AND CRISES

MARCELLA MULINO*

SUMMARY:

The paper calls into question the proposition that currency boards are a solution in preventing currency crises. On the basis of a model of the "second generation" type, it shows that, in the presence of unemployment persistence, a currency board system can become vulnerable to a currency crisis, as well. The model underlies the role played both by expectations of exchange rate realignments and by fundamentals in triggering the crisis. As the persistence of unemployment has a feedback effect on subsequent periods' expectations, the credibility of a currency board may decrease over time, eventually inducing a self-fulfilling crisis.

KEYWORDS: currency boards, crises, credibility.

* University of L'Aquila . Faculty of Economics. Piazza del Santuario, 19. 67040- Roio Poggio (L'Aquila). Italy. E-mail: mulino@ec.univaq.it

1. INTRODUCTION

The currency crises of the 1990s have raised once again a deep interest in the issue of the choice of exchange rate regimes, especially for emerging countries. Unilateral or multilateral pegs, so often devised to provide a nominal anchor to fight domestic inflation, proved vulnerable to speculative attacks and macroeconomic instability. The huge welfare costs of policymakers' efforts to defend a peg, even when successful, have called into question the viability of fixed rates in today's world of highly developed and liberalised capital markets.
Theoretical analyses show that a policymaker can be obliged to abandon the peg when fundamentals are inconsistent with long-run fixity of the exchange rate (according to so-called first generation models1); alternatively, she may choose to do it when expectations that the rate might be abandoned are so widespread to impose a social cost that outweigh the benefits of maintaining the peg (these second generation models envisage the possibility of self-fulfilling crises and multiple equilibria2).
More recently, yet another framework has been put forward. It stresses the fact that currency crises are often part of broader financial crises. The two elements interact with one another, giving life to what have been dubbed the "twin crises"3. In this approach financial intermediaries play an active role in generating large capital inflows, but in doing so they raise the risks of a sudden reversal of capital flows and of a bank run4. In "twin crises" these two elements are tightly intertwined: if agents expect a devaluation, early withdrawals will be beneficial. This generates financial panic and raises the risk of a bank run. On the other hand, a run against the intermediaries generates a sudden demand for foreign exchange reserves that may force currency devaluation.

The growing integration and liberalisation of world capital markets has made it fashionable to argue that only extreme exchange rate regimes are sustainable. The "two-corner" approach to exchange rate policy states that, in the presence of highly volatile short-term capital flows, a currency crisis can be avoided either by letting the exchange rate to freely float5 or by a final commitment to a fixed exchange rate. Short of adopting a common currency, currency board arrangements represent the most extreme form of exchange rate pegs.
On the basis of second-generation models, advocates of currency boards underlie their greater effectiveness, as they entail a fully binding commitment. By making the exchange rate commitment a credible one, there would be no room for self-fulfilling speculation6. In the '90s the recurrent currency crises showed the increasing vulnerability of fixed exchange rate regimes to speculative attacks. The positive examples of Argentina and Hong Kong, whose currency boards held out against the Mexican crisis in 1995 and the Asian one

1 Following Krugman (1979) and Flood-Garber (1984).
2 The seminal papers were by Obstfeld (1994) and (1996).
3 See Chang-Velasco (1998) and Kaminsky-Reinhart (1999).
4 There may also be a moral hazard problem associated with financial intermediaries when the latter are poorly supervised and monetary authorities act as lenders of last resort. See Krugman (1998) and Corsetti-Pesenti-Roubini (1998).
5 Few countries follow a pure float. A system whose diffusion is increasing, is the so-called "inflation targeting", where the objective of the monetary authority is to achieve a predetermined rate of inflation. Under "inflation targeting" the nominal exchange rate shows a certain degree of flexibility, while the desired rate of inflation is often set to a level allowing a constant real exchange rate. On this subject, see Masson-Savastano-Sharma (1997) and Svensson (1998).
6 See Hanke (2000).

in 1997, encouraged to recommend the adoption of currency boards in countries wishing to safely peg their exchange rate.
This paper calls into question the proposition that currency boards are the solution in preventing currency crises. We elaborate a formal model of the "second generation" type, showing that, in the presence of unemployment persistence, a currency board system can become vulnerable to a currency crisis, as well. A policymaker may be compelled to abandon the currency board when the economy is hit by a negative real shock with persistent effects, as growing realignment expectations make the cost of maintaining the peg too high. The forced exit is the only way out owing to the rigidities such arrangement entails, because there are no other means by which she can act to drive down unemployment.
The paper is organised as follows. The next paragraph explains how the features of a currency board can make such an exchange rate system so rigid that the policymaker cannot react at all to the economic environment's variability (for instance, to shocks affecting the terms of trade or the reserve country's interest rates, or to reversals in capital flows). Therefore, shocks play a much more important role than in ordinary peg systems. Paragraph 2 sketches the key features of the model, stating the problem faced by the policymaker and her choice criterion. The approach followed is of the "second generation" type, in which fundamentals, both unemployment and the policymaker's reputational capital, as well as market expectations play a role in determining the authorities' optimal policy. Paragraph 3 considers the role of exchange rate expectations, making a distinction among three types of equilibria: full credibility equilibrium, zero credibility equilibrium and partial-credibility equilibrium, in which private agents have positive realignment expectations. In the latter case, the currency board is maintained only at the expenses of higher unemployment. Paragraph 4 sketches the dynamic implications of the model, showing the influence of unemployment persistence on subsequent periods' expectations and how this will tend to reduce the credibility of the currency board.

2. CURRENCY BOARDS VERSUS FIXED EXCHANGE RATES

A currency board system can be seen as an extreme case of a fixed exchange rate system. It is often stressed that "the difference between a currency board and a pegged exchange rate is largely one of degree: a currency board can be abandoned just as a pegged exchange rate can." 7 Its main distinctive characteristics are the explicit legislative commitment to exchange domestic currency for a specified foreign currency at a fixed exchange rate, coupled with formal restrictions on the issuing authority (the currency board or the central bank8), as its monetary base must be fully backed by foreign exchange or liquid foreign exchange assets. In their "pure" version, currency boards eliminate traditional central bank functions like monetary regulation and the lender of last resort function. Moreover, they set restrictions on modifying the level of the exchange rate, as it can be altered only by parliamentary or even constitutional changes. Institutional arrangements typically make the abolition of a currency

7 Ghosh, Gulde, Wolf (1998, p. 5).
8 Even though a full-fledged central bank is not required, currency boards are often established in institutional frameworks encompassing an existing central bank. This is the case of Argentina, Estonia and Lithuania.

board considerably more difficult, thus providing additional credibility at the margin.

All these features explain why currency boards may be attractive to countries choosing fixed rates, but where lack of credibility feeds recurrent speculative attacks or where, starting from hyperinflation, the firm commitment to an exchange rate-based nominal anchor would reduce the output and unemployment costs of disinflation. Indeed, the choice of a currency board, by stating a strong anti-inflationary stance and by raising the costs of abandoning the strategy, may help a more rapid adjustment in expectations.

Besides enhancing credibility, however, the inherent rigidities of a currency board may have some dangerous side effects that magnify the shortcomings of fixed rates9. The most important one is maybe the constraint it imposes on the policymaker with respect to her ability to react to real shocks, because of the absence of policy instruments for stabilisation purposes. In currency board autonomous monetary policy is ruled out, and budget deficits are run under very strict conditions.

It is not simply a question of "bad luck". Several features of a currency board make the effects of an adverse shock much more painful than in ordinary pegs. First of all, when establishing a currency board, the reserve currency is chosen more with regard to its "soundness" than to trade flows or financial transactions. The domestic economy is tightly linked to the reserve country one, even when the two countries do not make an optimal currency union10. Their productivity growth and their economic cycle may be totally different and obviously there is not enough factor mobility to compensate for it. To a certain extent, the same apply also to unilateral pegs, the difference being that the currency board "imports" the reserve country's monetary policy, that is its dynamics of both the interest and the exchange rates, while being totally constrained on shaping the money supply.

Currency board arrangements, as well as unilateral pegs, in particular when meant to provide a nominal anchor in fighting domestic inflation, are often associated with cumulative real exchange rate appreciations, loss of competitiveness and structural worsening of the trade balance, as domestic inflation converges to international levels only gradually. In the short run, capital inflows can help supporting the economy, and they are likely to flow into the country owing to the higher nominal interest rates resulting from the gradual process of inflation convergence. However, in the medium run, they are likely to cause a further real exchange rate appreciation and to increase the country's vulnerability to shifts in foreign investors' confidence11. Large capital inflows (in optimistic periods) or outflows (when there are expectations of devaluation) can occur regardless of whether a country has a currency board or not. Nevertheless, in a currency board they pose an additional problem inasmuch as the central bank is not allowed to sterilise their effects on the monetary base. When capitals flow out, the monetary base falls, domestic interest rates are forced to increase, putting under considerable stress domestic banks and firms, and a recession may follow, feeding back devaluation expectations.

9 On the pros and cons of fixed and flexible exchange rates, see Edwards-Savastano (1999).
10 See Mundell (1961).
11 Owing to the anti-inflationary tight monetary stance, usually banks and firms borrow abroad to finance imports and current account imbalances, as well as economic activity and investment. In this way, the country's vulnerability to shifts in foreign investors' confidence is enhanced.

As trade is usually highly diversified, linking the local currency to a reserve currency makes relative price changes likely from time to time. Real overvaluations are likely to occur when the reserve currency appreciates against the currency board country's trading partners or, which is the same, when trading partners devaluate against the reserve currency12. In such a context, the adjustment mechanism goes from a current account imbalance to a decrease in the monetary base and to a deflation, assuming that wages and prices react quickly. Only a deflation can overcome real overvaluation. However, under nominal inertia, deflation in turn requires a recession, making the adjustment process slow and costly in terms of output and employment, as in the meanwhile short-term policies to support the economy are broadly ruled out. Recent experiences show that real exchange rate appreciations can occur to a considerable extent13. Moreover, even if the currency board is fully credible and there is no sovereign risk, meaning that nominal interest rates are the same as the reserve country's ones, real interest rates will be higher than abroad owing to domestic deflation. High real interest rates, in turn, strengthen the depressing effect of the fall of exports. The fact that the required adjustment process may entail large output losses could in turn undermine confidence in the sustainability of the peg.

In addition, countries adopting a currency board are more prone to financial crises, due to the lack of domestic or foreign institutions providing lender of last resort services in the face of system-wide liquidity crunches14. As in the "twin crises" approach, financial and currency crises are tightly intertwined. When devaluation expectations grow, the speculative attack makes the monetary base to decrease and interest rates to increase. Given required reserve ratios, banks are forced to recall loans and firms may go bankrupt. Unless foreign banks provide additional liquidity or the central bank holds excess foreign reserves compared to the monetary base, the run against the banks adds to the pressure on foreign reserves. On the other hand, if a financial panic occurs and the public starts to try to convert its demand deposits into the reserve currency, the commercial banks themselves are responsible for ensuring convertibility of demand deposits. While fully backing the monetary base (M0), a currency board does not hold reserve currency assets that cover the entire stock of liquid monetary assets (M1, let alone M2). As the domestic financial assets that may be used to buy foreign currency are usually a large multiple of the monetary base, the speculative attack may well succeed.

Up to now, empirical assessment of relative economic performance (in terms of inflation, output growth, unemployment, real interest rates and budget deficit ratios to GDP) in countries with and without currency boards has led to mixed results. Ghosh-Gulde-Wolf (1998) point to a slightly better performance of currency boards arrangements15, while Salater (2002) asserts that currency

12 "Some currency boards countries showed greater real effective exchange rate appreciation than similar peg regime countries and tended to be more responsive to negative employment shocks" (Rivera Batiz-Sy, 1997, pp. 7-8). Real exchange rate revaluation cannot be considered an "external shock" in the true sense of the term, but a self-inflicted one, resulting from the choice of the currency regime and of the reserve currency.

13 For instance, between 1990 and 1997 the Hong Kong currency appreciated in real terms by over 30%, while in Estonia the real appreciation of the currency since the adoption of the currency board in 1992 has been equal to over 70% and in Lithuania the real appreciation has been nearly 60% since 1994. However, both countries entered the currency board with an exchange rate that was undervalued (Roubini, 1998). Argentina's real exchange rate appreciated by 15% between January 1997 and mid-2001 (Eichengreen, 2001), while prices and wages were falling at a 2% rate per year.

14 Lending to financial institutions may be provided only when there are excess foreign reserves compared to the monetary base.

15 Their comparison is in terms of inflation and output growth rates only.

board countries achieved superior results only with respect to the inflation rate. It is undisputed, in any case, that "policy inflexibility has a cost and countries adopting currency boards often do worse than alternative regimes when facing strong shocks"16. The cost depends on the susceptibility of the economy to aggregate shocks, and on the absence or ineffectiveness of alternative policy instruments. We think that this statement holds not only for "strong" shocks, but for ordinary shocks as well, when they have cumulative effects into the economy.

3. THE MODEL

The model is based on standard models of monetary policy choice in a small open economy, whose basic framework is drawn from Barro-Gordon (1983). The model is an elaboration of that in Obstfeld (1996), but we assume that shocks and government policies have persistent effects on unemployment. This feature, common to Masson (1995) and Irwin (2001), captures a well-known characteristic of labour markets, that is the existence of a high degree of unemployment persistence17.

In addition, we assume that when choosing a fixed exchange rate regime the government chooses a currency board system. As stressed above, a currency board signals a very firm commitment to a fixed exchange rate, backed by institutional arrangements. However, a currency board can be abandoned just as other types of exchange rate peg, the main differences being that the abolition of a currency board is considerably more difficult and involves a higher political cost to the policymaker. This is the source of currency boards' higher credibility over fixed but adjustable exchange rate arrangements. In the model, we assume that this political cost is high but fixed and that the public knows it.

The government observes the shock hitting the economy before deciding on exchange rate policy, but the private sector is assumed not to observe the realisation of the shocks when forming its inflation expectations. Hence, as is standard in this literature, the policymaker enjoys an information advantage over the private sector.

We assume a small open economy in which purchasing power parity holds, so that the domestic price level is determined by the exchange rate policy. Normalising the foreign price level at 1 and taking logs, we have:

$$\pi_t \equiv p_t - p_{t-1} = e_t - e_{t-1} = \varepsilon_t$$

where e_t is the price of foreign currency in terms of domestic currency. Therefore, devaluations are equivalent to a positive inflation rate.

On any date *t* the policymaker minimises a one-period objective function. This hypothesis implies that the policymaker does not take into consideration the effects her current exchange rate decision has on subsequent periods' unemployment rate and on market expectations of her future behaviour. Albeit

16 Oliva-Rivera Batiz-Sy (2001, p. 609-610). With reference to the Argentine crisis, Perry-Servén (2002, p.3) underlie that, while the major slowdown in 1999 affected the whole Latin-American region, "the fact that Argentine did worse than other countries after 1999 must be attributed to her highr vulnerability to shocks, weaker policy responses or a combination of both".

17 According to Layard, Nickell, Jackman (1991) it is linked both to the so-called "job search ineffectiveness" of the unemployed and to wage pressure factors, such as unions, real wage resistance, and the generosity of the benefit system.

the model contains intertemporal links, the above assumption - as stressed by Masson (1995) - greatly simplifies the analysis, allowing to shed light on the interrelations among economic variables. In section 4 we are going to consider a multi-period objective function, in order to show how, even in a currency board regime, the policymaker's credibility may decrease over time18.

The loss function depends on the square both of the deviation of unemployment from the natural rate u_t and of the inflation rate19

[1] $$L_t = (u_t)^2 + \theta(\varepsilon_t)^2$$

where $\theta > 0$. Contrary to Drazen, Masson (1994), Masson (1995) and Oliva, Rivera-Batiz, Sy (2001), we assume that the private sector knows the value of θ, that is the weight the government assigns to the inflation rate target. In addition, we assume that θ is high, reflecting the policymaker's high concern for exchange rate and prices stability. The assumption is that a policymaker adopting or considering to adopt a currency board is a "tough" policymaker, aiming at making more quickly credible her commitment against inflation. The choice of such an institutional arrangement can decrease the cost of acquiring the reputation connected to the new attitude against inflation. Instead, a "weak" policymaker, who assigns a low value to θ, would not follow a consistent policy by choosing a currency board.

The deviation of unemployment from the natural rate is given by

[2] $$u_t = \alpha^{1/2}\left[\left(\varepsilon_t^e - \varepsilon_t\right) + k + \delta u_{t-1} + z_t\right]$$

with $\alpha > 0$ and where $\varepsilon_t^e = E_{t-1}e_t - e_{t-1}$ is private sector expectation of exchange rate changes conditional on information available prior to *t*. The previous equation can be derived assuming that private agents commit to nominal contracts that fix wages one period ahead. The private sector must forecast next period inflation in order to specify the nominal wage commitment. As unexpected exchange rate increases generate unexpected inflation, they have an impact on real wages and on the unemployment rate: surprise devaluations have an expansionary effect. On the other hand, expected devaluations when afterwards the policymaker abstains from modifying the exchange rate increase the unemployment rate.

$k > 0$ is a fixed distortion in the economy that causes unemployment systematically to be above the target rate. It implies that even in steady-state there will be a positive deviation of unemployment from the natural rate: when expectations are correct, the realisation of the shock is zero and $u_t = u_{t-1} = \bar{u}$, we will have:

18 Modelling explicit multi-period objective functions makes the analytical solution of the sequential game so complex that the model proves unfit for achieving clear-cut economic conclusions on pure analytical grounds. Drazen-Masson (1994) and Oliva-Rivera Batiz-Sy (2001) draw their conclusions by means of a numerical simulation.
19 All variables are in logs.

[3] $$\bar{u} = \alpha^{1/2} k\left(1 - \delta\alpha^{1/2}\right)^{-1} > 0$$

The assumption $k > 0$ is the source of the policymaker's credibility problem and it may explain why a rational government might wish to "tie its hands" by choosing a currency board. As the latter entails high exchange-rate realignment costs, it enhances its credibility.

δ is a measure of the persistence of unemployment deviations and z_t is an unemployment-increasing mean-zero shock, serially uncorrelated, which is assumed to be uniformly distributed in the interval $[-\mu, \mu]$. z_t depends on foreign interest rates movements, domestic private and government demand shifts, and foreign demand shift due to changes in competitiveness. In our simplified model, centred only on the supply side of the economy, the shock plays the role of representing the (stochastic) demand side, in a way as simple as possible. As stressed above, a currency board system is more constraining on the ability of the policymaker to react to shocks, owing to the absence of alternative policy instruments for stabilisation purposes. Therefore, for a given value of the shock, its effect on economic activity and on the unemployment rate will tend to be more marked.
If the government chooses a flexible exchange rate regime, the optimal ε_t is set minimising [1], subject to [2], given ε_t^e (which has been already set) and after observing the realisation of z_t. From the first order condition, we obtain:

[4] $$\varepsilon_t = \alpha(\alpha + \theta)^{-1}\left(\varepsilon_t^e + k + \delta u_{t-1} + z_t\right)$$

that, substituted in [1], gives the loss from the flexible exchange policy:

[5] $$L_t^{FL} = \alpha\theta(\alpha + \theta)^{-1}\left(\varepsilon_t^e + k + \delta u_{t-1} + z_t\right)^2$$

Assuming rational expectation of the public, from equation [4] we obtain $\varepsilon_t^e = \alpha\theta^{-1}(k + \delta u_{t-1})$, which gives the following value for the optimal ε_t

$$\varepsilon_t = \alpha\theta^{-1}(k + \delta u_{t-1}) + \alpha(\alpha + \theta)^{-1} z_t$$

and the following loss

[6] $$L_t^{FL} = \alpha\frac{\theta}{(\alpha + \theta)}\left[\frac{(\alpha + \theta)}{\theta}(k + \delta u_{t-1}) + z_t\right]^2$$

Instead, if the government chooses a currency board, committing itself to a fixed rate, that is to $\varepsilon_t = 0$, its loss is given by:

[7] $$L_t^{CB} = \alpha\left(\varepsilon_t^e + k + \delta u_{t-1} + z_t\right)^2$$

If the commitment is credible, that is if $\varepsilon_t^e = \varepsilon_t = 0$, equation [7] becomes:

[8] $$L_t^{CB} = \alpha\left(k + \delta u_{t-1} + z_t\right)^2$$

With credible commitment the currency board regime is clearly superior to discretion. The well-known problem of time-inconsistency, however, makes even the commitment to a currency board not fully credible, giving way to realignment expectations.

Therefore, we compare the two policy losses [5] and [7]. The government will choose a flexible exchange rate regime, setting ε_t according to equation [4], when $L^{CB} - L^{FL} > c$, that is when the cost of sticking to the currency board exceeds that of choosing a flexible exchange rate regime, plus the political cost of exiting the currency board, c. We assume that the latter is exogenously given at a high level, known by the public. Formally, this condition can be expressed as:

[9] $$\alpha^2\left(\alpha + \theta\right)^{-1}\left(\varepsilon_t^e + k + \delta u_{t-1} + z_t\right)^2 > c$$

For any ε_t^e, the farther the value of the random shock with respect to its mean (zero), the higher will be the relative costliness of the commitment to a fixed rate. In fact, while fixed rates do away with the inflationary bias of discretion, in the meanwhile they prevent the policymaker from absorbing the shock's effect on the unemployment rate.
The solutions to the above inequality are external to the roots:

$$\begin{cases} [10a] \quad \bar{z}_t = \dfrac{1}{\alpha}\sqrt{c\left(\alpha + \theta\right)} - \varepsilon_t^e - k - \delta u_{t-1} \\ [10b] \quad \underline{z}_t = -\dfrac{1}{\alpha}\sqrt{c\left(\alpha + \theta\right)} - \varepsilon_t^e - k - \delta u_{t-1} \end{cases}$$

Given the private sector expectations of exchange rate realignments, an unemployment shock such that $z_t > \bar{z}_t$ induces the government to devalue, while for $z_t < \underline{z}_t$ it will revalue. The threshold values of the shock depend on the state of the fundamentals of the economy (as reflected in the previous unemployment deviations u_{t-1}, given the degree of the persistence δ, and in the economy's structure *k*) and on private sector expectations of exchange rate changes ε_t^e, as well as on the given political cost of exiting a currency board and the policymaker's anti-inflationary stance.

4. EXPECTATIONS AND SELF-FULFILLING EQUILIBRIA

Equations [10] stress the role that is played by exchange rate changes expectations. Higher realignment expectations entail lower threshold values for the shock, that is a higher probability of choosing a flexible exchange rate. What

shapes then the expectations of the public? They cannot be taken as exogenous, inasmuch as expectations are determined rationally by agents that understand the choice the government faces. Accordingly, the expected ε_t^e is obtained from equation [4], where ε_t is weighted with the probabilities that the realisation of the shock z_t exceeds the above threshold values20

$\varepsilon_t^e = E\left(\varepsilon_t \middle| z_t < \underline{z}_t\right) Pr\left(z_t < \underline{z}_t\right) + E\left(\varepsilon_t \middle| z_t > \bar{z}_t\right) Pr\left(z_t > \bar{z}_t\right)$, that is

[11] $$\varepsilon_t^e = \frac{\alpha}{\theta}\left(k + \delta u_{t-1}\right) + \frac{\alpha}{\theta}\frac{\underline{z}_t^2 - \bar{z}_t^2}{2\left[\mu - \left(\bar{z}_t + \underline{z}_t\right)\right]}$$

which shows that the expectation of exchange rate realignments depends on the state of the fundamentals and on the threshold values for the shock. In other words, expectations depend on agents' perception of where the realignment trigger points lie. In turn, regime switch points depend on private sector expectations; there is thus an interdependence that creates the potential for a range of self-validating rational expectations equilibria to exist, as discussed at length in Obstfeld (1996 and 1997).

In this context, even a currency board is not a fully binding exchange rate regime, notwithstanding the tough attitude towards inflation and the high political cost faced by the policymaker if the currency board collapses. As the commitment may be not fully credible, implying that $\varepsilon_t^e \neq \varepsilon_t = 0$, it is possible that changes in realignment expectations lead to closer threshold values and eventually to self-fulfilling realignments.

Following Irwin (2001), we may distinguish between full-credibility equilibria, in which the private sector attaches probability zero or one to expected realignments, and partial-credibility equilibria, in which the private sector considers that realignments may occur with a positive probability.

In full credibility equilibrium, expectations are $\varepsilon_t^e = \varepsilon_t = 0$ and they must be correct for an equilibrium to exist. The private sector expects the currency board will be maintained with certainty when $\bar{z}_t = \mu$ and $\underline{z}_t = -\mu$, that is when $Pr\left(z_t > \bar{z}_t\right) = Pr\left(z_t < \underline{z}_t\right) = 0$. For a full credibility equilibrium it is necessary that fundamentals are in a good state (low k and u_{t-1}) and that both the political cost of realignment and the preference of the government for anti-inflationary policies are high. We may assume, as argued above, that in a currency board both c and θ are higher than in other forms of exchange rate peg. However, the latter is a necessary but not sufficient condition for the existence of a full credibility equilibrium, owing to the influence of fundamentals.

The commitment has no credibility at all, instead, when $\bar{z}_t = \underline{z}_t$. In particular, a devaluation is certain when the upper bound is so low that $\bar{z}_t = -\mu$, which means that $Pr\left(z_t > \bar{z}_t\right) = 1$. This situation can result, for example, when δu_{t-1} is high enough to make ε_t^e rise to the extent that $\bar{z}_t$ is stuck at $-\mu$. If this is the case, agents expect a devaluation with certainty. Their expectation is the same

20 Where $Pr\left(z_t < \underline{z}_t\right) + Pr\left(z_t > \bar{z}_t\right) + Pr\left(\underline{z}_t < z_t < \bar{z}_t\right) = 1$.

as under a flexible rate regime with rational expectations, as in equilibrium expectations must be correct. Indeed, as now we have both $\bar{z}_t = -\mu$ and $\underline{z}_t = -\mu$, equation [11] becomes: $\varepsilon_t^e = \alpha\theta^{-1}\left(k + \delta u_{t-1}\right)$.

In between, we have a partial credibility equilibrium21, with $\varepsilon_t^e > 0$, in which the policymaker maintains the fixed rate only when $\underline{z}_t < z_t < \bar{z}_t$. If the policymaker does not realign, the currency board is maintained at the expenses of higher unemployment. As unemployment deviations are persistent, this will tend to reduce the credibility of the exchange rate peg, augmenting the relative costliness of the commitment to a fixed rate. Given the constraints imposed on the policymaker by a currency board, there is no means by which she can act to drive down unemployment. Thus, she may eventually be forced to abandon a currency board.

5. INTER-TEMPORAL LINKAGES AND CURRENCY CRISIS

In the model there is an inter-temporal linkage, the unemployment deviation inherited from the previous period, making the outcome in one period to have implications for the outcome in subsequent periods.

In our model δu_{t-1} is the only inter-temporal linkage, as we assume both perfect information about the anti-inflationary stance of the policymaker, θ, and perfect information about the political cost of exiting a currency board. On the contrary, Drazen, Masson (1994), Masson (1995) and Oliva, Rivera-Batiz, Sy (2001) assume that the policymaker can have a "tough" or "weak" attitude with respect to inflation (with $\theta^T > \theta^W$). As the private sector does not observe the government type, it must infer the type from observations of the policies followed by the government, that is possible devaluations in previous periods or the choice of a currency board. Irwin (2001) takes a different approach, assuming that there is incomplete information about the political cost of devaluation, given its intangible nature. Overtime, the government behaviour has a signalling effect over the "true" cost. Both types of incomplete information shape the expectations of the public, eventually leading to question the credibility of the peg or of the currency board.

In our model, only shocks to unemployment create uncertainty and this uncertainty shapes the private sector's expectations. As expected realignments, when afterwards the policymaker abstains from modifying the exchange rate, make the unemployment rate to change, the persistence of unemployment has a feedback effect on subsequent periods' expectations. The assumption of complete information about θ and c, besides simplifying the algebra, allows us to focus on the possibility of a collapse of a currency board system just from the uncertainty about the value of the shocks hitting the economy.

Let us consider the role δu_{t-1} plays. Unemployment deviations grow whenever agents expect a realignment with a positive probability, but the government sticks to the peg. Equation [11] shows that realignment expectations (given the threshold values for the shock $\underline{z}_t$ and $\bar{z}_t$) are proportional to δu_{t-1}, meaning

21 The existence of multiple equilibria depends on the distribution function of the shock z_t.

that higher unemployment deviations inherited from the previous period raise the expected ε_t^e. In turn, $\underline{z}_t$ and $\bar{z}_t$ are inversely proportional both to δu_{t-1} and to realignment expectations, so that an increase in δu_{t-1} shortens the interval of threshold values for the shock $\underline{z}_t$ and $\bar{z}_t$. This occurs through two channels: a direct one, and an indirect one, *via* an increase in realignment expectations. Analytically, from equations [10], we have:

[12] $$\frac{\partial \bar{z}_t}{\partial u_{t-1}} = \frac{\partial \underline{z}_t}{\partial u_{t-1}} = -\delta\left[\frac{\alpha+\theta}{\theta} + \frac{\alpha}{\theta}\cdot\frac{\delta(\bar{z}_t - \underline{z}_t)\mu}{\mu - (\bar{z}_t + \underline{z}_t)}\right] < 0$$

In sum, the level of unemployment deviation the government chooses to leave behind, not moving to flexible exchange rates when unemployment grows, is detrimental to credibility, inducing a growth in inflationary expectations in the future, thereby increasing unemployment deviation and reducing the threshold values for the shock. As the level of unemployment is so key in determining the sustainability of the currency board, it is worth analysing how unemployment deviations evolve over time.

To this purpose, we consider a two period setting in which, without substantive loss of generality, revaluations are ruled out: only positive realisations of the stochastic unemployment shock occasion discretion, in which case a devaluation occurs. The policymaker's objective is to minimise an expected discounted loss function, conditioned on information available at $t=1$, that is on the observation of the first period shock, but non of the second period shock:

$$\Omega = L_1 + \beta E_1 L_2$$

where β is the government discount rate. We assume that, at the start, the unemployment deviation is equal to its steady-state value, such as in equation [3]. This is the positive deviation to which the system converges in the absence of exchange rate surprises. As we are interested in showing how in a currency board regime a full credibility equilibrium may turn to a partial credibility one, we are not going to define a two-period optimal choice of the exchange rate regime. Instead, we assume that the policymaker decides the exchange rate regime to be a currency board for the next two periods; on the basis of the delay implied by parliamentary and constitutional restrictions, we assume that this choice cannot be altered in the first period. Therefore, for the first period the commitment is fully credible, and expectations will be $\varepsilon_1^e = \varepsilon_1 = 0$. If the economy is hit by a shock in period one, the unemployment deviation (equation [2]) will however increase to the level

$$u_1 = \alpha^{1/2}(k + \delta\bar{u} + z_1)$$

In the second period, the government may devalue (or not).

Thus, on the basis of our assumptions, the expected loss function becomes

$$\Omega = \left\{\alpha\left[k + \delta\bar{u} + z_1\right]^2\right\} + \beta E_1\left\{\alpha\left[\left(\varepsilon_2^e - \varepsilon_2\right) + k + \delta\bar{u} + \alpha^{1/2}\delta z_1 + z_2\right]^2 + \theta(\varepsilon_2)^2\right\}$$

The first period loss is deterministic. The expected second period loss is given by the weighted sum of the loss in case the optimal choice in the second period is a devaluation and the loss in case it is optimal to keep the currency board:

$$
\begin{aligned}
E_1 L_2 &= E_1 L_2^{FL} + E_1 L_2^{CB} \\
&= \frac{1}{\mu} \int_{z_2=\bar{z}_2}^{z_2=\mu} \left[\alpha\left(\varepsilon_2^e - \varepsilon_2 + k + \delta\bar{u} + \alpha^{1/2}\delta z_1 + z_2\right)^2 + \theta\left(\varepsilon_2\right)^2 \right] d z_2 \\
&+ \frac{1}{\mu} \int_{z_2=0}^{z_2=\bar{z}_2} \alpha\left(\varepsilon_2^e + k + \delta\bar{u} + \alpha^{1/2}\delta z_1 + z_2\right)^2 d z_2
\end{aligned}
\qquad [13]
$$

Therefore, in order to compute L_2^{FL} and L_2^{CB} we must find the value of the shock that makes the cost of maintaining the currency board equal to that of devaluing, augmented by the political cost of exiting the currency board: $L_2^{CB} - L_2^{FL} = c$. The value of the unemployment shock that satisfies this condition is:

$$
\bar{z}_2 = \frac{1}{\alpha}\sqrt{c(\alpha+\theta)} - \varepsilon_2^e - k - \delta\bar{u} - \alpha^{1/2}\delta z_1 \qquad [14]
$$

Equation [14] shows a negative correlation between period-one shock and the trigger value for the shock in period two, $\bar{z}_2$. The higher the value of the shock in period one, not followed by a devaluation, the lower the threshold value of the shock that in period two will compel the policymaker to abandon the currency board. This effect is due to the persistence of unemployment from one period to the following ones $(\delta > 0)$. In addition, $\bar{z}_2$ is negatively linked to ε_2^e, as unfulfilled private sector expectations imply an unexpected low inflation and a worsening of fundamentals. Thus, we need an explicit expression for ε_2^e. It may be obtained by weighting the optimal rate of devaluation with the probability that the realisation of z_2 exceeds the above threshold value:

$$
\varepsilon_2^e = \frac{\alpha(\mu - \bar{z}_2)}{(\alpha+\theta)2\mu - (\mu - \bar{z}_2)}\left[(k + \delta\bar{u}) + \alpha^{1/2}\delta z_1 + (\mu + \bar{z}_2)\right] \qquad [15]
$$

Substituting in it the value of $\bar{z}_2$ from equation [14], we obtain:

$$
\varepsilon_2^e = \frac{(\alpha+\theta)\left(2\alpha\mu^2 - c\alpha^{-1}\right) + \left[\alpha\mu + c^{1/2}(\alpha+\theta)^{1/2}\right]\left(k + \delta\bar{u} + \alpha^{1/2}\delta z_1\right)}{\mu\left[2(\alpha+\theta) - \alpha\right] - \left[c(\alpha+\theta)\right]^{1/2}} \qquad [16]
$$

We should then substitute equation [16] in equation [13] and solve it, to obtain afterwards the expected loss for the two periods Ω. Besides being a very complex task, the analytical solution is unlikely to add further insights to the problem we are considering.

To our purposes, the important point is that both equations [14] and [15] show a positive correlation between period-one shock and the probability of devaluation perceived by the market in the second period.
Albeit our analysis is limited to a two-period setting, we may observe that, as both equations [14] and [15] show a negative link between ε_2^e and $\bar{z}_2$, the influence of the first period shock on these variables is mutually reinforcing. If the policymaker does not devalue in the second period, both the positive devaluation expectation, $\varepsilon_2^e > 0$, and the eventual realisation of a period-two shock, $z_2 > 0$, induce a further growth in the unemployment deviation:

$$u_2 = \alpha^{1/2}\left(\varepsilon_2^e + k + \delta\bar{u} + \alpha^{1/2}\delta z_1\right) + z_2$$

that is, a further deterioration in fundamentals, bringing an increase in the private sector's expectations of a devaluation.
Even if there is no shock in the second period, the effect of past unemployment on current unemployment persists. Moreover, the unemployment deviation is greater also for the influence of unrealised devaluation expectations, which become positive when the economy moves – after the first period shock – from a full credibility equilibrium to a partial one. In turn, unrealised devaluation expectations feed back expectations and further lower the threshold value for the shock, possibly to the point that a future shock may trigger a collapse. Thus, the realisation of a positive shock moves the economy from a situation of full credibility to one of partial credibility, in which expectations may trigger a speculative attack and eventually induce a self-fulfilling currency crisis22.

22 As the Mexican peso collapsed in 1994 and the Asian currencies collapsed in 1997, the currencies of Argentina (in 1995) and of Hong Kong (in 1997) were also subject to speculative attacks. The attack implied that agents perceived that the probability of a devaluation was positive and high. As capital outflows led to an automatic cut in the monetary base, money supply was cut to a dramatic extent, putting under considerable stress domestic banks and firms, while domestic interest rates rose as high as 20% in real terms (Roubini, 1998). Albeit the pressure to devalue was resisted and the expectation of a devaluation subsided, Argentina was pushed into a severe recession, with GDP falling by 6% and unemployment rising to 18%. Because of the lack of policy instruments to support the economy, the rise in unemployment persisted for a number of years. After the depreciation of the Brazilian real in 1999, competitiveness losses led to a further decrease in the monetary base, worsening the financial sector's strain, and pushing the economy into deeper recession. Devaluation expectations and capital outflows got strength, eventually leading to the currency crisis in late 2001 and early 2002.

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