

## **BUILDING A CASE FOR CURRENCY BOARDS**

by Carlos E. J. M. Zarazaga\*

Federal Reserve Bank of Dallas

Research Department

Forthcoming in *Pacific Economic Review*, 1999 special issue on Currency Boards

---

\*Senior Economist and Executive Director of the Center for Latin American Economies.

## **BUILDING A CASE FOR CURRENCY BOARDS**

by Carlos E. J. M. Zarazaga \*\*

### **ABSTRACT**

Two common objections to currency boards are that they are dominated by more flexible policies and that they are unsustainable. The paper confronts these objections with the insights from a model economy in which several constituencies who compete for subsidies do not have the ability to monitor the allocation of government spending. Such assumptions are meant to capture important features of the reality of many countries for which currency boards have been proposed. The model suggests that in such environments flexible policies in a certain class have an inflationary bias that a sustainable currency board can--but not necessarily--eliminate.

JEL: F31, F33, E52

---

\*\*Federal Reserve Bank of Dallas, Research Department, 2200 N. Pearl St., Dallas, TX 75201, USA. E-mail: carlos.zarazaga@dal.frb.org. The author is grateful to two anonymous referees and Kenneth S. Chan for an extremely useful and positive feedback on an earlier version of this paper. Of course, all remaining errors are my sole responsibility. The views expressed in this article are those of the author and do not necessarily reflect the positions of the Federal Reserve Bank of Dallas or the Federal Reserve System.

## 1 - INTRODUCTION

The unusual frequency with which a number of so-called emerging economies experienced financial and currency crises in the period 1994-98 has generated a heated debate on the causes of those crises, as well as a long list of policy recommendations to abort or avert them. Currency boards have consistently appeared on that list.

Prominent economists such as Barro (1995) and Dornbusch (1997), for example, proposed a currency board for Mexico after the devaluation of that country's currency on December 1994. Similar recommendations were given to Indonesia in the wake of the financial turmoil that spread throughout Southeast Asia after the devaluation of the Thailand baht on July 2nd 1997.<sup>1</sup> About a year later Russia was allegedly considering the adoption of a currency board to stop the seemingly free fall of its currency and stock markets during the Summer of 1998.<sup>2</sup>

Currency board advocates often claim that such a policy regime can achieve low inflation outcomes almost overnight and without pain, by virtue of the instantaneous credibility generated by the inherent transparency of the rule. The theoretical underpinnings of these claims are rarely made explicit and have been seriously challenged on two counts.

First, a currency board is just one out of many transparent policy rules and proponents of currency boards have failed to show convincingly that a currency board is the best of those rules. In fact, currency boards critics argue that currency boards deprive policymakers of the necessary flexibility to face unforeseen shocks. For example, under a currency board system the central bank

---

<sup>1</sup>See reports of Prof. Steve Hanke's proposal of a currency board for Indonesia in *The Wall Street Journal*, February 23, 1998, page 1.

<sup>2</sup>See *The Financial Times*, August 31, 1998 issue, page 2.

does not have the option to act as a lender a resort. More important, many countries have used those more flexible policies and yet been able to keep inflation low without the need for a currency board. Why use the straitjacket of a currency board when more flexible rules can accomplish the same goal of delivering low inflation outcomes?

Second, the claim that currency boards can bring down inflation almost overnight and without costs because they are fully credible is problematic in the light of optimal control theory. In a celebrated application of that theory to economic policy issues, Kydland and Prescott (1977) rigorously demonstrated that optimal plans are time inconsistent, that is, that there will be an inherent tendency for governments to abandon them. Therefore, if currency boards are the optimal policy their advocates claim it to be, they will be time inconsistent and will tend to be abandoned. Economic agents, aware of this tension, will be skeptical about the survival of a currency board. In that case, a currency board can eventually bring down inflation but, like any non-fully credible antiinflation program, not without costs.

Currency boards advocates get around the second criticism by postulating that currency boards, especially if enacted by law, provide the proverbial commitment technology assumed lacking in the time inconsistency literature. This easy way out, however, is questionable. Laws and even constitutions are also rules and, as such, subject themselves to the time inconsistency problem. In fact, laws and constitutions can and have been changed.

An eloquent evidence of this time inconsistency problem is Argentina's various currency board experiments throughout the 20th century. In 1929 that country abandoned the currency board (strictly speaking, the Gold Standard) that it had established by law only two years earlier. It is hard not to see the workings of the time inconsistency curse in the assessment that "...*the*

*rationale for suspending the system appears dubious in retrospect.*” (Hanke, 1996a).

More modern times have also provided ammunition against the argument that a currency board is fully credible and therefore “...it tends to encourage a net flow of capital rather than capital flight.” (Hanke and Schuler, 1994). This optimistic prediction was challenged in the aftermath of the devaluation of the Mexican peso on December 1994, when “On February 27th [of 1995], the international banks with branches in Argentina cut off their credit lines to their branch operations, citing “country risk”” (Hanke, 1996b). The problem was that, as predicted by the time inconsistent literature, international lenders (and domestic investors) feared that the currency board would be abandoned. It wasn’t in the end, but that outcome does not detract from the argument that investors, aware of the time inconsistency problem and of the temptation of governments to renege on their promises, assigned a non-negligible probability to the event that Argentina could repudiate the currency board as it had done earlier in history, in 1929.

The goal of this paper is the modest one of providing a possible scenario in which the two most common objections to currency boards outlined above, the superiority of flexible policy rules and the time inconsistency problem, cannot be used always and everywhere to build a case against currency boards.

The demonstration that some of the objections to currency boards do not always apply does not imply, of course, that currency boards are the best policy option. It is important to emphasize that on this subject the paper is silent. The paper does permit, however, to speculate on the circumstances and environments in which currency boards might turn out to be an optimal policy regime. In this respect, a subsidiary contribution of the paper is to point out features of the economic environment that should be taken into account in any attempt to resolve the issue of the

optimality of currency boards on more solid theoretical grounds.

The paper studies the criticisms to currency boards within the context of an artificial economy with two distinctive features: 1) the presence of powerful vested interests with the ability to influence the level and allocation of government spending in favor of their constituents and, 2) the inability of economic agents to monitor the allocation of government expenditures among alternative uses.

The paper argues that some of the flexible policies that currency boards critics may have in mind as superior to currency boards introduce a high inflation bias in the imperfect information conditions of the model economy. This bias may disappear, however, when a currency board is introduced in that same imperfect information economy.

The key to that result is that the flexible policies in the class we consider do not eliminate the imperfect monitoring (or equivalently, information) problem present in the model economy, preempting the possibility to support low inflation outcomes with the reputational considerations with which Barro and Gordon (1983) suggested to resolve the time inconsistency problem. By contrast, a currency board can replicate the perfect monitoring conditions otherwise missing in the artificial economy. This “transparency equivalence” property of currency boards permits to address trivially the time inconsistent criticism, because under perfect information it is possible to implement Barro-Gordon type equilibria to support otherwise time inconsistent low inflation outcomes. Technically, currency boards can circumvent the time inconsistent problem because they reintroduce in the equilibrium set of our model low inflation, time consistent, equilibria that would otherwise be missing from that set in imperfect information environments under the more flexible policies considered in the paper. In this sense, the paper provides a rationale for the

currency board advocates' claim that the transparency of that policy regime is instrumental in achieving low inflation outcomes.

The rest of the paper is organized as follows: Section 2 motivates the imperfect information assumption with evidence from actual economics, Section 3 presents the model, Section 4 presents the result that flexible monetary policies in a certain class introduce an inflationary bias that cannot be eliminated by appealing to Barro-Gordon type equilibria, Section 5 presents the main conclusions of the paper and suggests directions for future research.

## **2 - EMPIRICAL MOTIVATION**

This section documents the evidence that has motivated the two key assumptions of the model economy we present below: the presence of several policymakers and the inability to perfectly monitor the allocation of government spending among different uses.

In order to convince the reader that those assumptions capture a widespread feature of reality, we present and discuss below evidence for countries in three different regions of the world: Latin America, Southeast Asia, and the former Soviet Union (Russia). The choice of these regions is, of course, not casual: it is precisely these regions the ones that have suffered the most severe financial crises during the 1990s.

The information problems surrounding the allocation of fiscal spending in many Latin American countries is forcefully and aptly summarized by the following description of the situation of the Bolivian fiscal data at the time of that country's hyperinflation in 1985:

*Surprisingly, it is difficult even four years in retrospect, to uncover precisely the causes for this jump in money creation...The problem with nailing down a culprit lies with the disarray of Bolivian fiscal data during this period. The following*

*kind of problems inhibit a clear assessment of the fiscal situation...(Jeffrey Sachs, "The Bolivian Hyperinflation and Stabilization," Working Paper 2073, National Bureau of Economic Research, 1986).*

As to Southeast Asia, we reproduce below press reports suggesting that problems in monitoring the allocation of government spending have been the rule more than the exception, especially with respect to public funds poured into the financial sector:

*On June 25, 1997 Asia's economic miracle came to an end. That was the day Thanong Bidaya, named Thailand's new finance minister five days earlier, first managed to discover the true state of his country's foreign exchange reserves and the problems in its financial system. Fewer than a dozen people--all in the central bank--knew the answers. For months, they had been hiding two crucial numbers from the Thai government and the public. Mr Thanong knew he was not going to get the information just by sitting in his office, as his predecessor...had done. He and three assistants climbed into the leather seats of his blue Volkswagen van and set off to demand information from [the] governor of the Bank of Thailand...Sure enough, on his visit to the central bank that June day, Mr. Thanong quickly found the numbers he was looking for. He was horrified. With the blessing of his superiors, the central bank's...currency trader...had locked up most of Thailand's foreign reserves in forward contracts. Thailand's reported foreign reserves of over \$30bn were a myth--in fact they had dwindled to \$1.14bn, equal to just two days of imports. (The Financial Times, Monday, January 12, 1998, p. 6. The underline is ours).*

That same report makes apparent that not only was the Thailand central bank hiding foreign reserves figures, but also lending substantial amounts of public funds to faltering financial institutions :

*On top of that, the central bank's Financial Institutions Development Fund (FIDF) had lent over Bt200bn (\$8bn) to struggling financial institutions...This lending had effectively drained seven years' worth of the Thai government's fiscal surpluses; the central bank was printing money to make up for the rest. The financial system had become a black hole, sucking government money with no end in sight. (The Financial Times, Monday, January 12, 1998, p. 6).*

This last quote is relevant for justifying our imperfect information assumption, because even if the exact amount of government lending to financial institutions may have been known, it is hard to determine which portion of that figure became an ex-post subsidy when the financial institutions that received the assistance were liquidated later in the crisis.<sup>3</sup> In fact, loans to financial institutions entail an unknown amount of ex-ante “off the government books” subsidy if granted in particularly favorable terms. According to the press, such hidden subsidies have been standard practice in another Southeast Asian economy, South Korea, where

*“State-directed bank loans at negative real rates of interest allowed “strategic” industries to invest and expand at a sizzling rate.”* (The Economist, reporting on South Korea, November 29, 1997, p. 21).

To readers in need of further persuasion about the relevance of the imperfect information problems in Southeast Asian countries we can offer the authorized opinion of a privileged observer of the financial crisis still unfolding in those countries at the time of this writing:

*“In many respects, Thailand, Indonesia, and Korea do face similar problems... and a lack of transparency about the ties between government, business, and banks have both contributed to the crisis and complicated efforts to defuse it.”* (“The Asian Crisis: A View from the IMF,” edited remarks of Stanley Fischer, First Deputy Managing Director of the International Monetary Fund, in his address to the Midwinter Conference of the Bankers’ Association for Foreign Trade on January 22, 1998, in Washington D. C. The underline is ours)

Finally, the following two quotes about Russia provide convincing evidence that our assumptions about the presence of multiple policymakers and the lack of transparency in the

---

<sup>3</sup>In fact, financial rescue packages play an important role in the explanation of the Southeast Asian crisis offered by Krugman (1998). The financial fragility behind those packages is crucial in the negative assessment of currency boards offered by Chang and Velasco (1998).

allocation of government spending capture an important feature of reality:

*“Russia’s plethora of power centres has reinforced another worrying political development: the power of vested interests...and governmental chaos opens up opportunities for special pleading by interest groups.”* (The Economist, December 5, 1992).

The second quote we offer for Russia is in the context of a complaint by a government official that that country’s central bank had essentially left the sources of about 15% of the expansion of the money supply unaccounted for when reporting them in a “miscellaneous” item:

*“...in July and August together there were 370 billion rubles’ worth of new credits for the Government, compared with slightly more than 400 billion rubles to commercial banks, 150 billion rubles for “working capital” for state enterprises, at least 200 billion rubles for other republics and 170 billion rubles in “miscellaneous” credits...”* (The New York Times, September 15, 1992).

Summarizing, the evidence documented above suggests that the economies for which currency boards are often recommended (typically those which have experienced traumatic financial meltdowns, large devaluations of their currencies and/or chronically high inflation) seem to share monetary and fiscal institutions, as well as a structure of information with respect to the economic operations of the public sector, that make it difficult, if not impossible, to establish with certainty how the private resources appropriated by the government (through, for example, the inflation tax) have been apportioned between different uses, jurisdictions, and constituencies.

This is precisely the reality we have tried to capture in the abstraction of the model of the next section.

### **3 - THE MODEL**

### 3.1 Representation of households' welfare

Considering the reality described in the previous section, and in the spirit of Alesina and Drazen (1991), we take the view that the high inflations currency boards supposedly help to prevent are ultimately a reflection of a deep distributional conflict between different constituencies of society.

We model this distributional conflict in the abstraction of an artificial economy populated by  $N$  constituencies. It will be assumed that the welfare of the representative household of the typical constituency  $i$  can be measured by the function:

$$\mathbf{E}_0 \sum_{t=0}^{\infty} \beta^t U^i \left[ \frac{G_t^i}{P_t} ; \frac{P_t}{P_{t-1}} \right] \quad (1)$$

where  $\beta < 1$ ,  $G_t^i$  is a nominal subsidy to the representative household of constituency  $i$ ,  $G_t^i / P_t \equiv g_t^i$  is the corresponding real subsidy,  $P_t / P_{t-1} \equiv \Pi_t$  is the gross inflation rate, and  $U^i$  is the single-period utility. We assume that  $\partial U^i / \partial g_t^i > 0$  and that  $\partial U^i / \partial \Pi_t < 0$  to capture the idea that consumers will benefit from subsidies, but will be hurt by the inflation tax necessary to finance them.<sup>4</sup> Furthermore, it will be assumed that there is an upper bound  $\mathbf{K}$  such that  $|U^i| \leq \mathbf{K}$  for all  $g_t^i$  and  $\Pi_t$ .

### 3.2 - The money supply process

A key aspect of our model is that the money supply process is not assumed entirely

---

<sup>4</sup>This is admittedly a very "reduced form" utility function, but by no means implausible, as it can be derived from primitives such as consumption and real money balances. For an example of such a derivation, see Zarazaga (1995).

exogenous, as is standard in the literature, but it is endogenously determined by the actions of  $N+1$  policymakers.

Of those  $N+1$  policymakers,  $N$  are political agents representing the constituencies whose welfare measure was introduced in the previous section. Each of these  $N$  policymakers takes advantage of his political leverage on different government agencies and institutions (ministries, local governments, state-owned enterprises and banks, and even the Congress and the President) to induce expansions of nominal government spending in favor of his constituencies.

The  $N+1$ th policymaker is an impartial fiscal authority, in the sense that it does not represent any constituency in particular. The role of this policymaker in our model will be to implement the kind of more flexible policy rules that at least some critics of currency boards seem to have in mind when questioning the straitjacket feature of a currency board. The motivation for the class of flexible policies we consider below is in the very ambiguity of this “straitjacket criticism.”

According to Chari (1998, p. 183), for example, a policy regime “is simply a function which prescribes the policies for each state of the economy.” This definition conjures up the vision of a policy that can be mechanically conducted by a computer fed with well defined information about the state of the economy. In this sense, any well defined rule, currency board or not, ties the hands of a policymaker.

We suspect, therefore, that the flexible policies that many critics of currency boards have in mind when complaining about the straitjacket feature of a currency board are policies that allow the policymaker to overrule the imaginary computer at his discretion. In what follows, we refer to these kind of policy rules as “rules with judgement calls”.

We introduce those rules with judgement calls in the abstraction of our model by assuming that the impartial policymaker--the N+1th fiscal authority--makes his nominal government spending decisions according to the equation:

$$\frac{G_t}{M_{t-1}} = \mu + \epsilon_t \quad (2)$$

where  $\mu$  is a constant and  $\epsilon_t$  is a random variable with zero mean.

For reasons that will become apparent later and without loss of generality, the level of government spending in the current period has been normalized in the above expression to the money base in the preceding period. Notice that in more conventional models, the policy rule (2) is the one that would be followed by a policymaker targeting an average inflation rate of  $\mu$  %. If it were for this systematic component, the impartial policymaker of our model could be replaced by a computer that would mechanically expand the money supply every year at a constant rate of, say, 4%, following Milton Friedman's proverbial recommendation.

The term  $\epsilon_t$  captures the non-systematic component of the N+1th policymaker rule and is meant to capture the flexibility granted to the policymaker of departing, at his discretion, from the policy that the systematic component of the rule would instruct him to follow, perhaps to adjust to circumstances or shocks that were unforeseen at the time the systematic component was formulated.<sup>5</sup>

---

<sup>5</sup>A large body of literature has appealed to "rules with judgment calls" to study the effects of alternative monetary policies and formally represented the "judgement call" with a stochastic term like  $\epsilon_t$ , especially Leeper (1991), Christiano and Eichenbaum (1992), Salemi (1995), Gavin and

It will be assumed that the stochastic variable  $\epsilon_t$  is an i.i.d. process with zero mean (e.g.,  $E(\epsilon_t) = 0$ ) and beta distribution  $B(\alpha_1, \alpha_2)$  in the compact interval  $[\epsilon_L, \epsilon^U]$ ;  $-\infty < \epsilon_L < 0$ ,  $0 < \epsilon^U < \infty$ . The reason for this assumption is the versatility of the beta distribution, which can take quite a variety of shapes, depending on the values of the parameters  $\alpha_1$  and  $\alpha_2$ . We will confine attention, however, to the subset of beta distributions that has a normal looking hill-shaped density function and satisfies therefore the conditions  $\varphi(\epsilon_L) = \varphi(\epsilon^U) = 0$  and  $\varphi(\epsilon_t) > 0$  for all  $\epsilon_t$  in the interval  $(\epsilon_L, \epsilon^U)$ , where  $\varphi(\cdot)$  is the density function of the beta distribution  $B(\alpha_1, \alpha_2)$  with cumulative distribution function denoted  $F(\cdot)$ .

With the above specification, total nominal government spending  $TG_t$  in each period  $t$  is given by:

$$TG_t = \sum_{i=1}^N G_t^i + G_t$$

A final assumption is that any increase in government spending is financed with money creation. This assumption is standard in the high inflation literature, and therefore one very appropriate to adopt in studying policy rules such as a currency board allegedly designed to eliminate and prevent high inflations. In the model the central bank behaves passively, that is, it acts mostly as an automatic teller, issuing as much fiat money as requested by any of the  $N+1$  different fiscal authorities (namely, the impartial policymaker and the  $N$  political agents of the constituencies).

---

Kydland (1996), and Leeper, Sims, and Zha (1996) among many others.

Because nominal government spending decisions of the N+1 fiscal authorities result in an equivalent expansion of the nominal money supply, in the model it is as if each of them had direct access to the mint or, equivalently, as if there were multiple money suppliers. The formal institutional reality that there is just one money supplier, a central bank, should not obscure the fact that several fiscal authorities may in fact intervene indirectly in setting the path of the money supply. For this reason in the remainder of the paper the N+1 policymakers will be regarded as making decisions on additional expansions of the money supply, rather than on the level of nominal government spending.

The assumption that all nominal government spending is financed with money creation determines the evolution of the money supply according to the identity:

$$M_t - M_{t-1} \equiv \sum_{i=1}^N G_t^i + G_t \quad (3)$$

Dividing both sides of the above expression by  $M_{t-1}$  and using the definitions:

$$\delta_t^i \equiv \frac{G_t^i}{M_{t-1}} \quad (4)$$

$$\mu_t \equiv \frac{G_t}{M_{t-1}} \equiv \mu + \epsilon_t \quad (5)$$

expression (3) can be rewritten:

$$\frac{M_t - M_{t-1}}{M_{t-1}} \equiv \theta_t \equiv \sum_{i=1}^N \delta_t^i + \mu_t \quad (6)$$

In words, the overall net rate of growth of the money stock in every period,  $\theta_t$ , is the result of the cumulative decisions of the  $N+1$  policymakers: the  $N$  net expansions  $\delta_t^i$  induced by the political agents of the constituencies plus the net expansion  $\mu_t$  originated in the impartial policymaker.

We have already specified that the impartial policymaker sets  $\mu_t$  according to the rule with judgement calls (2). It is now necessary to specify how each  $\delta_t^i$  (or, equivalently,  $G_t^i$ ) is set. In the set up of the model economy, it is only natural to assume that the political agent of each constituency will choose the  $\delta_t^i$ 's so as to maximize the welfare of the representative consumer of the constituency he represents. The next section is devoted to examine this decision process.

### 3.3 - Structure of information

Section 2 documented the pervasiveness of information problems regarding the allocation of government spending in many actual economies. As anticipated in the introduction, that imperfect information reality plays a key role in our arguments, and is captured in our model by the assumption that each political agent  $i$  can observe the overall level of government spending  $TG_t$ , but not how it is distributed among its alternative uses, except for the part of government spending determined by the systematic component of the impartial policymaker's rule and for  $G_t^i$ , which of course is known to each constituency.

Since by assumption all government spending is financed with money creation, the

equivalent of that assumption in terms of the identity (6) is that each political agent  $i$  can observe  $\theta_t$  and  $\delta_t^i$ , but not the  $\delta_t^j$ 's and the  $\epsilon_t$ 's. To make this assumption more precise, rewrite identity (6) as:

$$\theta_t - \delta_t^i \equiv \sum_{j \neq i}^N \delta_t^j + \mu + \epsilon_t$$

(7)

The assumption on the structure of information means that each political agent can observe with certainty the values of the variables on the left hand side of (7). From this information, he can establish with certainty the overall size of the right hand side as well, but not the value of each of the individual components of that “residual.” In particular, a political agent  $i$  cannot tell whether an unusually large  $\theta_t$  was the result of an unusually large “judgement call”  $\epsilon_t$ , or of an unusually large subsidy  $\delta_t^j$  to a constituency other than his.

In other words, expansions of the money supply that benefit only a particular constituency (those induced by each constituency) can be confused with those that do not (those induced by the impartial policymaker). In exploiting this confusion, the paper carries the flavor of the approach Lucas (1972) followed to address a different question. It is important to emphasize, however, that in contrast to that paper, all agents do observe the overall net rate of growth of the money supply,  $\theta_t$ , in our model economy

### 3.4 - The political agents' maximization problem

The goal of the political agent is to maximize the utility of the representative consumer of

the constituency he represents.

For notational convenience, in what follows the single-period utility  $U^i$  in (1) will be presented in terms of rates of growth of the money supply. Taking into account (4), (5), and (6) and considering that the price level will in general be a function of the money supply process  $\{\theta_t\}$ , the single-period utility function  $U^i$  can be rewritten:

$$U_t^i \left[ \mathbf{g}^i \left( \left\{ \delta_t^i ; \delta_t^i + \sum_{j \neq i}^N \delta_t^j + \mu_t \right\}_{t=0}^{\infty} \right) ; \Pi \left( \left\{ \delta_t^i ; \delta_t^i + \sum_{j \neq i}^N \delta_t^j + \mu_t \right\}_{t=0}^{\infty} \right) \right] \equiv W^i \left[ \left\{ \delta_t^i ; \theta_t \right\}_{t=0}^{\infty} \right] \quad (8)$$

For later use, it is convenient to rewrite (8) separating the elements in the argument of  $W^i$  into those that pertain to the current period and those that pertain to the future, that is

$$W^i \left[ \left\{ \delta_t^i ; \theta_t \right\}_{t=0}^{\infty} \right] \equiv W^i \left[ \delta_t^i ; \delta_t^i + \sum_{j \neq i}^N \delta_t^j + \mu_t ; \theta^{t+1} \right]$$

where we have made use of the identity (6) and of the definition  $\left\{ \delta_{t+1}^i + \sum_{j \neq i}^N \delta_{t+1}^j + \mu_{t+1} \right\}_{t=0}^{\infty} \equiv \theta^{t+1}$ .

Notice that  $\theta^{t+1}$  denotes all possible histories of the overall net rate of growth of the money supply after period  $t$ . The history of  $\theta_t$  up to period  $t$  will be denoted instead  $h_t$ ;  $h_t \equiv \{\theta_s\}_{s=0}^t$ .

It will be assumed that the price function is increasing in all of its arguments, that is, that the price level is increasing in current and future expansions of the money supply. It will also be

assumed that real revenues from the inflation tax are monotonically increasing in the inflation rate. The role of this assumption is to guarantee that a higher  $\delta_t^i$  will always result in a higher level of real subsidies.<sup>6</sup>

The non-trivial nature of the maximization problem each political agent will face becomes apparent upon examination of the typical term in the summation (1), that is, the function  $U^i$  used to characterize mathematically the welfare of the representative member of each constituency in each period  $t$ . Notice the tension built into the single-period payoff: a higher  $\delta_t^i$  can increase constituency's  $i$  welfare by financing a higher level of real subsidies  $g_t^i$  but this gain will come at the expense of a welfare reducing higher inflation. From the perspective of each political agent, then, his job is to increase  $\delta_t^i$  to the point in which the utility gains from a marginal subsidy to his constituency are exactly offset by the marginal losses the resulting inflation inflicts on his own constituents. Each political agent  $i$  will leave out of this equation, however, the costs that the higher inflation induced by  $\delta_t^i$  will impose on the other constituencies. This failure to internalize all the costs of inflation to society gives rise in our setup to Nash equilibria that are not Pareto optimal.

The preceding discussion readily suggests that the maximization problem faced by the typical political agent  $i$  can be written:

$$\text{Max}_{\{\delta_t^i\}_{t=0}^{\infty}} \mathbf{E}_0 \sum_{t=0}^{\infty} \beta^t W^i \left[ \left\{ \delta_t^i ; \theta_t^i \right\}_{t=0}^{\infty} \right]$$

---

<sup>6</sup>For a particular parameterization of this model that deliver this properties, see Zarazaga (1995).

where each  $\delta_t^i$  can take any value in the interval  $[0, \infty)$ . In other words, we do not impose any out of the model constraints on the size of the nominal subsidies.<sup>7</sup>

In what follows the superscript of the payoff function will be omitted, because without loss of generality the analysis will be focused on the case in which all constituencies are symmetric, that is, in which the representative consumers of those constituencies are equal in every respect.

The particular sequence/s  $\{\delta_t^i\}_{t=0}^{\infty}$  that will solve this maximization problem will depend on the equilibrium concept. For example, typically in the optimal plan the political agent will choose all elements of the sequence at time 0. However, this optimal plan will be in general time inconsistent in the presence of distortionary taxation (see Calvo (1978)) and inflation is one such a tax.

In the time consistent solution, the solution sequence/s  $\{\delta_t^i\}_{t=0}^{\infty}$  will be that which result from choosing each of the elements of  $\{\delta_t^i\}$  sequentially, that is, from choosing  $\delta_t^i$  in period  $t$ ,  $\delta_{t+1}^i$  in period  $t+1$ , and so on. This is the equilibrium concept the paper will adopt, given the maintained hypothesis stated in the introduction that societies in general lack commitment technologies. Because with this solution concept decisions are made "one at a time," the political agent's maximization problem becomes recursive in nature and can be formulated, therefore, with a dynamic programming approach.

With this sequential equilibrium concept, the task of each political agent is to choose in

---

<sup>7</sup>This will have the technical implication that the choice set of the political agents is not compact.

each period the  $\delta_t^i$  that will maximize the welfare of the consumers he represents, taking as given the decisions made by the other policymakers, that is, taking as given  $\sum_{j \neq i}^N \delta_t^j + \mu_t$ . In other words, the problem can be set up in terms of a game between the political agents representing each of the N constituencies of the model economy.

Formally, a time consistent solution of that game will have to satisfy the following functional equation:

$$(9) \quad V(h_{t-1}) = \underset{\delta_t^i}{\text{Max}} \text{ E}_t \left[ W \left[ \delta_t^i ; \delta_t^i + \sum_{j \neq i}^N \delta_t^j + \mu_t \right] + \beta V(h_t) \right]$$

where  $V(h_t)$  is a mapping from all possible histories  $h_t$  into the real numbers and where the dependence of  $W$  on  $\theta^{t+1}$ , the future net rates of growth of the money supply, has been omitted to emphasize that such history is not an object of choice but taken as given in period  $t$ , when making the decision on  $\delta_t^i$ .<sup>8</sup>

The standard interpretation of  $V(h_t)$  is that it gives the continuation value of the game after history  $h_t$ , that is, the expected discounted present value of the stream of single-period payoffs that each political agent will receive if he continues behaving optimally after history  $h_t$ .

The mapping  $V(h_t)$  is crucial for the outcome of the game. For example, suppose  $V(h_t)$  is

---

<sup>8</sup>In equilibrium, expectations are rational, so the expected future history at time  $t$  will be exactly recovered by the distribution of possible histories along the equilibrium path. For details, see Zarazaga (1995).

flat, in the sense that  $V(h_t)$  has the same value  $V_M$  for every history  $h_t$ . This implies that the current choice of  $\delta_t^i$  will have no effect whatsoever on the payoffs that the political agent  $i$  can get after  $t+1$ . Therefore, the political agent will act myopically, in the sense that he will only care about maximizing his current single-period payoff, taking as given the actions of the other policymakers. This myopic equilibria are the counterpart of the standard single-shot Nash equilibrium in the popular prisoner's dilemma example of the game theory literature. In the analysis that follows it will be assumed that at least one myopic Nash equilibrium exists.<sup>9</sup>

As is well known, myopic Nash equilibria are in general not socially optimal. In the context of our model, this is because in setting the level of subsidies for his own constituents, each political agent ignores the costs that the resulting inflation will impose on the other constituencies.

However, it is also known from the so-called "Folk theorems" that socially optimal outcomes can be supported by structuring the mapping  $V(h_t)$  in a way that punishes players for deviating from actions that deliver Pareto efficient payoffs. This can be accomplished with strategies that induce continuation payoffs of the form  $V(h_C) > V(h_{NC})$ , where  $h_C$  stands for "history of cooperation" and  $h_{NC}$  for "history of non-cooperation".

In the celebrated Barro and Gordon paper mentioned earlier, for example, deviations from the low inflation policy  $h_C$  (and associated continuation Pareto optimal payoff  $V_C$ ) are punished with reversions to a myopic high inflation equilibrium that delivers the lower continuation payoff  $V(h_{NC}) = V_M$ . This threat can sustain low inflation Pareto efficient equilibria provided the policymakers do not discount the future too much.

---

<sup>9</sup>The existence of such an equilibrium is not guaranteed in our setup because  $\delta_t^i \in [0, \infty)$ , that is, the strategy space is not compact.

It is tempting to conjecture that Folk theorems could be applied in the context of our model to induce the political agents to cooperate and keep the subsidies at a low level, thus preventing the high inflation outcomes associated with the myopic equilibria described above.

However, we demonstrate in the next section that under certain conditions that intuition is wrong.

#### **4 - THE INFLATIONARY BIAS OF RULES WITH JUDGEMENT CALLS**

The proposition below shows that in the imperfect information environment of our model high inflation myopic equilibria cannot be upset by Pareto efficient (low inflation) outcomes supported with Barro-Gordon type reputational considerations.<sup>10</sup>

It will be useful to introduce some notation and discuss the intuition behind the proposition before proceeding with the formal proof.

The proposition will consider only stationary equilibria. To that end, it will be assumed that all possible histories of the game can be mapped into an ergodic set  $H$  with a finite number of elements  $H_t$ . In the spirit of Barro and Gordon, all possible histories are partitioned into two categories: a history will be considered one of low inflation (or cooperation) as long as the overall net rate of growth of the money supply does not exceed certain threshold  $\theta^P$ . It will be considered one of high inflation (or no cooperation) otherwise.

---

<sup>10</sup>Radner, Myerson, and Maskin (1986) and Abreu, Pearce, and Stachetti (1986) showed in a different context that the standard Folk theorems may not apply in conditions of imperfect monitoring. The proposition below takes advantage of their insight to verify that this result holds for our model economy as well.

In the stationary equilibria considered in the proposition, the political agents will play the same action  $\delta_C^i$ , that is, choose the same level of nominal subsidies, period after period, as long a realized history of cooperation is observed. Define the vector  $\delta_C \equiv (\delta_C^1, \delta_C^2, \dots, \delta_C^i, \delta_C^N)$ . If this vector is a stationary equilibria, then any realization of the overall net rate of growth of the money supply along the equilibrium path will satisfy the inequality:

$$\theta_t \leq \sum_{i=1}^N \delta_C^i + \mu + \epsilon^U \equiv \theta^U$$

where equality will hold when  $\epsilon_t = \epsilon^U$ .

The inequality makes apparent that a deviation from the path of play  $\delta_C$  will be immediately detected if at any period  $t$  the inequality above is not satisfied, in particular, if a realization  $\theta_t > \theta^U$  is observed. This would naturally suggest that a way to deter deviations from  $\delta_C$  is with the threat to revert the play to a sub-game perfect (time consistent) equilibrium delivering a lower payoff if  $\theta_t > \theta^U$ . However, the proposition shows that this choice of a threshold to trigger the punishment is a poor one, because it does not deter small deviations that can go eventually undetected under imperfect information.

In particular, suppose that a player  $i$  deviates from action  $\delta_C^i$  by a small amount  $\Delta^i$ ,  $\Delta^i < \epsilon^U - \epsilon_L$ . Such small deviation will go undetected for realizations of  $\epsilon_t$  such that  $\epsilon_t \leq \epsilon^U - \Delta^i$ , since in that case

$$\theta_t \equiv \sum_{i=1}^N \delta_C^i + \Delta^i + \mu + \epsilon_t \leq \sum_{i=1}^N \delta_C^i + \mu + \epsilon^U \equiv \theta_t^U$$

Since the probability of the event  $\epsilon_i \leq \epsilon^U - \Delta^i$  is given by  $F(\epsilon^U - \Delta^i)$ , the deviation will be detected only with probability  $1 - F(\epsilon^U - \Delta^i)$ .

The inability to detect deviations with probability one will not go away even if the threshold that will trigger the reversion to a lower payoff equilibrium is set at a value lower than  $\epsilon^U$ , that is, if the trigger value is set at  $\epsilon^P$  such that  $\epsilon^P \in (\epsilon_L, \epsilon^U)$ . For any such threshold  $\epsilon^P$ , a small deviation will still go undetected with strictly positive probability  $F(\epsilon^P - \Delta^i)$ . For later use, it will be convenient to define  $\theta^P$  as

$$\theta^P \equiv \sum_{i=1}^N \delta_C^i + \mu + \epsilon^P ; \quad \epsilon_L \leq \epsilon^P \leq \epsilon^U$$

Summarizing, in our imperfect information economy small deviations from some agreed level of subsidies will go eventually undetected. Notice that this in contrast with the situation under perfect information, where all deviations, however small, are detected with probability one. This contrast suggests an intuitive interpretation of the proof of the proposition we present below.

Suppose that in a perfect information environment it is possible to deter deviations from the optimal plan by appealing to a very harsh punishment. That same punishment will not be as harsh in an imperfect information environment, because it will be weighted by the small probability with which small deviations will be detected. This implies that the strong punishments eventually required to support Pareto efficient (low subsidies-low inflation) outcomes will lose its effectiveness under imperfect information. Basically, the proposition says that under imperfect information there are no punishments (themselves Nash equilibria) strong enough to support Pareto efficient outcomes as sustainable (time consistent) Nash equilibria

We now proceed to formally state and proof the following:

**Proposition:**

Consider the vector  $\delta_C$  and assume that  $\delta_t^i = \delta_C^i$  for all  $t$  and  $i$  delivers a Pareto efficient payoff  $V_C$ . Assume that such stationary optimal plan is time inconsistent, but can be supported under perfect information with the threat to revert the play to another sub-game perfect (time consistent) Nash equilibrium with the lower continuation value  $V_M$  if any political agent  $i$  deviates from  $\delta_C^i$ . Assume also that  $\epsilon_t$  has a distribution function in the class described in subsection 3.2. Then under imperfect information all the time consistent Nash equilibria are Pareto inefficient when the impartial policymaker conducts monetary (and fiscal) policy according to the rule with judgement calls (2).

Proof:

If the vector  $\delta_C$  is indeed an equilibrium, then it must solve for all  $i$  the following version of the dynamic programming problem (9):

$$\text{Max}_{\delta^i} \left\{ \mathbf{E}_t \mathcal{W} \left( \delta^i ; \delta^i + \sum_{j \neq i}^N \delta_C^j + \mu_t \right) + \beta F[\epsilon^P - (\delta^i - \delta_C^i)]V_C + \beta [1 - F[\epsilon^P - (\delta^i - \delta_C^i)]]V_M \right\}$$

The second term in the above equation reflects that with probability  $F(\epsilon^P - \Delta^i)$  the overall net rate of growth of the money supply  $\theta_t$  will not exceed the threshold  $\theta^P$  and that a small one-time deviation  $\Delta^i$  will go undetected. In that "lucky" event, the game will continue in the cooperative regime in which all political agents will play at  $t+1$  the strategy  $\delta_C$  delivering the continuation payoff  $V_C$ . The third term in the above equation reflects that with probability  $[1 - F(\epsilon^P - \Delta^i)]$  a small deviation will be discovered and the game revert to the Nash equilibrium with the lower payoff  $V_M$ .

Taking into account the identity  $V_M \equiv V_C - (V_C - V_M)$  the maximization problem above can be rewritten:

$$\begin{aligned} \text{Max}_{\delta^i} \left\{ \right. & E_t W \left( \delta^i ; \delta^i + \sum_{j \neq i}^N \delta_C^j + \mu_t \right) + \\ & \left. \beta V_C - \beta [1 - F(\epsilon^P - (\delta^i - \delta_C^i))] (V_C - V_M) \right\} \end{aligned} \quad (10)$$

The first order Kuhn-Tucker necessary condition for this problem is:

$$\frac{\partial E_t W \left( \delta^i ; \delta^i + \sum_{j \neq i}^N \delta_C^j + \mu_t \right)}{\partial \delta^i} \leq \beta \varphi [\epsilon^P - (\delta^i - \delta_C^i)] (V_C - V_M) \quad (11)$$

If a Pareto efficient vector  $\delta_C$  is a solution to the maximization problem (10), condition (11) must be satisfied at  $\delta^i = \delta_C^i$ . We show next that this condition, however, cannot be satisfied for any  $\epsilon^P \in [\epsilon_L, \epsilon^U]$ . We consider first the case for which  $\epsilon^P = \epsilon^U$  and then the case for which  $\epsilon^P \in (\epsilon_L, \epsilon^U)$ .<sup>11</sup>

Case  $\epsilon^P = \epsilon^U$

Notice that by the assumption that  $\delta_C$  is time inconsistent, the left hand side of the inequality (11) is always positive. But in this case the right hand side is 0 because  $\varphi[\epsilon^U - (\delta^i - \delta_C^i)] = \varphi(\epsilon^U) = 0$  by the assumption in subsection 3.2. Since the inequality (11) cannot be satisfied,  $\delta_C$  cannot be supported as a Nash equilibrium in trigger strategies when  $\epsilon^P = \epsilon^U$ .

Case  $\epsilon^L < \epsilon^P < \epsilon^U$

The strategy of the proof in the previous case does not work in this one because the right hand side of the inequality (11) is positive by the assumption in subsection 3.2 that  $\varphi(\epsilon^P) > 0$  for any  $\epsilon_L < \epsilon^P < \epsilon^U$ . The proof of this case proceeds instead by contradiction.

Assume that the strategy  $\delta_C$  is indeed a solution to the maximization problem (10) delivering the Pareto efficient payoff  $V_C$ . This implies that inequality (11) is satisfied at such an

---

<sup>11</sup>The case  $\epsilon^P = \epsilon_L$  is trivial, because the event  $\epsilon_t = \epsilon_L$  has measure 0, and therefore, any realization  $\epsilon_t$  will push the money supply over the threshold with probability one. Since the reversion to the lower payoff equilibrium will occur anyway, the political agents will have no incentive to cooperate and set subsidies at the low level of the Pareto efficient strategy  $\delta_C$ .

equilibrium. Therefore, it must be possible to find  $\mathbf{x} \geq 0$  such that

$$\mathbf{z} = \mathbf{V}_C - \mathbf{V}_M - \mathbf{x}$$

solves the equation:

$$\frac{\partial \mathbf{E}_t \mathcal{W} \left( \delta_C^i ; \delta_C^i + \frac{N}{\sum_{j \neq i}} \delta_C^j + \mu_t \right)}{\partial \delta^i} = \beta \varphi(\epsilon^P) \mathbf{z}$$

Note that  $\mathbf{z}$  is always positive, since by assumption  $\mathbf{V}_C - \mathbf{V}_M > 0$ . Conceptually,  $\mathbf{z}$  represents the minimum utility loss that will deter a deviation from  $\delta_C^i$ . This implies that any vector  $\delta_C$  that solves (10) will also solve the following maximization problem:

$$\text{Max}_{\delta^i} \left\{ \mathbf{E}_t \mathcal{W} \left( \delta^i ; \delta^i + \frac{N}{\sum_{j \neq i}} \delta_C^j + \mu_t \right) + \beta \mathbf{V}_C - \beta [1 - F(\epsilon^P - (\delta^i - \delta_C^i))] \mathbf{z} \right\}$$

Therefore, the by hypothesis Pareto efficient payoff  $\mathbf{V}_C$  associated with the proposed equilibrium  $\delta_C$  will satisfy the equation

$$\mathbf{V}_C = \mathbf{E}_t \mathcal{W} \left( \delta_C^i ; \delta_C^i + \frac{N}{\sum_{j \neq i}} \delta_C^j + \mu_t \right) + \beta \mathbf{V}_C - \beta [1 - F(\epsilon^P)] \mathbf{z}$$

which implies:

$$\mathbf{V}_C = \frac{\mathbf{E}_t \mathcal{W} \left( \delta_C^i ; \delta_C^i + \frac{N}{\sum_{j \neq i}} \delta_C^j + \mu_t \right)}{1 - \beta} - \frac{\beta}{1 - \beta} [1 - F(\epsilon^P)] \mathbf{z}$$

Note that the first term in the equation above is the payoff that the political agent  $i$  will receive if the vector  $\delta_C$  were played forever and that the payoff associated with that vector is precisely, by assumption,  $V_C$ . The equation above can be rewritten, therefore:

$$V_C = V_C - \frac{\beta}{1 - \beta} [1 - F(\epsilon^P)] z$$

a contradiction, since  $z$  must be strictly positive. **Q.E.D.**

Notice that the last equality formalizes the intuition given before for the basic result of the proposition: under perfect information,  $F(\epsilon^P) = 1$  for any  $\epsilon^P$  because all deviations, however small, are discovered with probability one. In that case, the second term of the last equality would be weighted by 0, and the equilibria would achieve the Pareto optimal payoff  $V_C$ .

Some technical comments are in order before summarizing the policy implications of the proposition for the debate on flexible policies versus currency boards.

First, a myopic Nash equilibrium, which exists by assumption, will always solve the maximization problem (10), regardless of the choice of  $\theta^P$ . This ensures the existence of equilibria.

Second, (10) only checks the incentives for one-period deviations because, as is well known, this criteria is necessary and sufficient to prove that a strategy is subgame perfect (time consistent) in infinitely repeated games with discounting and single-period payoffs uniformly bounded above, all conditions that hold under the assumptions in subsection 3.1.

Third, Nash equilibria that solve (10) and are not myopic Nash equilibria will have the property that along the equilibrium path the play will switch back and forth from a low inflation,

low subsidies policy, to a high inflation, high subsidies policies.<sup>12</sup>

Fourth, the assumptions in the Proposition are admittedly rather restrictive, bringing up the fair question of its practical relevance. However, some general results obtained in the game theory literature, especially by Abreu, Pearce, and Stachetti (1986), make it fair to conjecture that the Proposition will survive relaxation of the assumptions in a number of dimensions. To this regard, what is key to our results is the recursive nature of the problem and the “judgement call” component of the rule followed by the impartial policymaker. Notice that this component will remain if the rule (2) were replaced with more general ones of the type  $\mu_t = g(S_t) + \epsilon_t$ , where  $g(S_t)$  is a publicly known function of the state of the economy  $S_t$ . If the set of states of the economy is ergodic and has finite number of elements, the strategy of the proof can still be applied to each of the maximization problems like (11) (one for each state of the economy) that will replace that problem.

#### 4.1 - Implications of the proposition for a theory of currency boards

The implication of the proposition in the previous subsection is that some of the flexible policies often proposed as a better alternative to currency boards can indeed attain low inflation outcomes in economies with perfect monitoring in the allocation of government spending. But those same policies will introduce a high inflation bias in economies where the ability to establish “where the public monies went” is missing or severely hampered.

The proposition suggests that it is precisely in economies plagued with information problems about the allocation of government spending that currency boards may have an

---

<sup>12</sup> Curious readers interested in understanding with the aid of a baseball analogy the subtle mechanics behind these switching equilibria can consult Zarazaga (1994).

important role to play.

Under a currency board, the rule (2) is replaced by one according to which:

$$\theta_t = \frac{FR_t - FR_{t-1}}{FR_{t-1}} * e$$

where  $FR_t$  is the level of foreign reserves and  $e$  the fixed exchange rate.

The advantage of this rule in the imperfect information environment of our model economy is that it eliminates the suspicion that expansions of the money supply are used to finance hidden subsidies. There cannot be central bank subsidies (open or hidden) under this system because, loosely speaking, any economic unit (private or public) receiving domestic currency from the central bank will have to give in exchange an equivalent amount in an asset denominated in foreign currency.

As long as the level of foreign reserves is observed, deviations from this policy of money creation, no matter how small, will be detected with probability one. Recall from the intuitive explanation of the proposition that this ability to always detect deviations makes it possible to support Pareto efficient (low inflation-low subsidies) outcomes as time consistent Nash equilibria. This implies that a currency board eliminates the high inflation bias that more flexible policies will introduce in the imperfect information environment of our model economy.

However, the miraculous virtues often attributed to currency boards are not warranted by the proposition. First, a currency board is not in and by itself more transparent than the flexible policy (2). Both policies would be equally transparent in an economy where it is possible to monitor the allocation of government spending.

The second qualification to the transparency feature of a currency board is that a currency board is not the only policy rule capable of restoring perfect information conditions in the actual economies represented by the abstraction of our model. Any rule that shuts down the “judgement call” will do. In particular, increasing the money stock at a fixed rate of  $\mu$  % every year made popular by Friedman (and which inspired the systematic component of our flexible rule (2)) would satisfy that criteria.

Since one of the purposes of the paper is to suggest directions of future research in building a more complete theory of currency boards, it is not entirely inappropriate at this point to step a little bit outside the strict boundaries of the model and speculate that the “transparency equivalence” result between a currency board and a policy rule like the one suggested by Friedman as described above is very fragile and will not survive, for example, the introduction of more sophisticated equilibrium concepts.

In this more speculative mood, let’s envision a model along the lines of the one in this paper in which it is optimal to increase the money supply at the constant rate of, say, 5 % a year, with 2% going to finance subsidies to each of the, say, two constituencies present in that economy, and 1% to finance government consumption. Such an optimal policy can eventually be enforced with reputational strategies, because any attempt by any constituency to increase subsidies above its 2% share would lead to rates of growth of the money supply above 5% and trigger a welfare reducing retaliation.

However, examination of equation (7) (now with the judgement call  $\epsilon_t$  dropped from it) suggests that under this 5% rule it is still impossible to verify the value of each of the individual components on the right hand side of that equation. Under the structure of information of the

paper, it would be impossible to believe, for example, the suspicion by at least one of the constituencies that the fraction of the money supply growth supposedly devoted to finance government consumption has been instead diverted to finance a subsidy to the other constituency. In this sense, a  $\mu$  % rule could be less transparent than a currency board, which does nip in the bud such a suspicion. In other words, the set of beliefs that are not falsifiable along the equilibrium path could be larger under the  $\mu$  % rule than under a currency board rule. This opens up the possibility that the equilibrium set under the  $\mu$  % rule will include bad--in a welfare sense--equilibria driven just by unfalsifiable beliefs. In some sense, the situation would be the converse of that in the proposition in the paper: the  $\mu$  % rule could introduce bad equilibria that would be absent under a currency board. In fact, this conjectured converse proposition has been proved to be true by Chari, Christiano, and Eichenbaum (1996) in the context of a different model.

The issue of the multiplicity of equilibria is related to the implications of the proposition for the time inconsistency objection to currency boards. As asserted in the discussion that preceded the formal proof of the proposition, under perfect information optimal plans can eventually be supported as subgame perfect (time consistent) Nash equilibria that incorporate reputational constraints. As explained before, a currency board restores those conditions when they are missing in environments like the one of our model economy. In that case, if the currency board is indeed an optimal plan, it can eventually be supported as a Nash equilibrium in trigger strategies and circumvent, therefore, the common time inconsistency criticism mentioned in the introduction. However, this result is not as powerful as currency board advocates could have wished for, because the introduction of a currency board adds “good” low inflation equilibria to the equilibrium set, but it does not eliminate bad high inflation equilibria from that set. In

particular, the myopic high inflation Nash equilibrium used in the proof belongs to the equilibrium set. This implies that a currency board can sustain low inflation outcomes, but by not mean guarantees them, as advocates of currency boards often like to claim.

#### 4.2 - Financial crises and currency boards

As mentioned in the introduction, currency boards have been proposed for some East Asian countries after the financial crisis that unfolded in that region in mid 1997. Thus, an interesting question is whether the framework of analysis proposed in this paper is of any relevance for countries in that area of the world.

Without claiming any definite answer, one can certainly point out to evidence suggesting the presence in many of those economies of the two fundamental ingredients of the model: lack of transparency and the use of fiscal and monetary policies to subsidize particular constituencies.

The first element, the lack of transparency, has been detected by the IMF, as reported in section 2. The second element, the possible use of monetary and fiscal policy to favor particular sectors, became apparent in the massive bailout of the financial system by the governments of many of those countries in the aftermath of the crisis. The subsidies implied in those bailouts were sizable, representing as much as 15% of GDP in Mexico and South Korea.<sup>13</sup>

Thus, it seems that a tentative application to the East Asian crisis of 1997-98 of the analytical framework proposed in this paper could start by identifying the financial intermediaries of those countries with the vested interests in the abstraction of the model. The imperfect

---

<sup>13</sup>Figures for Mexico are reported in *El Financiero* (International Edition) April 6-12, 1998, p.1, Mexico City, and for Korea in the September 1998 report issued by that country's Division of Monetary Policy, Ministry of Finance and Economy.

information problem would be created by a liquidity-solvency confusion. More precisely, the monetary authority could make a “judgement call” to expand the money supply to provide liquidity assistance to a fundamentally solvent financial intermediary under temporary stress. However, the rest of the financial intermediaries cannot tell whether this monetary authority action is prompted by a short-term liquidity problem or by a long run insolvency problem. In the latter case, the assistance is a hidden form of subsidy to the financial intermediary receiving the liquidity injection. The suspicion by some financial intermediaries that monetary policy is used to favor a competitor sets up the conditions for the Proposition above to hold. The implication is that the liquidity-solvency confusion just suggested will make it hard for the monetary authority to keep a low inflation outcome in this environment.

It is beyond the scope of this paper to construct a rigorous model along the lines suggested in the previous paragraph. Here, we can only conjecture that a mechanism analogous to that described heuristically in Zarazaga (1994), and more rigorously in Zarazaga (1995), might emerge in such an environment. In particular, in the application of the model just suggested, the “judgement call” that expands the money supply--perhaps only slightly--in an attempt to solve what the monetary authority regards as a short-term liquidity problem of just one financial intermediary may trigger a “subsidy war” that takes the form of a massive bail out package for the financial sector, several times higher than the one intended with the original liquidity support.<sup>14</sup>

In other words, the conjecture above suggests that the attempt to solve the liquidity problem of one financial institution can eventually put the monetary authority under pressure to

---

<sup>14</sup>This conjecture, roughly consistent with the evidence, leaves out a lot of important modeling details that are the object of work in progress by the author.

bail out the whole financial system. The monetary authority seems to face an “all or nothing situation” in that imperfect information scenario: either it bails out all financial intermediaries, or none of them. Which of the two options is preferable in terms of welfare is not obvious. Of course, the latter one is the only one consistent with a currency board arrangement

On the one hand, a bail out package needs to be financed with taxes, most of which are distortionary and, therefore, costly in terms of welfare, especially given the order of magnitudes that seem to be involved (15% of GDP for Mexico and South Korea, as documented earlier).

On the other hand, a currency board will let a fundamentally viable financial institution fail and eventually lead to a chain reaction of foreclosures of financial intermediaries and the businesses they finance that will be damaging in terms of welfare. Understandably, many policymakers will resist that course of action if they believe the bleak outcome can be averted by being a little bit more flexible.<sup>15</sup> This lack of flexibility to face bank runs not driven by fundamentals is often mentioned as one of the main drawbacks of a currency board.

It is impossible to establish *a priori* which one of the two choices available to the monetary authority in imperfect information environments (bail out the whole financial system or let it be prey of “self-fulfilling” panics) is Pareto superior. The development of a model with which to address this question should be a priority in the research agenda suggested by this paper.<sup>16</sup>

---

<sup>15</sup>This belief could be extrapolated from the experience in countries without the kind of imperfect monitoring problems pointed out in this paper, but of course it would ignore that such flexibility would create havoc in countries where the distinction between solvency and liquidity problems is more difficult.

<sup>16</sup>Incidentally, and contrary to popular belief, it is not obvious that a lender of last resort is the best tool with which to face bank runs even in perfect information environments. Wallace (1988, 1990), for example, has forcefully shown that the best policy to confront bank runs is not lender of last resort loans, but partial suspension of payments. More precisely, financial intermediaries

## 5 - CONCLUSIONS

Currency boards are often recommended as a powerful and sustainable antiinflation program for countries suffering from high inflation and recurrent financial crises. Such stark policy recommendation has been criticized on empirical and theoretical grounds. The empirical evidence that critics of currency boards like to exhibit is that many countries have been able to keep low inflation and financial stability using precisely the more flexible policies currency board proponents criticize. On the theoretical side, the objection is that currency boards are not immune to the problem of the time inconsistency of optimal plans.

This paper has attempted to make some contribution to that debate from the perspective of a political economy model where different constituencies can influence government spending in their favor, but cannot monitor how that spending is finally allocated between alternative uses.

The model suggests that there are conditions under which both sides of the debate might be right. Some of the flexible policies often presented as a superior alternative to currency boards may have been successful at keeping inflation low in some countries because in those countries perfect information conditions in the allocation of government spending prevail. But those same flexible policies may lead to out of control inflation, as currency board advocates complain, in countries where the ability to monitor the final destiny of public funds is seriously hampered. In fact, the negative correlation between the degree of fiscal transparency and inflation reported in Alesina, Hausmann, Hommes, and Stein (1996) is in principle consistent with the predictions of the model.

---

should honor deposits only partially in the event of a bank run.

The reason why a currency board might turn out to be a particularly useful antiinflation regime in countries plagued with public spending monitoring problems is that a currency board replicates perfect information conditions that would otherwise be missing in those countries. This “transparency equivalence” feature of currency boards reintroduces in the feasible equilibrium set Pareto efficient, low inflation-low subsidies, outcomes that can be sustained as subgame perfect Nash equilibria in reputational constraints. In other words, a currency board can eventually be a much more sustainable arrangement than suggested by the time inconsistency criticism. On this count, the model does provide a role for the transparency enhancing feature many times mentioned, but without much rationale, as one of the great virtues of currency boards.

On the other hand, the model also highlights some limitations of currency boards. First, the “transparency equivalence” of a currency board in our environment is not powerful enough to guarantee that a low inflation outcome will indeed emerge. Bad, high inflation equilibria are also possible. Second, the “transparency equivalence” feature of a currency board is only relevant in imperfect information environments like the one of our artificial economy. Third, other policy rules may have that “transparency equivalence” property and it is far from obvious that a currency board will dominate them in a welfare sense.

Interesting enough, the implications of the model are consistent with the experience of Argentina, the only large country of the world that has had a currency board regime for quite some time now. The assumptions of the model capture well that country’s reality, because anyone familiar with Argentina’s statistics and government budgets will know how difficult it was, at least until not long ago, to obtain reliable figures for that country on the level and final use of government spending, especially of the government expenditures administered through the quasi-

fiscal accounts under control of that country's central bank until 1991. Many analysts are stunned by the resilience of Argentina's currency board arrangement, whose quick demise they had predicted at the time of its inception on April 1991. Such resilience is not surprising in the light of the model in this paper. Perhaps the "transparency equivalence" feature of a currency board returned to the Argentinean society the ability to coordinate on the Barro-Gordon type reputational strategies that make low inflation policies sustainable in the logic of our model.

The evidence presented in section 2 suggests that Southeast Asian countries and Russia may offer another potentially fertile real world application of the analytical framework of our model. The state of disarray of the Russian statistics and fiscal accounts was too well known, even before the meltdown of that country's financial markets on the Summer of 1998, to merit further discussion. The same early awareness may have been missing in Southeast Asia, but the recent financial turmoil experienced by that area of the world has forced a closer look and brought to the daylight how certain practices, especially with respect to subsidized credit and financial rescue packages, have hampered in those countries not only the ability to quantify the public funds allocated to financial intermediaries, but also to trace the ultimate use and/or beneficiaries of those funds.

In the logic of the analytical framework presented in this paper, the citizens of those countries may ask now, as their Argentineans counterparts perhaps did before April 1991, whether the recurrent financial bail outs implemented by their central banks and governments are really a way to solve a short-term liquidity problem of otherwise solvent financial institutions, or rather a way to hand over concealed subsidies to institutions that exploit the central bank assistance to take risky bets at taxpayers' expense. Would currency boards in those countries limit

those suspicions, thereby helping to support more financially stable, low inflation outcomes?

Certainly, much research remains ahead before we can answer that question with some confidence. In this regard, it is important to emphasize the serious limitations of the modeling approach taken in this paper. Although the paper may have captured a relevant feature of reality with its imperfect information assumption, it has certainly left out another one at least as important: the role of financial intermediaries in bridging the mismatch between the typical maturity of bank deposits and that of physical investment. This mismatch is at the heart of the financial fragility problem more fully addressed in Chang and Velasco (1998) and at the core of their result that a flexible exchange rate regime is preferable to a currency board. The inability of the monetary authority to act as a lender of last resort under a currency board is responsible for this result. However, Chang and Velasco's analysis abstracts from the imperfect information problems considered in this paper, and also from the result by Wallace already mentioned that financial panics should be confronted with suspension of payments rather than with a lender of last resort.<sup>17</sup> Wallace's result is particularly relevant for the subject of this paper, because it suggests that the lack of a lender of last resort feature under a currency board system may not be such a fatal flaw as currency board critics maintain.

Obvious questions for future research are whether or not the Chang-Velasco conclusion against currency boards will survive the introduction of imperfect monitoring problems like the ones stressed in this paper and the suspension of payments policy option suggested by Wallace. All these are fascinating questions that deserve much attention and will undoubtedly keep

---

<sup>17</sup>Suspension of payments in this context does not mean default in the sovereign debt, but rather, as mentioned in the previous footnote, that financial intermediaries should be allowed not to fully honor deposit withdrawals triggered by "self-fulfilling" bank panics.

policymakers and scholars very busy for years to come.

## REFERENCES

Abreu, D., D. Pearce, and E. Stachetti (1986): "Optimal Cartel Monitoring with Imperfect Information," *Econometrica* 58: 1041-63

Alesina, A. and A. Drazen (1991): "Why Are Stabilizations Delayed?" *American Economic Review* 81: 1170-88.

Alesina, A., R. Hausmann, R. Hommes, and E. Stein (1996): "Budget Institutions and Fiscal Performance in Latin America," Inter-American Development Bank, mimeo.

Barro, Robert J. (1995): "Latin Lessons in Monetary Policy," *The Wall Street Journal*, May 1.

Barro, Robert J. and David B. Gordon (1983): "A Positive Theory of Monetary Policy in a Natural Rate Model," *Journal of Political Economy* 91, Number. 4: 589-609.

Calvo, Guillermo (1978): "On the Time Consistency of Optimal Policy in a Monetary Economy," *Econometrica* 46, Number 6, November: 1411-28.

Chang, R and A. Velasco (1998): "Financial Fragility and the Exchange Rate Regime," NBER Working Paper No. 6469 (March)

Chari, V. V. (1998): "Nobel Laureate Robert E. Lucas, Jr.: Architect of Modern Macroeconomics" *Journal of Economic Perspectives*, Volume 12, Number 1 (Winter): 171-186.

Chari, V. V., L. Christiano, and M. Eichenbaum (1996): "Expectation Traps and Discretion," Working Paper 96-04 (March), Federal Reserve Bank of San Francisco.

Christiano, L. J. and M. Eichenbaum (1992): "Liquidity Effects, Monetary Policy, and the Business Cycle," Working Paper No. 4129, National Bureau of Economic Research.

Dornbusch, Rudi (1997): "Argentina's Monetary Policy Lesson for Mexico," *The Wall Street Journal*, February 28.

Gavin, W. T. and F.E. Kydland (1996): "Endogenous Money Supply and the Business Cycle," Working Paper 96-05, Federal Reserve Bank of Cleveland.

Hanke, Steve H. (1996a): "Currency Board for Mexico," *Central Banking*, Volume 6, Number 4, Spring, p. 88.

\_\_\_\_\_ (1996b): "Argentina and the Tequila Effect," *Central Banking*, Volume VI, Number 4 (Spring), p.92

Hanke, Steve H, and Kurt Schuler (1994): "Currency Boards for Developing Countries. A Handbook." Sector Study No. 9, International Center for Economic Growth. San Francisco, California, USA: Institute for Contemporary Studies Press, p. 22.

Krugman, Paul R. (1998): "What happened to Asia?" mimeo.

Kydland, Finn E. and Edward C Prescott (1977): "Rules Rather than Discretion: The Inconsistency of Optimal Plans," *Journal of Political Economy* 85, Number 3 (June): 473-91.

Leeper, E. (1991): "Equilibria under "active" and "passive" monetary and fiscal policies," *Journal of Monetary Economics* 27: 129-47.

Leeper, E., C. Sims, and T. Zha (1996): "What Does Monetary Policy Do?" *Brookings Papers on Economic Activity* 12: 1-78.

Lucas, Robert E., Jr. (1972): "Expectations and the Neutrality of Money," *Journal of Economic Theory* 4: 103-24.

Radner, R., R. Myerson, and E. Maskin (1986): "An Example of a Repeated Partnership Game with Discounting and with Uniformly Inefficient Equilibria," *Review of Economic Studies* 53: 59-69.

Salemi, Michael K. (1995): "Revealed Preference of the Federal Reserve: Using Inverse Control Theory to Interpret the Policy Equation of a Vector Autoregression," *Journal of Business and Economic Statistics* 13: 419-33.

Wallace, N. (1988): "Another Attempt to Explain an Illiquid Banking System: The Diamond and Dybvig Model With Sequential Service Taken Seriously," *Quarterly Review*, Federal Reserve Bank of Minneapolis (Fall): 3-16.

\_\_\_\_\_ (1990): "A Banking Model in Which Partial Suspension is Best," *Quarterly Review*, Federal Reserve Bank of Minneapolis (Fall): 11-23.

Zarazaga, C. E. J. M. (1994): "How a Little Inflation Can Lead to a Lot," *Business Review*, Federal Reserve Bank of Philadelphia (September-October): 3-13.

\_\_\_\_\_ (1995): "Hyperinflations and Moral Hazard in the Appropriation of  
Seignorage: An Empirical Implementation with a Calibration Approach" Working Paper 95-17.  
Federal Reserve Bank of Dallas. November 1995.