Solutions (?) to the "Devaluation Bias": Some Preventive Measures to Defend Fixed Exchange Rates against Self-Fulfilling Attacks*

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Abstract

The objective of this paper is to provide an analysis of alternative preventive measures that can be introduced to defend fixed exchange rates against speculative attacks due to self-fulfilling expectations *à la* Obstfeld (1996). Drawing on the similarity between the "devaluation bias" and the "inflation bias", we examine solutions (familiar from the latter literature) as possible preventive measures against self-fulfilling attacks—viz., imposition of a reputational constraint, appointment of a conservative central banker, design of an incentive contract for the central banker, and exchange rate (devaluation) targeting. We also discuss possible differences in forces behind attacks on currency boards *vis à vis* standard pegs, and consider convertibility insurance as an alternative defensive measure.

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1 Introduction

Research on currency crises has largely been focused on their economic causes—in particular, the role of fundamentals vs. self-fulfilling expectations. [See, e.g., Krugman (1979, 1999) and Obstfeld (1996).] Some attention has recently been directed to the defense of fixed exchange rates against speculative attacks and crisis prevention. [See, e.g., Drazen (1999), Flood and Jeanne (2000), and Lahiri and Végh (2000).] Attacks arising from "wrong" fundamentals such as the policy inconsistency in first-generation crisis models of Krugman (1979) are simply unavoidable. The only way to prevent them is to "correct" such fundamentals through, say, better (and more consistent) coordination of policy actions among different branches of the government. On the other hand, attacks arising from self-fulfilling expectations as in second-generation models of Obstfeld (1996) are in principle avoidable—if, somehow, such expectations can be altered or eliminated by appropriate preventive measures. In this paper, we shall focus on the analysis of the prevention of self-fulfilling attacks.

Most papers in this currency crisis literature treat standard pegs and currency boards—alternative fixed exchange rate arrangements—as one and the same thing. [Chang and Velasco (2000) is an obvious exception.] Differences between their institutional features (see Appendix for details), however, imply that their adjustment mechanisms in face of currency attacks can be quite different. Specifically, central banks can resort to either foreign exchange intervention or (active) interest rate defense under standard pegs, whereas (passive) interest rate adjustment through bank arbitrage has to be relied upon under currency boards. Between them, would the nature of attacks and thus the desired preventive measure be very different? We shall provide some discussion about this issue.

The objective of this paper is to provide an analysis of alternative preventive measures that can be introduced to defend these two alternative forms of fixed exchange rates against possible attacks. The organization of the paper is as follows. Section 2 reviews the self-fulfilling crisis model of Obstfeld (1996) that we shall use as the theoretical framework throughout. Some measures (familiar from the inflation bias literature) to prevent self-fulfilling attacks—viz., imposition of a reputational constraint, appointment of a conservative central banker, and design of an incentive contract for the central banker—are examined in Section 3. These measures can be commonly applied to both regular pegs and currency boards. Section 4 discusses possible differences in forces behind attacks on currency boards rather than standard pegs, and considers convertibility insurance as an alternative defensive measure. Concluding remarks are contained in Section 5.

2 The Self-Fulfilling Crisis Model of Obstfeld (1996)

Suppose, as in Obstfeld (1996), that

- the country in question has adopted a fixed exchange rate regime;
- purchasing power parity holds, so that the rate of change of exchange rate (ε) equals the domestic inflation rate (g_p), given a constant foreign price level ($g_p^* = 0$);
- the government cares about both output stability and exchange rate (hence, inflation) stability, viz., its loss function is given by $\mathcal{L} = E[(y - \widetilde{y})^2 + \beta\varepsilon^2]$, where y and $\widetilde{y}$ are respectively the actual and socially optimal levels of output, and $\beta \in [0, \infty)$ the weight attached to the exchange rate objective;
- the government faces a Lucas-type supply function (mirror image of the expectations-augmented Phillips curve), viz., $y = \overline{y} + \alpha(\varepsilon - \varepsilon^e) - u$, where $\overline{y}$ is the natural level of output (which falls short of the social optimum due to some distortions in the economy, i.e., $\overline{y} = \widetilde{y} - d < \widetilde{y}$), ε^e the expected rate of devaluation (or inflation), u an adverse supply shock, and $\alpha > 0$ the effectiveness of surprise devaluation (or inflation) in stimulating output; and
- the government enjoys an informational advantage, observing the true value of the supply shock *before* making its decision whether to adhere to the fixed rate regime; while the public only observes the realized value of u *after* (and thus has to form expectations about the equilibrium exchange rate ε^e *before*) the government makes its policy choice.

If the government sticks to the fixed rate regime, then $\varepsilon = 0$ so that $y = \overline{y} - (\alpha\varepsilon^e + u) = \widetilde{y} - (\alpha\varepsilon^e + u + d)$ and, given ε^e and the realization of u, its *ex post* policy loss is

$$\mathcal{L}^{fix} = (y - \widetilde{y})^2 = (\alpha\varepsilon^e + u + d)^2. \tag{1}$$

If the government chooses to switch to a floating rate regime either through a devaluation ($\varepsilon > 0$) or a revaluation ($\varepsilon < 0$), its discretionary choice of the rate of change of exchange rate will be determined by solution to the following problem:

$$\begin{gathered} Min_{\{\varepsilon\}} E[(y - \widetilde{y})^2 + \beta\varepsilon^2 \mid \varepsilon^e, u] \\ s.t. \;\; y = \overline{y} + \alpha(\varepsilon - \varepsilon^e) - u \;\; \text{and} \;\; \widetilde{y} = \overline{y} + d. \end{gathered}$$

The optimal devaluation rate is given by

$$\varepsilon = \left(\frac{\alpha}{\alpha^2 + \beta}\right)(\alpha\varepsilon^e + u + d), \tag{2}$$

which implies an actual output level of $y = \widetilde{y} - \left(\frac{\beta}{\alpha^2+\beta}\right)(\alpha\varepsilon^e + u + d)$. Hence, the government's *ex post* loss is

$$\mathcal{L}^{flex} = [(y - \widetilde{y})^2 + \beta\varepsilon^2] = \left(\frac{\beta}{\alpha^2 + \beta}\right)(\alpha\varepsilon^e + u + d)^2. \tag{3}$$

Comparing (1) and (3), we see that $\mathcal{L}^{fix} > \mathcal{L}^{flex}$ for all possible values of ε^e and u.[1] In other words, in the absence of some preventive measures, the government always has the temptation to voluntarily abandon the peg irrespective of its ability (say, in terms of its reserve position) to maintain it. Understanding this, the public will rationally expect such outcome and choose to attack the regime before it is abandoned. In other words, the fixed rate regime is not sustainable.

[1] *Ex ante*, the government's policy losses are respectively $\mathcal{L}^{fix} = \sigma_u^2 + d^2$ and $\mathcal{L}^{flex} = \left(\frac{\beta}{\alpha^2+\beta}\right)\sigma_u^2 + \left(\frac{\alpha^2+\beta}{\beta}\right)d^2$ (assuming that u has zero mean and constant variance σ_u^2). Hence, $\mathcal{L}^{fix} \gtreqless \mathcal{L}^{flex}$ as $\sigma_u^2 \gtreqless \left(\frac{\alpha^2+\beta}{\beta}\right)d^2$. In other words, σ_u^2 must have been estimated to be smaller than $\left(\frac{\alpha^2+\beta}{\beta}\right)d^2$ for the fixed rate regime to be chosen in the first place.

This "devaluation bias" is in many ways akin to the "inflation bias" in monetary policy analysis.[2] [See, e.g., Walsh (1998), Chapter 8.] For this reason, we examine in the next section whether three "solutions" that have been proposed to reduce or eliminate the latter bias will also work for the former.

3 Some Measures to Prevent Self-Fulfilling Attacks

3.1 Imposing an exit penalty or reputational constraint (*à la* Barro-Gordon (1983))

Suppose, in breaking the peg, the government has to incur a fixed exit cost, C, due to, say, loss of reputation and credibility. Given this reputational constraint, the cost C has to be incorporated into $\mathcal{L}^{flex}$ in (3). Direct comparison of $\mathcal{L}^{fix}$ in (1) with this modified $\mathcal{L}^{flex}$ indicates that the government will choose to give up the peg if the supply shock is too large in absolute values. Define the critical shock values as follows:

$$u^0 \equiv \sqrt{\left(\frac{\alpha^2+\beta}{\alpha^2}\right)C} - (\alpha\varepsilon^e + d) \;\text{ and }\; u_0 \equiv -\sqrt{\left(\frac{\alpha^2+\beta}{\alpha^2}\right)C} - (\alpha\varepsilon^e + d). \tag{4}$$

Then, the peg will be kept intact (i.e., $\varepsilon = 0$) if $u_0 \leq u \leq u^0$. There will be a devaluation ($\varepsilon > 0$), however, when $u > u^0$, and a revaluation ($\varepsilon < 0$) when $u < u_0$.

It is not difficult to see that, by setting the punishment at a high enough level, the government can be induced not to switch to the floating rate under all circumstances. Specifically, we want to set C at a level such that $\mathcal{L}^{fix} \leq \mathcal{L}^{flex}$ at all possible levels of ε^e and for all possible realizations of u, i.e.,

$$C \geq \left(\frac{\alpha^2}{\alpha^2+\beta}\right)(\alpha\varepsilon^e + u + d)^2 \;\text{ for all } \varepsilon^e, u. \tag{5}$$

One can easily verify that setting C this way will ensure that the supply shock will always

[2] This analogy is not surprising, given the purchasing power parity assumption (which implies $\varepsilon = g_p$).

fall within the no-attack zone $[u_0, u^0]$.

Under rational expectations, we have

$$\varepsilon^e = E(\varepsilon) = \Pr(u > u^0) \cdot E(\varepsilon \mid u > u^0) + \Pr(u < u_0) \cdot E(\varepsilon \mid u < u_0), \quad (6)$$

where $E(\varepsilon \mid u > u^0) = \left(\frac{\alpha}{\alpha^2+\beta}\right)[(\alpha\varepsilon^e + d) + E(u \mid u > u^0)]$ and $E(\varepsilon \mid u < u_0) = \left(\frac{\alpha}{\alpha^2+\beta}\right)[(\alpha\varepsilon^e + d) + E(u \mid u < u_0)]$.[3] As an example, suppose that u is uniformly distributed on $[-\mu, \mu]$, $\mu \in \Re_+$.[4] Then, $\Pr(u > u^0) = \frac{\mu - u^0}{2\mu}$ and $\Pr(u < u_0) = \frac{\mu + u_0}{2\mu}$ whereas $E(u \mid u > u^0) = \frac{\mu + u^0}{2}$ and $E(u \mid u < u_0) = \frac{u_0 - \mu}{2}$. Together with (4), these expressions suggest that (6) is a quadratic equation in ε^e. As Obstfeld (1996) shows, in addition to the two roots corresponding to this quadratic equation, ε^e can assume an even higher value of $\varepsilon^e_{\max} = \frac{\alpha d}{\beta}$ corresponding to the depreciation expectation under a completely flexible exchange rate[5]—as when the devaluation threshold u^0 is stuck at its lower bound $-\mu$.

Despite the possibility of multiple equilibria, the government can fully rule out self-fulfilling currency crises (i.e., eliminate the "bad" equilibria) if it is constrained by a reputational cost of

$$\overline{C} \equiv \left(\frac{\alpha^2}{\alpha^2+\beta}\right)(\alpha\varepsilon^e_{\max} + u_{\max} + d)^2 = \left(\frac{\alpha^2}{\alpha^2+\beta}\right)\left[\left(\frac{\alpha^2+\beta}{\beta}\right)d + \mu\right]^2. \quad (5')$$

Note that $\overline{C}$ is defined for the maximum possible levels of ε^e (i.e., $\varepsilon^e_{\max} = \frac{\alpha d}{\beta}$) and u (i.e., $u_{\max} = \mu$). Consequently, a sufficient condition for $\mathcal{L}^{fix} < \mathcal{L}^{flex}$ is to set the exit penalty C at the level $\overline{C}$.

[3] We omit the term $\Pr(u_0 \leq u \leq u^0) \cdot E(\varepsilon \mid u_0 \leq u \leq u^0)$ because $\varepsilon = 0$ for $u \in [u_0, u^0]$..

[4] In this case, the definitions of the threshold values of u given in (4) have to be modified as $u^0 \equiv \max\left\{\min\left[\sqrt{\left(\frac{\alpha^2+\beta}{\alpha^2}\right)C} - (\alpha\varepsilon^e + d), \mu\right], -\mu\right\}$ and $u_0 \equiv \min\left\{\max\left[-\sqrt{\left(\frac{\alpha^2+\beta}{\alpha^2}\right)C} - (\alpha\varepsilon^e + d), -\mu\right], \mu\right\}$.

[5] Under a floating rate regime, the (rationally) expected rate of depreciation satisfies $\varepsilon^e = E(\varepsilon) = E\left[\left(\frac{\alpha}{\alpha^2+\beta}\right)(\alpha\varepsilon^e + u + d)\right] = \left(\frac{\alpha}{\alpha^2+\beta}\right)(\alpha\varepsilon^e + d)$, which implies $\varepsilon^e = \frac{\alpha d}{\beta}$.

3.2 Appointing a conservative central banker (*à la* Rogoff (1985))

An alternative way to prevent the government from shifting to a float is to assign the duty of maintaining the peg to a "conservative" central banker, i.e., one with a higher weight β (say, $\beta + \delta$) attached to the exchange rate objective than the society at large. As a result, the central banker's loss function becomes:

$$\mathcal{L} = E\left\{[\alpha(\varepsilon - \varepsilon^e) - (u + d)]^2 + (\beta + \delta)\varepsilon^2 \mid \varepsilon^e, u\right\}, \tag{7}$$

which implies $\varepsilon = \left[\frac{\alpha}{\alpha^2+(\beta+\delta)}\right](\alpha\varepsilon^e + u + d)$, $y = \widetilde{y} - \left[\frac{\beta}{\alpha^2+(\beta+\delta)}\right](\alpha\varepsilon^e + u + d)$, and

$$\mathcal{L}^{flex} = \left[\frac{\beta + \delta}{\alpha^2 + (\beta + \delta)}\right](\alpha\varepsilon^e + u + d)^2. \tag{3'}$$

How weight-conservative do we want this central banker to be? From (3′), we require $\delta \to \infty$ for $\mathcal{L}^{flex} \to (\alpha\varepsilon^e + u + d)^2 = \mathcal{L}^{fix}$. This means that, in the absence of the exit penalty, the difficult task of eliminating self-fulfilling attacks should be assigned to a die-hard conservative—one with $\beta + \delta \simeq \infty$.

It is straightforward to show, however, that the socially optimal level of δ—obtained from minimizing the (indirect) loss function of the government with respect to δ—is $-\beta$ so that the exchange rate weight $(\beta + \delta)$ should be zero! In other words, although this conservative central banker solution is feasible, it is by no means socially efficient.

3.3 Designing an incentive contract for the central banker (*à la* Walsh (1995))

Instead of punishing a non-credible central banker or appointing an ultra-conservative one, we can design a compensation package for the banker to give her/him the right incentive to adhere strictly to the peg.

Suppose the incentive contract takes the simple linear form:

$$W(\varepsilon) = W_0 + \omega\varepsilon. \tag{8}$$

In the presence of this contract, the wage compensation W has to be deducted from the government's objective function to obtain the relevant (net) policy losses.

Under the fixed rate regime, $\varepsilon = 0$ so that $W(\varepsilon) = W_0$ and the central banker's *ex post* policy loss is

$$\mathcal{L}^{fix} = (\alpha\varepsilon^e + u + d)^2 - W_0. \tag{1'}$$

Under the alternative floating rate regime, the optimal choice of ε is determined by minimization of the loss function:

$$\mathcal{L} = E\left\{[\alpha(\varepsilon - \varepsilon^e) - (u + d)]^2 + \beta\varepsilon^2 - W(\varepsilon) \mid \varepsilon^e, u\right\} \tag{7'}$$

The optimal devaluation rate becomes

$$\varepsilon = \left(\frac{1}{\alpha^2 + \beta}\right)\left[\alpha(\alpha\varepsilon^e + u + d) + \frac{\omega}{2}\right], \tag{2'}$$

which implies an actual output level of $y = \widetilde{y} - \left(\frac{1}{\alpha^2+\beta}\right)\left[\beta(\alpha\varepsilon^e + u + d) - \frac{\alpha\omega}{2}\right]$. Hence, the banker's *ex post* loss is

$$\mathcal{L}^{flex} = \left(\frac{1}{\alpha^2 + \beta}\right)\left\{\beta(\alpha\varepsilon^e + u + d)^2 + \left(\frac{\omega}{2}\right)^2 - \omega\left[\alpha(\alpha\varepsilon^e + u + d) + \frac{\omega}{2}\right]\right\} - W_0. \tag{3''}$$

In designing the incentive contract, we would like to choose W_0 and ω in such a way that $\mathcal{L}^{fix} \leq \mathcal{L}^{flex}$ for all possible values of ε^e and u. Subtracting (3″) from (1′), we have

$$\mathcal{L}^{fix} - \mathcal{L}^{flex} = \left(\frac{1}{\alpha^2 + \beta}\right)\left[\alpha(\alpha\varepsilon^e + u + d) + \frac{\omega}{2}\right]^2 \geq 0.$$

The best we can do in order to maintain the peg is thus to set the *proportional* payment at a rate

$$\omega = -2\alpha(\alpha\varepsilon^e + u + d) < 0, \tag{8a}$$

proportional to ε, so as to keep $\mathcal{L}^{fix} = \mathcal{L}^{flex}$. The *lump-sum* component W_0 can be freely set, though, at any finite level. Under such contract, a central banker that deviates from the fixed rate rule will have to suffer a salary cut proportional to the devaluation rate s/he chooses.

Substituting (8a) into (2′), we get $\varepsilon = 0$—i.e., under this incentive scheme, the central banker will willingly choose to stick to the peg even though s/he has the option to shift to the float.

3.4 An assessment of the practicality of the three solutions (and their equivalents)

All three solutions considered above basically yield the same outcomes in terms of the actual and expected rate of change of exchange rate and the equilibrium level of output. In particular, complete exchange rate stability is achieved, but only at the expense of output volatility.

It is difficult, however, to conceive how these solutions can actually be implemented in practice. This is especially so for the second (conservative central banker) solution due to (a) its social sub-optimality as argued above and (b) the difficulty in reality in identifying the true preferences of potential candidates for the central banker. If one is willing to ignore (a), then the problem in (b) can somehow be dodged by assigning to the central banker—whatever her/his degree of conservativeness—a flexible *exchange rate devaluation* (or inflation) *target* of $\overline{\varepsilon} = 0$ and imposing on her/him a penalty related to deviations from the target devaluation rate of $\mathcal{P} = \rho E(\varepsilon - \overline{\varepsilon})^2$.

Adding this penalty term $\mathcal{P}$ to the central banker's loss function, given $\overline{\varepsilon} = 0$, yields

$$\mathcal{L} = E\left\{[\alpha(\varepsilon - \varepsilon^e) - (u + d)]^2 + (\beta + \rho)\varepsilon^2 \mid \varepsilon^e, u\right\}. \tag{7″}$$

Observe that $(7'')$ is equivalent to the conservative central banker's loss function (7) for $\rho = \delta$. Again, $\mathcal{L}^{flex} \to \alpha(\varepsilon^e + u + d)^2 = \mathcal{L}^{fix}$ for $\rho \to \infty$. This means that the penalty for failing to achieve the devaluation target ($\overline{\varepsilon} = 0$) has to be prohibitively high in order to ensure that a central banker with arbitrary weight-conservativeness will try to hit such target. Though plausible, this alternative targeting solution is no more realistic than the original conservative central banker solution.

Turning to the first (reputational constraint) and third (incentive contract) solutions, they are very similar to one another in nature. Both are alternative forms of punishment schemes to deter the central banker from breaking the peg. Due to its simple lump-sum form, the former is nonetheless more easily implementable than the latter (which is made proportional to the magnitude of exchange rate realignment).

Once more, the question is how often do we see them used in practice. Not at all, perhaps. And even when adopted, they probably do not assume the exact same forms as these two solutions would dictate. We show below, however, that the incentive contract solution is replicable by a more commonly adopted targeting rule.

Suppose the central banker has been assigned an *exchange rate devaluation target* of $\overline{\varepsilon}$ (possibly different from zero), but there is no penalty for failing to hit the target (i.e., $\rho = 0$). Then her/his objective function will be altered as follows:

$$\mathcal{L} = E\left\{[\alpha(\varepsilon - \varepsilon^e) - (u + d)]^2 + \beta(\varepsilon - \overline{\varepsilon})^2 \mid \varepsilon^e, u\right\}.$$

Upon rearranging terms, we can express it as

$$\mathcal{L} = E\left\{[\alpha(\varepsilon - \varepsilon^e) - (u + d)]^2 + \beta\varepsilon^2 - V(\varepsilon) \mid \varepsilon^e, u\right\}, \qquad (7''')$$

where

$$V(\varepsilon) = -\beta\overline{\varepsilon}^2 + (2\beta\overline{\varepsilon})\varepsilon. \qquad (8')$$

Observe that $(7''')$ assumes the same form as $(7')$, and $(8')$ the same form as (8). Consequently, we can equate the slope term in ($8'$) to the ω term in (8a), implying that a devaluation (revaluation, as it turns out) target of $\bar{\varepsilon} = -\alpha(\varepsilon^e + u + d)/\beta < 0$ will replicate the incentive contract solution.[6] In this sense, one can view the solution as being more popularly used in this disguised (targeting) form in practice.

4 Are Currency Boards Different from Regular Pegs?

The solutions we have examined thus far do not permit even the slightest adjustment in the exchange rate one way or the other from the fixed parity rate. This is obviously too stringent a restriction to impose on the monetary authority. In reality, most fixed exchange rate regimes around the world are better characterized as "currency bands" and/or "adjustable pegs", where some room for exchange rate movement and/or realignment is allowed. Incorporation of these possibilities will complicate the analysis without affecting the essence of the solutions.

On the other hand, there does exist in the real world exchange rate regimes that are literally "fixed" and have strict rules governing their operations—viz., currency boards. [See Appendix for a brief description of their salient features.] In fact, under this rule-based monetary system, such operational (e.g., reserve backing and exchange rate parity) rules are like laws written in stone.[7] Although there is no explicit statement as to how the monetary authority will be penalized if it fails to abide by the rules, the perceivable costs involved in altering these rules are by no means minor. The deterring effects of these costs are comparable to those of the reputational constraint considered in Section 3.1.

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[6] In addition, we should set the intercept term $W_0 = -\beta\bar{\varepsilon}^2 = -[\alpha(\alpha\varepsilon^e + u + d)]^2/\beta < 0$. It may not make sense to pay the central banker a negative lump-sum while penalizing her/him for deviations from the peg. But since the lump-sum component does not really affect the central banker's marginal choice between sticking to the peg and switching to the float, we can add an arbitrary constant to convert it into a positive sum without affecting the results.

[7] For instance, Article 111 of the Basic Law of the Hong Kong Special Administrative Region of the People's Republic of China states that *"... [T]he authority to issue the Hong Kong currency shall be vested in the Government of the Hong Kong Special Administrative Region. The issue of the Hong Kong currency must be backed by a 100% reserve fund. The system regarding the issue of the Hong Kong currency and the reserve fund system shall be prescribed by law. ..."*

Does it mean then that self-fulfilling attacks on currency boards can never occur? Under the *classical* currency board, the monetary base is fully backed by foreign reserves so that its convertibility is guaranteed. Coupled with a fractional reserve banking system with a money multiplier larger than unity, however, convertibility of the money supply is not similarly assured. This suggests that if a currency crisis should ever occur due to internal drains (rather than external attacks), it will be accompanied by bank runs. Under our theoretical framework where the public knows for sure the determination and ability of the central banker in maintaining the fixed parity, fortunately, such attacks can be ruled out by the same three solutions examined in the previous section.[8]

Could we thus rest assured that, with a credible and strong (in terms of reserves and other economic fundamentals) government and with either one of these preventive measures in place, currency boards will be free from attacks? A glimpse at the recent history of Hong Kong at the height of the Asian financial crisis suggests, unfortunately, that the answer is negative. In October 1997 and again in August 1998, even with its high reserves and sound banking system, the economy's currency (the Hong Kong dollar, HKD) was attacked by foreign speculators, who, in retrospect, might not have expected their actions to induce any sizable depreciation at all. What then motivated them to attack the HKD in the first place? The answer probably lies in their perfect understanding of the operation of the currency board system. Under the system, any attack on the HKD would reduce liquidity in the banking system and thus drive up the interest rate through an automatic adjustment mechanism. Given the negative correlation between the interest rate and stock prices, this would lead to a drop in the prices of Hong Kong stocks. Seeing through such correlation, speculators could therefore engineer a "double market play" to make profits by attacking the HKD in the foreign exchange market on the one hand and short-selling Hong Kong stocks in the market for stock futures on the other—without actually causing a collapse

[8]If the government views a bank run as inflicting extra costs on the society, then such costs will appear as an extra term in its loss function, thus making it less likely to abandon the fixed parity. In formulating its policy, it will have to be more cautious and to take into account the possibility of triggering bank runs by its exchange rate policy. See Kaminsky and Reinhart (1999) for an analysis of the co-existence of financial and banking crises in general, and Ho (1999) for such analysis in the context of a currency board.

in the HKD.[9] [See Chakravorti and Lall (2000) for a theoretical analysis of this double play.] These episodes suggest that depreciation expectations is not a necessary condition for a currency attack.[10] What is necessary instead is the existence of some sort of expected profits resulting from the attack.

Obviously, the preventive measures analyzed in Section 3 above do not work here. Two questions immediately come to mind. First, could regular pegs also encounter the "double market play" type of attack? Second, what other measure(s) could prevent such attacks?

Regarding the first question, the answer is "yes, but not absolutely necessary." The difference with regular pegs is that the government could choose to use (sterilized) foreign exchange intervention rather than (active) increase in interest rate as a defensive device—so that the expected sharp rise (drop) in interest rates (stock prices) may not materialize to generate profits for the speculators. If the government choose to rely on active interest rate defense instead, however, speculators would still have room to manipulate a double play. Our argument here thus strengthens Flood and Jeanne's (2000) conclusion that raising the interest rate could hasten the speculative attack.[11]

Regarding the second question, it has been noticed that the sharp rise in interest rates in Hong Kong when its currency was attacked in 1997 and 1998 was not merely a natural consequence of auto-piloting, but also a reflection of a confidence problem—i.e., depreciation expectations—arising from the discretionary intervention of the Hong Kong Monetary Authority (HKMA) in the currency market in 1997 and in the stock market in

[9]These speculators were ultimately fended off by the Hong Kong Monetary Authority through an intervention in the spot market for Hong Kong stocks.

[10]The existence of large players such as Soroi are also not necessary. Such attacks can be initiated either internally or from outside and either by unconcerted efforts among a large group of small players or by large players. It is debatable whether to classify them as "fundamental" or "self-fulfilling"—as one could argue that they arise from a fundamental problem with the system's over-reliance on interest rate arbitrage as an adjustment mechanism.

[11]Their analysis is conducted in a Krugman-type (1979) first-generation model, where it is shown that while increasing domestic interest rate can make domestic assets more attractive, it will at the same time weaken the domestic currency by increasing the government's fiscal liabilities and thus motivate speculative attacks when the economy is fiscally fragile.

1998. Instead of demonstrating its determination and ability to defend the HKD-USD link, the interventions raised suspicion among the local people about the HKMA's confidence in the currency board system itself (which is supposed to be rule-bound and discretion-free). As a costly signal to show its commitment to the public, the HKMA should, Chan and Chen (1999) propose, issue an HKD put option at an exercise price equal to the official HKD/USD exchange rate of 7.8 with a 3-month to 6-month maturity (followed by new issues of similar options). They (Chan and Chen 2000) also show in a theoretical model how using such a signalling device will help induce a separating equilibrium and rule out self-fulfilling attacks on currencies with relatively good fundamentals and governments with strong determination to keep the link. In a nutshell, issuing such options is like providing "convertibility insurance" to lower the public's devaluation expectations. This proposal has been subject to heated debate among academics and policy-makers in Hong Kong. Lui, Cheng, and Kwan (2001) argue forcefully that it turns out to be the ultimate winner.[12]

But so far as the convertibility insurance proposal is related to the solution of the devaluation bias, the infamous time inconsistency problem remains. In particular, how can the government, however benevolent and well-intentioned, guarantee that it will never renege on such insurance just like it always has the temptation to default on public debt in its optimal fiscal policy design? We therefore surmise that a combination of the solutions we consider in Section 3 and this insurance proposal will enhance the workability of the latter. The issues here involve the explicit role of foreign reserves and asymmetric information between the government and the public about the former's preferences and constraints, to which the simple theoretical framework we have been using is not easily amenable. We shall therefore leave these complications for future research.

[12] They view that, in addition to strengthening the interest rate arbitrage mechanism, the so-called "technical" measures introduced by the HKMA in September 1998 are functionally equivalent to such convertibility insurance. Using credibility measures extracted from financial market data, they show how the implementation of this proposal has put the HKMA back on a rule-bound track and made the auto-piloting mechanism effective again.

5 Conclusion

- Should rewards be better than punishment (as the psychologists would believe)?
- What about Malaysian-type capital and/or exchange controls as a preventive measure?
- Could asymmetric information between the public and the monetary authority about the latter's determination and ability give rise to self-fulfilling attacks on fixed exchange rates? If so, what preventive measures are needed?
- Can same preventive measures rule out self-fulfilling attacks of the type (balance sheet effects) emphasized by third-generation models *à la* Krugman (1999)?

6 Appendix: Salient features of currency boards

Fixed exchange rates are seldom 'fixed' literally. Instead, they typically have explicit finite bands (sometimes called 'currency bands' or 'target zones') within which exchange rates are allowed to fluctuate without any central bank interventions. For instance, the bands were $\pm 1\%$ around dollar parities under the Bretton Woods System and $\pm 2.25\%$ around bilateral central rates against member currencies under the European Monetary System. On the other hand, there does exist in reality an extreme form of 'fixed' rate regime where the rate is rigidly fixed at some level without any bands around it. One such example is the linked exchange rate regime under the currency board system as currently adopted by Hong Kong, Argentina, and some East European countries.

Under pure currency boards, there are rigid reserve backing rules that govern the issuance of currency and legal restrictions on revisions of exchange rates and on the discretionary use of other policy tools. In this sense, a currency board can be interpreted as a rule-based monetary system that serves to establish credibility in exchange rate stability. In outlook, however, the "standard pegs" and the "linked rate" are so similar that many people fail to make the distinction and simply think of them as one and the same system, thus leading to a lot of confusions in the debate about the merits of the latter *vis à vis* the floating rate regime. [See, e.g., Roubini (1998).]

One major difference between "currency boards" and "currency bands" lies in the adjustment mechanism that will be triggered whenever the otherwise market equilibrium exchange rate deviates from the target rate in the former case and from the (upper and lower) bands in the latter. In the former case, the disequilibrium (over- or under-valuation of the domestic currency) will be eliminated through an automatic adjustment in the domestic interest rate—i.e., through market forces.[13] In the latter case, the disequilibrium has to be

[13] Under devaluation pressure as when there is a fall in private demand for domestic currency in the FX market, for instance, there exists arbitrage opportunities for those who care to buy up the domestic currency 'cheaply' at the prevailing ER from the FX market and turn around and sell it 'dearly' at the official ER to the monetary authority issuing the currency. These arbitrage activities will set in motion a fall in the supply of domestic currency, which will induce in turn a rise in the domestic interest rate, making it more attractive to hold the domestic currency (i.e., releasing the pressure of devaluation). The reverse argument

corrected through central bank interventions in the foreign exchange market and/or active use of interest rate policy as a defensive device—i.e., through artificial forces. One implication of this difference is that a country adopting an orthodox currency board need not have a central bank. As a consequence, there is no room for monetary policies and there is no lender of last resort under a classical currency board system.

In summary, the distinct features of a *pure* or *classical* currency board include:

- reserve backing rule: 100% backing of the monetary base by foreign exchange reserves, hence full convertibility of M_0, which implies restrictions on currency issuance and credit creation;

- commitment to exchange rate parity: an explicit legislative commitment to exchange domestic currency for a specified foreign (reserve) currency at a fixed exchange rate (the 'linked' rate), which implies a legal barrier to exchange rate realignments;[14]

- legal restrictions on the use of other policy tools: restrictions on discretionary monetary policy (esp. monetary financing of fiscal deficits), which implies fiscal discipline and

- absence of traditional central bank functions such as monetary operations, banking supervision, and lender of last resort;

- adjustment mechanism in case of deviation of market rate from the linked rate: through automatic adjustments in domestic interest rates induced by foreign exchange arbitrage rather than through central bank intervention in the foreign exchange market

In practice, instead of being bound rigidly by the above features, *modern* currency boards that exist today may diverge in one way or another from this 'pure' or 'classical' benchmark. In particular, they may differ with respect to their detailed arrangements:

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holds when there is pressure for revaluation.

[14]Excess reserves must be used in a way that subordinates concerns over monetary and banking sector developments to the objective of preserving the exchange rate parity.

- exchange rate rule: choice of reserve currency, target level of the linked rate, extent of access to convertibility at the monetary authorities, and degree of foreign exchange control;

- backing rule: coverage of backing, set of assets eligible for backing, and the power of the monetary authority to change the exchange rate rule and the backing rule; and

- profit transfer rule for seigniorage revenue earned from the foreign reserves.

In addition, modern day currency boards may vary by the details of their central banking operations in terms of the set of monetary instruments (such as reserve requirements, liquidity requirements, rediscounts and advances, Treasury bills, etc.), the payments system, as well as Treasury operations (including operations in relation to government deposits and credit to government by the monetary authorities). Last but not least, they may differ according to their prudential arrangements (i.e., the existence of a supervising/regulatory agency for banks and of deposit insurance and other prudential measures) and the availability of lender-of-last-resort facilities. In other words, while preserving the benefits of credibility offered by the essentially rule-based system, some flexibility is built into the working of these "*quasi* currency boards" of today. [See Baliño et al. (1997) and Schwartz (1993) for further details.]

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