Financial Sector Development and Self-fulfilling Currency Crises

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Abstract: We build a model of a fixed exchange rate regime with escape clauses and output persistence. In the spirit of the literature following the Asian crisis in 1997, persistence in our model arises from the inability of the domestic financial institutions to intermediate international credit. Our main message is that since persistence generates long run credibility effects that are sensitive to the prevailing policy preferences, the choice of an optimal exchange rate regime and the preference for a policy target should reflect the degree of development of the domestic financial institutions. If the domestic financial market suffers from credit constraints that generate persistence, the likelihood of self-fulfilling currency crisis may be reduced if the government assigns a greater weight on the output stabilisation objective. However, if financial market liberalisation successfully eliminates the credit constraints, liberalisation should be associated with a switch in policy preferences more in favour of exchange rate stability.

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1. Introduction

The experiences from the collapse in the 1990's of several fixed exchange rate regimes in Europe and in emerging market countries have generated renewed interest towards research in currency crises. In particular, a considerable amount of work has been devoted in the past few years to analyse the link between financial crises and currency crises.[1] Indeed, the experiences from the currency crises in Scandinavia in the early 1990's and in Far East in 1997 suggest that vulnerability to crisis may be intensified not only by structural rigidities in the labour market but also by financial market imperfections. Such a view is also supported by the influential research programme on the role of credit constraints in economic fluctuations. From the Bernanke's and Getler's (1989) seminal article to the recent contributions such as Kioytaki and Moore (1997), Aghion, Bacchetta, and Banerjee (1999a) and Caballero and Krishnamurthy (1999), this research suggests that the financial link is perhaps *the* source of the output persistence and instability of open economies.

Another insight arising from the recent research (see e.g. Guzzo and Velasco, 1999) is that in the presence of severe market rigidities, monetary policy that is oriented towards output stability moderates wage claims, lowers expected inflation and improves social welfare. In general, there seems to be increasing consensus that market imperfections and output persistence may make a case for an activist government policy.[2] In the context of fixed exchange rate regimes, this gives rise to a presumption that a monetary authority that is too heavily biased towards maintaining exchange rate stability may actually find it difficult to defend a currency peg if the domestic financial and economic institutions are underdeveloped.

The models inspired by the currency crises in 90's generally focus on the interaction between depositors and banks in an international context and in so doing, they do not incorporate the monetary authority's potential trade-off between several objectives as a separate argument. The aim of this paper is to elaborate on the optimal exchange rate policy in an economy that is characterised by financial market distortions leading to output persistence. We first show how the model of optimal monetary policy under output persistence used, for instance, in Svensson (1997, 1999), can be explained by the financial market imperfections that restrict the amount of

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[1] This work is sometimes classified as the "third generation" model of currency crises. See Jeanne (1999) for an excellent survey of currency crisis models and a discussion on the taxonomy. We agree with Jeanne (1999) that this "generation" terminology is often misleading.
[2] Besides Guzzo and Velasco (1999), this conclusion is unavoidable from Blanchard and Wolfers (1999).

foreign capital in an economy. We then generalise this model to include the "escape clause" approach to currency crises. This approach, which tends to be associated with Obstfeld (1994, 1996, 1997), has formalised the conventional wisdom that even though a reversible commitment to a fixed currency peg renders monetary policy vulnerable to speculative attacks, it lowers the average rate of expected depreciation. We argue that the scope in which the conventional wisdom holds is somewhat restricted, as introducing fixed costs of currency realignment reduces the expected depreciation only when a devaluation is known to be more costly than a revaluation. This suggests that in countries with a history of frequent devaluations the quasi-fixed exchange rates may actually only lead to higher expected depreciation and lower social welfare.

The principal message of our analysis, however, deals with the impact of financial market imperfections on the credibility of a fixed exchange rate regime. Provided that the credit constraints are sufficiently severe, the credibility of a currency peg can be increased if the government assigns greater weight on the output stability objective relative to exchange rate stability *per se*. This happens because in a dynamic analysis, an increasing level of financial market frictions makes the optimality of a floating exchange rate regime more evident if output stabilisation is neglected. Shocks that are not properly stabilised in the first period of the game will cumulate in the second period, thus increasing the government's long run temptation to abandon the peg, making the regime over time vulnerable to speculative attacks. In contrast, knowledge that the government is *ex ante* willing to put effort on stabilising shocks may reduce the expected rate of depreciation and thus the likelihood of speculative attacks.

In addition to being able to confirm our *ex ante* argument on the potential benefits of more activist policy in the presence of severe financial market constraints, our analysis also yields some policy recommendations for the institutional design of financial market liberalisation. In particular, if the credit constraints and persistence are to be eliminated by opening up the domestic lending market for fully developed foreign financial institutions, the credibility of the exchange rate regime can be improved by appointing a "conservative" monetary authority. This is in line with the traditional policy delegation result. However, if the financial sector is allowed to develop more gradually under domestic ownership with a transition period when the economy is characterised by credit constraints and persistence, credibility can be improved under a less "conservative" monetary authority. Under fixed exchange rate regimes, changes in the financial market structure should therefore be associated with appropriate changes in the monetary policy regime.

The rest of this article is organised as follows. The model of self-fulfilling currency crisis with financial market imperfections is introduced in the next section. In section 3, we analyse the role of these frictions in determining the credibility of a fixed exchange rate regime. The concluding remarks are in section 4.

2. The Model

In the spirit of the research tradition on the financial market imperfections and business cycles following Bernanke and Gertler (1989), the source of output persistence is in our model a constraint on the entrepreneurs' ability to obtain outside funds and invest. This constraint can be justified by, for instance, costly state verification, moral hazard temptations and weak corporate governance hindering efficient monitoring.[3] We introduce this financial market friction by assuming that the entrepreneurs can borrow at most a fraction $n \in [0,1]$ of their expected future revenues. As in some recent literature (see e.g. Aghion, Bacchetta and Banerjee, 1999b, Burnside, Eichenbaum, and Rebelo, 1999, and Caballero and Krishnamurthy, 1999), we highlight the capacity of financial markets to intermediate international finance. For brevity, we take the starkest possible approach, as the lending in our model can only be extended by the foreign investors. This assumption also considerably simplifies our analysis of the optimal monetary policy under imperfect financial markets, which is an issue inadequately addressed in the previous literature. As a result of the assumption, we can identify n as a degree of financial market development of the economy in obtaining funds from the international capital markets. The entrepreneurs' debt capacity at period t, D_t, is thus determined by

$$D_t \le \frac{n y_{t+1}^e}{R}, \tag{1}$$

where R is the international interest rate which is assumed to be constant, and y_{t+1}^e is the expected output formed by the foreign investors at period t and defined as $y_{t+1}^e = E_t\left(y_{t+1}\right)$.

Assuming a linear production technology, we can aggregate across the entrepreneurs, and the aggregate output can be determined as a function of previous period's investment and short-run monetary policy effects according to the following augmented Phillips-curve:

$$y_t = pI_{t-1} + p_t - p_t^e + z_t \,. \tag{2}$$

In (1), y_t denotes output, I_{t-1} is the aggregate investment level in period t-1 and $p > R$ stands for productivity of this investment, p_t is the inflation rate and p_t^e is the expected inflation of the private sector (p_t^e = $E_{t-1}(p_t)$). Under *PPP*, the inflation rate is equal to the realised rate of currency depreciation (defined as $e_t - e_{t-1}$, where e_t denotes the nominal exchange rate). Finally, z_t is a stochastic output shock with $E(z_t) = 0$ and $VAR(z_t) = s_Z^2$. In the absence of shocks and policy surprises, *i.e.* when $p_t = p_t^e$, output is at the natural rate which amounts to the previous period's investment only.[4]

As, for instance, in Kioytaki and Moore (1997**,** Aghion, Bacchetta and Banerjee (1999a,b), and Caballero and Krishnamurthy (1999), the amount of investment in every period is determined by the entrepreneurs' income and ability to borrow. The entrepreneurs' budget constraint is given by

$$y_t + D_t = I_t + RD_{t-1} \,, \tag{3}$$

where the assets are in the left-hand side and the liabilities in the right-hand side. With rational expectations, $E_t(y_{t+1}) = pI_t$, so that when entrepreneurs are credit constrained, $D_t = npI_t/R$. Clearly, the entrepreneurs are credit constrained as far as $D_t < I_t$ or, equivalently, $n < R/p$. When n is sufficiently high ($n \geq R/p$), the investment level is independent on current output. [5]

[3] For an account of a link between corporate governance and currency crises, see Johnson, Boone, Breach and Friedman (1999).

[4] We resort to this version of the aggregate Lucas-type supply function in order to make our model comparable to the research tradition in monetary policy following Barro and Gordon (1983). In this tradition, the supply function is usually derived under assumptions on labour market frictions. However, a similar supply function can easily be obtained from the financial market considerations alone as shown in Jeanne (1999).

[5] If n^3R/p, the credit constraint vanishes, and the investment level D_t=I_t is determined by the supply of international finance and the international interest rate. For our purpose there is no need to explicitly analyse this case; it is sufficient to note that when the activities in the economy are unconstrained, there is no persistence in output.

Assume now that debt contracts can be written contingent on the output so that $D_{t-1} = ny_t/R$. when the credit constraint is binding. This assumption not only simplifies our set-up, but it can also be shown that it is in general optimal to index debt contracts (see e.g. Krishnamurthy, 1998). Note that even though the level of debt is increasing in the inflation rate (via y_t, due to the contingency assumption), debt is hedged against the changes in the *real exchange rate*. The budget constraint can now be rewritten as $y_t + \frac{npI_t}{R} = I_t + ny_t$. Solving for I_t yields

$$I_t = \frac{(1-n)y_t}{1-np/R}. \tag{4}$$

The fact that the current investment depends on current output when the financial market is underdeveloped (i.e. when $n<R/p$) generates persistence in output. By some minor manipulation, (4) can be rewritten as

$$pI_{t-1} = \frac{p(1-n)y_{t-1}}{1-np/R}. \tag{5}$$

Now substituting (5) for (2) yields

$$y_t = ry_{t-1} + p_t - p_t^e + z_t, \tag{6}$$

where $r = \frac{p(1-n)}{1-np/R} < 1$. In other words, in every period the natural rate of output amounts to the rate of which the previous period's output carries over due to the economy's inability to clear. This rate, captured by r, in turn is a decreasing function of the degree of financial market development, that is, $dr/d\text{v}<0$. We have therefore arrived at the supply function with output persistence that has recently been applied e.g. by Jeanne (1997, 1999) and Svensson (1997, 1999). In those models, the presence of persistence is usually explained by referring to the labour market-based microfoundations derived by Lockwood and Philippopoulos (1994). We do not deny the importance of labour market frictions but just provide alternative, and especially in the context of fixed exchange rate regimes (nowdays often associated with emerging markets) perhaps even more relevant, explanation of output persistence in this supply function.

Given the supply function and the institutional set-up of the game, the government chooses the rate of currency depreciation in order to minimise a standard loss function that is quadratic in both output and inflation (currency depreciation). We assume that the economy's transmission mechanism is fully known and such that the government can directly control the inflation rate and, due to the PPP assumption, the exchange rate. Government's loss function is then given by

$$L_t = \frac{1}{2}\left[l p_t^2 + (y_t - y^*)^2 + C(p_t) \right], \tag{7}$$

where $l > 0$ is the relative weight assigned by the government on the respective policy objectives. We assume that the private sector knows the government's preferences, *i.e.* there is no uncertainty about l.[6] The standard time-inconsistency problem is here captured by assuming that y^*, government's target level of output, is higher than the natural rate. Therefore, under a finite l and under *discretionary* policymaking the government has an incentive to generate policy surprises. Under a *fixed exchange rate rule* the government commits *ex ante* to a zero rate of depreciation so that $p_t = 0$.[7]

In practice, a binding commitment to a fixed exchange rate regime is hardly possible. Instead, what we observe could be called "fixed-but-adjustable" regime, where the government can utilise some escape clause that allows it to abandon the fixed currency peg in the aftermath of an exceptionally large output shock. The purpose of the commitment is, however, to temper the credibility problem by rendering the exercise of such an escape clause option costly. These costs are captured by the last term $C(p_t)$ in government's loss function (7). More specifically, the government has placed itself in a position where any upward change in e_t (a devaluation,

[6] Together with the assumption that the transmission mechanism is known, this could reflect a situation where the economy's political and economic features have become familiar to the different parties of the economy, perhaps over a longer period of time.

[7] The literature on optimal central bank institutions (Rogoff 1985, Lohmann 1992, Walsh 1995, Svensson 1997 and others) analyses the case where government tries to move from the discretionary equilibrium towards the time-inconsistent optimal policy rule by explicitly delegating monetary policy to an agent with different preferences and/or targets. The equilibrium time-consistent inflation rate under an optimally designed monetary institution is lower than under government's discretion.

implying that $p_t > 0$) has a cost of $C(p_t) = c_d$ whereas any downward change in e_t (a revaluation, implying $p_t < 0$) has a cost of $C(p_t) = c_r$.[8]

The timing of events is as follows. (i) The private sector rationally forms its expectations on the future rate of depreciation, knowing that period's level of investment and the government's output target y^*. (ii) The output shock is realised. (iii) The government makes the realignment decision. If the government opts for discretionary monetary policy (floating exchange rate), the external value of the currency is determined by private sector expectations only. In other words, the government chooses the money supply rate and thereby the rate of depreciation, after observing the shock and taking the expectations as given.[9] The government's strategy can thus be expressed as functions of y_{t-1}., that is, the intertemporal decision problem has the following form:

$$V(y_{t-1}) = \min_{p} E_{t-1}\left[L_t + dV(y_t)\right]. \tag{8}$$

We start with analysing the set of actions following the decision to abandon the fixed currency peg. When choosing the optimal money supply rate, the government takes into account that changes in *current* output will affect *current expectations* of future inflation through $V(y_t)$. Minimising (8) with respect to p_t and subject to (6) gives the following first-order condition,

$$l p_t + (y_t - y^*) + d\frac{\partial V(y_t)}{\partial y_t} = 0\,. \tag{9}$$

As the problem is linear-quadratic, we can conjecture that the value function takes the following quadratic form:

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[8] Following the majority of the literature (e.g., Obstfeld 1994, 1996, 1997, Jeanne, 1997, 1999) we regard these fixed costs as exogenous. An exception is De Kock and Grilli (1993) who demonstrate how the costs can be interpreted as the political cost of government from breaking the commitment to the exchange rate peg. Their argument, however, resorts to such a punishment strategy that violates the assumptions underlying the Markov-perfect equilibrium concept used here (cf. footnote 6). An alternative explanation could be that a deviation from the rule incurs a direct cost on government if it has issued foreign currency debt denominated in domestic currency (For a related argument, see Bohn, 1990).

[9] Note that the autoregressive term ry_{t-1} will introduce past output as a state variable. We restrict our attention to Markov-perfect equilibria where strategies at date t depend on the past only through this payoff-relevant state variable y_{t-1}. Making this common restriction involves in our framework a substantial advantage of excluding the strategies that directly depend on the realignment decision (cf. footnote 5).

$$V(y) = g_0 + g_1 y + \frac{1}{2} g_2 y^2 . \qquad (10)$$

Substituting for $V(y)$ and writing (9) in terms of depreciation we obtain that on period t, the rate of depreciation under a floating exchange rate regime is

$$p_t^{Float} = \frac{y^* - a - b\bar{y}_t}{l + b}, \qquad (11)$$

where $a = dg_1$, $b = 1 + dg_2$, and $\bar{y}_t = ry_{t-1} - p_t^e + z_t$. Constants a and b are to be determined later, but taking them as given for a while enables us to characterise the equilibrium *without* output persistence. This is the standard case: the rate of depreciation under free float is the higher the higher is the government's output target (and thus the more severe is the time-inconsistency problem). Furthermore, the rate of depreciation is decreasing in l and in $\bar{y}_t$, so that *ceteris paribus* a higher priority assigned on the exchange rate objective and a lower expected rate of depreciation lead to lower realised depreciation. Substituting (11) back into equation (6) gives the output rate under a free float:

$$y_t^{Float} = \bar{y}_t + p_t = \frac{l\bar{y}_t + y^* - a}{l + b}. \qquad (12)$$

Again, if constants a and b were given, one could conclude from (12) that output under free float would be increasing in y^* and decreasing in l as could be expected.

If the government is able to commit itself to a fixed exchange rate regime, the rate of depreciation is zero. From (12) it is then straightforward to solve that output under fixed rate regime is

$$y_t^{Fix} = \bar{y}_t . \qquad (13)$$

Ignoring the fixed costs of currency realignment, we can use (7), (11), (12) and (13) to calculate the government's expected *per period* welfare loss under fixed and floating exchange rates, respectively:

$$L_t^{Fix} = \frac{1}{2}\left(\bar{y}_t - y^*\right), \tag{14a}$$

$$L_t^{Float} = \frac{1}{2}\left[l\left(\frac{y^* - a - \bar{y}_t b}{l+b}\right)^2 + \left(\frac{l\bar{y}_t + y^* - a}{l+b} - y^*\right)^2\right]. \tag{14b}$$

When there are no options of altering the exchange rate, the government's overall *per period* loss is lower than under discretion. The difference between the two equilibrium loss levels is decreasing in l, the weight assigned by the government on the low depreciation objective. Thus, l inversely measures the degree of government's commitment problem. From (8) and (14) we can now get the equilibrium intertemporal loss functions under the two regimes:

$$V^{Fix}\left(y_{t-1}\right) = E_{t-1}\left[\frac{1}{2}L_t^{Fix} + dV^{Fix}(y_t^{Fix})\right], \tag{15a}$$

$$V^{Float}\left(y_{t-1}\right) = E_{t-1}\left[\frac{1}{2}L_t^{Float} + dV^{Float}(y_t^{Float})\right]. \tag{15b}$$

We now turn to analyse the role played by the fixed costs of currency realignment, $C(p_t)$. Given those costs, the authorities would deviate from the fixed exchange rate regime only when z_t, the stochastic output shock, is low enough so that V^{Fix}-V^{Float}> c_d (in which case currency is devalued), or high enough so that V^{Fix}-V^{Float}> c_r (in which case currency is revalued). Invoking *the unimprovability principle* of dynamic programming, it is sufficient to consider one-period deviations only, and we can rewrite both intertemporal loss functions in (15) by using the same functional form given above in equation (10) as

$$V^{Fix}\left(y_{t-1}\right) = E_{t-1}\left[\frac{1}{2}L_t^{Fix} + d\left(g_0 + g_1 y_t^{Fix} + \frac{1}{2}g_2 {y_t^{Fix}}^2\right)\right], \tag{16a}$$

$$V^{Float}\left(y_{t-1}\right) = E_{t-1}\left[\frac{1}{2}L_t^{Float} + d\left(g_0 + g_1 y_t^{Float} + \frac{1}{2}g_2 {y_t^{Float}}^2\right)\right]. \tag{16b}$$

Inserting (12), (13) and (14) into (16), and employing the definition of $\bar{y}_t \equiv ry_{t-1}-p_t^e+z_t$, the conditions V^{Fix}-V^{Float}> c_r and V^{Fix}-V^{Float}> c_d can be simplified to

$$\bar{z} = \frac{y^* - a + \sqrt{2c_r(l+b)}}{b} - ry_{t-1} + p_t^e, \tag{17a}$$

$$\underline{z} = \frac{y^* - a - \sqrt{2c_d(l+b)}}{b} - ry_{t-1} + p_t^e. \tag{17b}$$

Equation (17) determine the range of output shocks in which the exchange rate peg is optimally defended. If the shock realisations are small, $z_t \in [\underline{z}, \bar{z}]$, the fixed exchange rate is maintained. For given devaluation expectations, a revaluation occurs when $z_t > \bar{z}$ and devaluation occurs when $z_t < \underline{z}$. Encountering sufficiently large shocks, the government prefers incurring the fixed costs of currency alignment in order to stabilise output. Clearly, the higher are c_r and c_d, the more vigorously the government is expected to defend the peg against the shocks. In addition, taking *a* and *b* as constant, the range $z_t \in [\underline{z}, \bar{z}]$ is increasing in *r* and hence decreasing in *n*, the degree of financial market development. In addition, it is increasing in *l*, the weight assigned on the exchange rate objective under the fixed-but-adjustable regime. The crucial feature of our model is, however, that *a* and *b* are functions of the parameters of the model, including *l*. We must thus solve for *a* and *b* before we can make any definite conclusions about the characteristics of the equilibrium. We return to this point in the following subsection upon determining p_t^e, the private sector's devaluation expectations.

The essence of the fixed-but-adjustable regime is that the government holds an option to abandon the currency peg in "exceptional circumstances", that is, in circumstances where a large output shock has realised. In other words, the government implicitly defines "trigger shocks" that release the escape clause and the decision to switch from a fixed to a floating exchange rate regime, as equation (17) manifests. These trigger shocks have to be incorporated in the rational expectation for inflation and thus depreciation. The expected depreciation is thus a function of both the expected shocks and the "trigger shocks" defined as

$$E_{t-1}p_t = E_{t-1}(p_t | z_t < \underline{z})P(z_t < \underline{z}) + E_{t-1}(p_t | z_t > \bar{z})P(z_t > \bar{z}),$$

where P denotes probability. As is characteristic for the escape clause approach, expected inflation enters here both in determining the inflation rate conditional on realignment, and in determining the probability of realignment. Since the *ex post* equilibrium inflation depends on expected inflation and on past output, there is a possibility of multiple equilibrium expected inflation rates under the "fixed-but-adjustable" exchange rate scheme. Assuming that the output shock z_t is uniformly distributed on [$-Z/2$, $Z/2$], the equilibrium expected depreciation reads in terms of $\bar{z}$ and $\underline{z}$ as

$$E_{t-1}p_t = \int_{-Z/2}^{\underline{z}} p_t^{Float}(z) f(z)dz + \int_{\bar{z}}^{Z/2} p_t^{Float} f(z)dz. \tag{18}$$

The substitution of (11) for $p_t^{Float}(z)$ in (18) yields

$$E_{t-1}p_t = \frac{1}{l+b}\left\{\left[y^* - a - b\left(ry_{t-1} - p_t^e\right)\right]\left(1 - \frac{\bar{z}-\underline{z}}{Z}\right) + \frac{b}{2Z}\left(\bar{z}^2 - \underline{z}^2\right)\right\}. \tag{19}$$

The equilibrium expected rate of depreciation depends on the relationships between $\bar{z}$, $\underline{z}$ and Z. We now make a small but informative departure from the previous literature and derive the expected rates of depreciation explicitly. From (17), we see that

$$\bar{z} - \underline{z} = \frac{\sqrt{l+b}}{b}\left(\sqrt{2c_r} + \sqrt{2c_d}\right), \tag{20a}$$

$$\bar{z}^2 - \underline{z}^2 = \frac{2}{b}\left[\sqrt{l+b}\left(\sqrt{2c_r} + \sqrt{2c_d}\right)\left(\frac{y^* - a}{b} + p_t^e - ry_{t-1}\right) + \frac{l+b}{b}\left(c_r - c_d\right)\right]. \tag{20b}$$

Inserting (20) into (19) gives us an explicit form for the expected rate of depreciation:

$$E_{t-1}p_t = \frac{1}{l}\left(y^* - a - bry_{t-1} + \frac{l+b}{bZ}\Delta c\right). \tag{21}$$

In (21) $\Delta c = c_r - c_d$ approximates *the devaluation premium* in expectations that is caused by the relative cost to be paid by the government if it reneges from its commitment. The premium is positive if the cost of devaluation is lower than the cost of revaluation, because then the government is expected to be relatively apt to devalue its currency. As it stands, equation (21) displays how the existence of multiple equilibria hinges on cost asymmetry, $\Delta c \neq 0$. If the costs are of equal size, the expected rate of depreciation simply equals to the expected rate of depreciation under free float, which can be obtained by setting $\Delta c = 0$ in (21).

The impact of the devaluation premium on the optimal monetary policy can be demonstrated in detail by substituting (21) for p_t^e in (11) and imposing rational expectations $p_t^e = p_t^{Float}$. The optimal rate of inflation under the discretionary monetary policy can thus be written as

$$p_t^{Float*} = \frac{1}{l}\left(y^* - a - bry_{t-1} + \frac{\Delta c}{Z} \right) - \frac{bz_t}{l+b}, \tag{22}$$

where a and b are still to be determined. We can now obtain the *average* inflation rate by substituting $p_t^{Float*}(z)$ from (22) for $p_t^{Float}(z)$ in (18). This exercise confirms that in the rational expectation equilibrium the actual average inflation rate equals the expected inflation rate displayed in (21). By noting that the policy outcome under free float follows by letting $\Delta c = 0$ in (21), we can easily prove the following claim.

PROPOSITION 1. *Under the fixed exchange rate regime with escape clauses, the average rate of inflation and depreciation is lower (higher) than in the floating exchange rate regime only when devaluation involves larger (smaller) fixed costs than revaluation.*

The explanation of Proposition 1 is straightforward. Equation (22) characterises the optimal monetary policy when the economy encounters large output shocks ($z_t < \underline{z},\ z_t > \bar{z}$). In such circumstances, the government optimally abandons the exchange rate peg even if there are fixed costs associated with such an action. Otherwise, the fixed rate is maintained. However, if the abandonment of the peg is known to be less costly when the exchange rate has become overvalued rather than undervalued ($\Delta c > 0$), this fact is incorporated in the expectations as one can see from (21). In such circumstances, the policy surprises must be relatively large to generate the desired output effects. In other words, even though the rate of depreciation is zero in the "fixed-but-adjustable" regime under small output fluctuations ($z_t \in [\underline{z}, \bar{z}]$) the average rate of depreciation will be higher due to the premium in expectations. Therefore, the widely held view in the literature that a fixed exchange rate regime with escape clauses may lead to a lower average rate of inflation thus only holds when it is known that $\Delta c < 0$.

3. The Credibility of Fixed Exchange Rates with Underdeveloped Financial Markets

In this section we return to our primary interest and study how the degree of financial market development influences the determination of the exchange rate regime. By prohibiting the market from clearing every period, credit constraints and output persistence worsen the economic fundamentals and thus affect not only the limits at which the government decides to abandon the peg and switch to a floating exchange rate regime but also the rate of expected inflation within and outside these limits. In order to establish how persistence affects the government's optimal choice of exchange rate regime, we must first solve for a and b by identifying the value function's parameters g and g. To do this, we first differentiate equation (8) with respect to y_{t-1}. This gives:

$$\frac{\partial V(y_{t-1})}{\partial y_{t-1}} = E_{t-1}\left\{\left[y_t(1+dg_2)+dg_1-y^*\right]\left(1-\frac{b}{l}\right)r\right\}. \tag{23}$$

Remembering that $a = dg$, $b = 1 + dg$ and $E_{t\text{-}1}y_t = ry_{t\text{-}1}$, we can re-write (23) as

$$\frac{\partial V(y_{t-1})}{\partial y_{t-1}} = r^2 b\left(1-\frac{b}{l}\right)y_{t-1} + (a-y^*)\,r\left(1-\frac{b}{l}\right). \tag{24}$$

We first solve for $a = dg$. Upon setting the constant term in (23) equal to g and using some manipulation, we get

$$a = \frac{y^*\, dr\,(b-l)}{l + dr\,(b-l)}. \tag{25}$$

Being merely a constant in the optimal policy rule that is given by (21) and (22), parameter a plays only a limited role in the credibility of the fixed currency regime in the presence of credit constraints. We thus proceed to solve for coefficient b that is essentially the channel whereby past output and the performance of financial market influence current monetary policy. By the definition of $V(y)$ in (10), (24) must equal to $\frac{\partial V(y)}{\partial y} = g_1 + g_2 y$. Equating the coefficients of $y_{t\text{-}1}$ then gives that $g_2 = r^2 b\left(1 - \frac{b}{l}\right)$ or, equivalently, $b = 1 + bb\left(1 - \frac{b}{l}\right)$, where $b = dr^2$ captures the impact of output persistence on b. This has two solutions but, as $b = 1$ when $b = 0$, *L'Hôpital's rule* allows us to exclude the negative root. Solving for the positive root gives

$$b = \frac{-\, l(1 - b) + \sqrt{l^2(1 - b)^2 + 4\, lb}}{2b}. \tag{26}$$

The equilibrium average depreciation rate and the optimal discretionary policy are now fully characterised by (21) and (22) where a and b are given by (25) and (26). We summarise the most relevant aspects of (25) and (26) in the following lemmas. All the proofs are relegated to appendix.

LEMMA 1. If $l > 0$, $b > 0$ and $db/dl > 0$. In particular, it holds that

(i) If $l = 1$, then $l = b = 1$, and $a = 0$.

(ii) If $l > 1$, then $l > b > 1$, and $a < 0$.

(iii) If $l < 1$, then $l < b < 1$, and $a > 0$.

LEMMA 2. The sign of db/dn is determined by the sign of $(1 - l)$.

We are now ready to detect the effect of financial market development on the credibility of the fixed exchange rate regime. Equation (20a) determines the range of output shocks in which the fixed regime is considered as optimal. Abstracting from the constant multiplier $\sqrt{2c_r} + \sqrt{2c_d}$ in (20a), we can concentrate on the effects arising from the financial market rigidities and the preference for output stabilisation.

DEFINITION 1. The measure of credibility of the fixed exchange rate regime is

$$f(l, b(l)) \equiv \frac{\sqrt{l+b}}{b}.$$

We first use this measure to isolate the impacts of output persistence and government's preferences on the credibility of the regime in two lemmas, and then we characterise the relative magnitudes of these impacts in two propositions.

LEMMA 3: $\partial f/\partial b < 0$.

LEMMA 4: $\partial f/\partial l > 0$.

Lemma 4 simply restates the result of the previous literature: In the absence of persistence, a higher weight assigned on exchange rate stabilisation increases the credibility of a fixed exchange rate regime. The main new insight stemming from Lemmas 1-3 can be summarised in the following proposition:

PROPOSITION 2. *An increase in the level of financial market development increases (decreases) the credibility of the fixed exchange rate regime if the government assigns a high (low) relative weight on the exchange rate stability objective, that is, the sign of* $d\phi/d\nu$ *is determined by the sign of (* l-1*).*

The economics of proposition 2 is that the interaction between the government's preferences and the performance of financial market in fact determines the vulnerability of the currency to speculative attacks. Only when a relatively strong weight is assigned on the exchange rate objective ($l > 1$), the credibility of a peg is increasing in the degree of financial market development. From the practical point of view, perhaps the key suggestion of proposition 2 is that the welfare results from removing the sources of persistence are sensitive to the government's preferences. This implies, *inter alia*, that opening up the domestic financial market to foreign lending may be counterproductive if such a move is not preceded by reforms in the domestic monetary policy institutions in favour of "conservative" policy preferences.

Proposition 2 is, however, not as such a statement about the effect of the government's preferences on the credibility of the fixed exchange rate regime. To study this effect we need to take the total derivative of f with respect to l, that is, we are interested in the sign of

$$\frac{df}{dl} = \frac{\partial f}{\partial l} + \frac{\partial f}{\partial b}\frac{db}{dl}. \qquad (27)$$

Lemmas 1 and 3 establish that *the long-run effect* (the last term on the right-hand side) is negative, but we must also take into account that *the short-run effect* (the first term on the right-hand side) is positive by Lemma 4. The common wisdom that "conservative" policy preferences increase exchange rate credibility in fact holds only when there is sufficient access to the international capital markets, as proven by the following proposition.

PROPOSITION 3: *In the presence of severe financial market constraints that gives rise to output persistence, the credibility of the fixed exchange rate regime is higher if the government assigns a greater relative weight on output stabilisation. The threshold level of persistence above which this result holds is implicitly given by* $\bar{b} = 1 - \frac{1}{l+b}$.

In other words, we claim that when the financial market of an economy is underdeveloped, a government that puts a higher priority on output stabilisation relative to exchange rate stabilisation increases the credibility of the fixed exchange rate regime. This finding is somewhat in conflict with the result from the credibility versus flexibility literature (Rogoff 1985, Lohmann 1992), where a government that maintains a tight monetary stance increases society's equilibrium welfare. The conflict arises because the long-run considerations are usually ignored. When the economy is characterised by credit constraints and persistence, insufficient shock stabilisation on a given period has a much higher cost because shocks that are not stabilised will have a negative bearing on future output, thus increasing future devaluation expectations. In contrast, if the government is *ex ante* known to "compensate" for the financial market distortions by putting effort on stabilising the real economy the private sector can scale down its devaluation expectations, thus contributing to a lower probability of speculative attacks against the exchange rate. To sum up, our results envisage two different avenues to increased fixed exchange rate credibility when initially the domestic financial sector is underdeveloped. If the government decides to eliminate the credit constraints "quickly" by allowing fully developed foreign financial institutions to take over the lending market, monetary policy should be geared towards exchange rate stabilisation (the standard credibility versus flexibility result). However, if priority is given to allowing the financial institutions to develop gradually under domestic ownership, sufficient attention must be paid on stabilising the real sector due to the remaining persistence problem.[10]

From an empirical point of view, the series of currency crises in the Nordic countries (Finland, Norway and Sweden) in early 1990's provides a good case where the fixed exchange rate regimes were combined with underdeveloped financial markets and labour market rigidities. In addition to emphasising that in such circumstances the defence of the currency peg was difficult, it can be argued that removing the rigidities in one sector may not have been enough to increase exchange rate credibility. In the Nordic countries the liberalisation of the domestic financial markets was not matched by sufficient reforms in the institutions of monetary policy or labour markets. Drawing from these developments, Honkapohja and Koskela (1999) report how in Finland the liberalisation of capital markets under a fixed exchange rate regime made the domestic sector exceedingly sensitive to changes in the exchange rate. Obviously, this "financial channel" must have been even a more prominent factor behind the series of collapse of the fixed US dollar exchange rate regimes in the Far East in 1997, as the labour markets were not characterised by significant distortions there.

4. Conclusion

Previous research on speculative attacks against fixed exchange rate regimes has detected two basic causes for devaluations. First, the fundamentals may have worsened to the extent at which abandoning the peg becomes a tempting alternative. The second cause follows from a high expected depreciation in itself that, by reducing output under a zero-depreciation commitment, creates an incentive for the government to validate the expectations *ex post* by devaluing the currency. In this article we have analysed how insufficient capacity of domestic financial institutions to intermediate international credit can generate output persistence that increases the vulnerability of a fixed exchange rate regime to speculative attacks. It turns out, that in the

[10] In assessing the observations here, however, it should be borne in mind that $\bar{b} = 1 - \frac{1}{l + b(\bar{b})}$ has potentially three solutions. To obtain some flavour of the magnitude of $\bar{b}$, we can consider a simple numerical example and let l be equal to unity. We can then observe with help of Lemma 2 that there is a unique critical level of the output persistence that is given by $\bar{b} = \frac{1}{2}$.

presence of financial market constraints the devaluation expectations are *lower* when the monetary authority is known to assign a *high* relative weight on stabilising the real sector of the economy. This somewhat surprising outcome arises because in a dynamic environment, insufficiently stabilised shocks cumulate over time, thus increasing the intertemporal devaluation incentives. As the fundamentals worsen there will be a reduction in the area where the monetary authority finds it optimal to maintain the exchange rate peg, which in turn leads to higher devaluation expectations and an increased likelihood of speculative attacks against the regime. However, if the credit constraints are to be eliminated, for instance, by allowing fully developed foreign lenders to take over the financial sector, this long-run effect vanishes. Exchange rate stability can then be enhanced by delegating monetary policy to an institution with more conservative preferences than the government itself has, which is consistent with the traditional literature.

Generally, adding new distortions to a standard framework has the potential of partially cancelling out other distortions. The outcome that under output persistence, the government's preferences may have the opposite effect on the credibility of the fixed exchange rate regime than envisaged by earlier analysis is in line with other recent findings in research in optimal monetary and fiscal institutions. For instance, Guzzo and Velasco (1999) arrive at a broadly similar conclusion when analysing the optimal preferences of a central bank in a model of centralised wage-setting. Broadly speaking, these results tend to suggest that the relevance of an excessively tight policy stance can been questioned in the cases where the domestic economic institutions are not yet fully developed creating long run distortionary effects. Our contribution to this debate has been to shed some light on the links between financial market development and monetary and exchange rate policy, suggesting that the dangers of insufficient shock stabilisation can be significantly amplified if the domestic financial markets are subject to credit constraints.

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Appendix 1: Proof of Lemma 2

To see that $db/d\,l$ is always positive, differentiate first (21) with respect to l to get

$$\frac{db}{d\,l} = \frac{1}{2b}\left[\frac{l(1-b)^2 + 2b}{\sqrt{l^2(1-b)^2 + 4b\,l}} + b - 1\right]. \tag{A1}$$

Equation (A1) is positive if

$$\frac{l(1-b)^2 + 2b}{\sqrt{l^2(1-b)^2 + 4b\,l}} \geq 1 - b\ . \tag{A2}$$

Straightforward calculation shows that (A2) holds if $b \geq 0$.

To prove part (iii), check out from (21) that setting $l = 1$ yields $b = 1$ which in turn leads to the fact that $a = 0$ in (20). To start with the proof of part (i) we show that the necessary and the sufficient condition for $b < l$ is that $l > 1$. From (21) we get that

$$b = \frac{-\ l(1-b) + \sqrt{l^2(1-b)^2 + 4b\,l}}{2b} < l\,.$$

Rearrange this condition to obtain

$$\sqrt{l^2(1-dr^2)^2 + 4\,l\,dr^2} < 2\,dr^2 + l(1-dr^2)\,. \tag{A3}$$

Simplifying (A3) yields that the inequality holds only if $l > 1$. After noting that the denominator of a in (20) is always positive, it is obvious that the sign of a is given by the sign of (b - l). The proofs of part (ii) and (iii) is analogous.

QED

Appendix 2: Proof of Proposition 3

We want to establish the condition when the total derivative in (23) is negative. Straightforward differentiation of f with respect to l by using Definition 1, (22), and (A1) yields

$$\frac{1}{2b\sqrt{l+b}} + \frac{1}{2bb^2}\left(\frac{b}{2\sqrt{l+b}} - \sqrt{l+b}\right)\left[\frac{l(1-b)^2+2b}{\sqrt{l^2(1-b)^2+2\,lb}} + b - 1\right] < 0. \tag{A4}$$

By multiplying (A4) by $4b^2 b\sqrt{l+b}$ one can see that the derivative is negative if

$$2bb - (b+l)\left[\frac{l(1-b)^2+2b}{\sqrt{l^2(1-b)^2+2\,lb}} + b - 1\right] < 0. \tag{A5}$$

We next note that (21) can be re-expressed as

$$2bb = \sqrt{l^2(1-b)^2+2\,lb} - l(1-b). \tag{A6}$$

The substitution of $2bb + l(1\text{-}b)$ for $\sqrt{l^2(1-b)^2+2\,lb}$ in (A5) gives

$$2bb < (b+l)\left[\frac{l(1-b)^2+2b}{2bb+l(1-b)} + b - 1\right].$$

After some manipulations this equals

$$2bb[2bb + l(1-b)] - l[2b - 2bb(1-b)] < b[2b - 2bb(1-b)]. \tag{A7}$$

Employing (A6) on the left-hand side of (A7) yields

$$l(1-b)\sqrt{l^2(1-b)^2+4\,lb} - l^2(1-b)^2 < b[2b - 2bb(1-b)].$$

By means of some rearrangements, the inequality can be rewritten as

$$l(1-b)\left[\sqrt{l^2(1-b)^2+4\,lb} - l(1-b)\right] < b[2b - 2bb(1-b)]$$

or, equivalently by using (A6), as

$$l(1-b)2bb < b[2b - 2bb(1-b)]. \tag{A8}$$

Simplifying (A8) produces the desired form:

$$\bar{b} > 1 - \frac{1}{l+b}.$$

QED