

Currency Realignment Crises

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Abstract

Most theoretical models of currency crises focus on movements in nominal variables, under the assumption of PPP. A few exceptions allow for real exchange rate fluctuations, but only as a temporary by-product of the nominal fluctuations. This paper presents a ‘second generation’ model of crises explicitly associated with exchange rate misalignment, which focuses directly on the movement of real variables: real exchange rates, real interest rates, and the real stock of public debt. Multiple equilibria and self-fulfilling prophecies may arise in the speed of exchange rate realignment. Conditions are specified under which policy reversals – protracted defense of a slow realignment trajectory followed by a large step devaluation – can be justified as the choice of a single, rational policymaker.

1 Introduction

When theoretical modelling of currency crises began in earnest two decades ago, the research strategy was to focus on movements in nominal exchange rates: adherence to the convenient assumption of purchasing power parity at all times meant that real exchange rate variations were simply assumed away. Now, two generations of models later, the economics profession has learned a great deal about how to incorporate into solid models such self-insinuating phenomena as self-fulfilling prophecies, herd behavior, contagion, and moral hazard. We have gone a long way in figuring out accordingly more complex informational structures. Disregarded under layers and more layers of modelling sophistication, the assumption of purchasing power parity remained a staple among currency crisis models.

That state of affairs is startling, in light of the massive body of empirical evidence connecting crises to real exchange rate fluctuations (see, among

*I wish to thank, hoping not to implicate, Afonso Bevilaqua, Brian Doyle, Jeff Frankel, Paolo Pesenti and Dani Rodrik.

others, Goldfajn and Valdés, 1998, 1999). Whenever one sees a crisis, a real appreciation is likely to lie behind it; whenever one finds pent up pressure for real depreciation, a crisis looms ahead. Crises are often the sudden event that releases the pressure and brings about the necessary realignment of the real exchange rate. That is particularly true in the wake of disinflation programs, during which the currency is likely to appreciate in real terms – how to realign without reigniting inflation is indeed the catch in the exit from exchange-rate based stabilization (on exit strategies, see Eichengreen et al., 1999).

The theoretical literature on currency crises has consistently turned a deaf ear to those stylized facts. To be sure, there are studies that allow for real exchange rate movements, although they are few and far between in a literature that has vastly expanded in recent years. Early examples, all belonging to the first generation of crisis models, include Connolly and Taylor (1984), Connolly (1986), Flood and Hodrick (1986), Willman (1988), and Goldberg (1991).¹ A number of features shared by these models, however, do not sit well with the notion of a realignment crisis – which, in fairness, was never their avowed object. When the models include nontraded goods, the role of real appreciation (i.e., of the corresponding increase in the domestic price level) is to make the transactions demand for domestic currency higher than it would have been under PPP, thus reducing the drain of reserves caused by a given expansion of domestic credit and *mitigating* the pressure against the peg. When they attribute deviations from PPP to sticky prices, real exchange rates fluctuate only because there has been, or agents know there will be, a nominal devaluation; when all is said and done, the real exchange rate may very well settle back at its initial level. In a realignment crisis, by contrast, the real appreciation is arguably best described as a predetermined condition, one which ought to be eventually reversed through differential inflation if the nominal parity is to remain fixed, and acts meanwhile as the catalyst for speculative pressure against the peg.

Here, instead of lavishing all attentions on nominal variables, I take a diametrically opposite approach, which I find much more germane to realignment crises. A parsimonious yet quite lifelike theoretical representation of that sort of episode obtains by homing in on the trajectory of correction of the *real* exchange rate and the corresponding trajectory of *real* interest rates, in a model uncluttered by the determination of nominal variables. This is not to say that nominal variables do not matter. It is enough that nominal variables matter only through their effects on the real variables being tracked – once the movements of the latter are taken into account, what nominal antics take place in the background becomes irrelevant for the purpose at hand.

One of the variables of interest is the real stock of government debt. That has been a prominent issue in recent episodes, where the fiscal burden of defending a peg has taken center stage. Other costs – notably, the depressed level of activity associated with the overvalued currency – may very well be just as important in the eyes of policymakers, or even more so. What sets debt dynamics apart is that it is fully determined by real interest rates and real exchange rates

¹I am indebted to Afonso Bevilaqua for drawing my attention to these papers.

through mere accounting relations, thus establishing intertemporal links along the trajectory of realignment that are reasonably robust to the overall structure of the economy. Other costs and benefits of different realignment trajectories are more sensitive to structural relations, but insofar as they lend themselves to a static, period-by-period treatment, and as long as they do not seriously disturb the accounting identities involved in debt dynamics, they may be incorporated under a simple parametric representation.²

If the idea is to pit costs against benefits of maintaining a given exchange rate regime against speculative pressure, then the entry level modelling style must be that of second generation models of currency crises (as in Obstfeld, 1986), with room for self-fulfilling prophecies and all. Real exchange rates may seem an unnatural candidate for self-fulfilling prophecies, for they supposedly have an ‘equilibrium’ level, entirely determined by fundamentals, constraining movements at the mere whim of financial markets. If real rates – of exchange and interest – have endogenous equilibrium levels, they are also not policy variables. But the possibility of different realignment trajectories, influenced in part by control of nominal policy variables lurking in the background, opens enough room to consider policy choices over such trajectories and for equilibrium multiplicity to arise.

The story that emerges is no longer one of changes in nominal parities that may either occur (being subsequently justified) or not happen ever. It is instead about a real realignment that will absolutely need to take place, the only remaining question being whether to make the realignment faster or slower, sooner or later. Expectations of a sooner *dénouement* will weigh in favor of actually letting it happen sooner, thus creating the possibility of self-fulfilling prophecies. Timing will be of essence here: it directly affects the endpoint of the trajectory for variables such as public debt, instead of simply being a question of how patiently one needs to wait to arrive at the same final outcome.

2 Basic setup

At time t , the real exchange rate is denoted e_t (written so that an increase in e_t means a real depreciation). Between t and $t + 1$, domestic assets earn a riskless (gross) real return r_t . These may be interpreted as claims on the country’s real GDP, or bonds denominated in domestic currency but protected against domestic inflation, or plain domestic nominal bonds if inflation is itself a predetermined or perfectly forecasted variable. At any time, the riskless real interest rate on foreign assets is r^* . Real interest rate parity requires that:

$$r_t = r^* \frac{\hat{e}_{t+1}}{e_t} \tag{1}$$

²There is one specific channel through which the ‘rest of the model’ might affect the flow budget constraints governing the evolution of real public debt, which is not already captured in the trajectories of real interest rates and real exchange rates, namely, the response of primary deficits to the state of the economy.

where \hat{e}_{t+1} denotes the expectations held at t for the real exchange rate at $t + 1$. Unlike inflation (as assumed in the case of nominal bonds), the real exchange rate is not predetermined, and can in principle be the object of mistaken forecasts. The asymmetry is equivalent to attributing all possible surprises in the real exchange rate to sudden movements in the nominal exchange rate and not to lower frequency movements in inflation rates. Regardless of the path of nominal variables, any real depreciation that is perfectly anticipated must be reflected one-for-one in real interest differentials.

Denote by b_t the net government liabilities at time t , in real terms (that is, nominal liabilities divided by the *domestic* price level), which I assume throughout is a positive quantity. All debt is assumed to be in bonds with a riskless one-period real return, either domestic or foreign, as I will not explore the effects of debt maturity on the costs of financing or on the danger of roll-over panics. Abstracting from the existence of government liabilities dominated in rate of return but sought after for their superior liquidity – notably, the monetary base – allows the trajectory of government liabilities to be described without reference to interest rate differentials across government liabilities – in particular, without reference to nominal interest rates.

Debt management then reduces to allocation between domestic and foreign bonds. That can be described by a single parameter γ , measuring the participation of domestic bonds in the total net debt. The government is assumed to rebalance its debt portfolio to that composition at the beginning of each period. Note that γ is not restricted to the unit interval: if $\gamma > 1$, the government has negative net liabilities in foreign denomination, as would be the case if it issued mostly domestic debt and held positive net foreign reserves; likewise, $\gamma < 0$ would mean that the government has negative net liabilities in domestic denomination, which is less likely but not logically impossible. If net assets are positive in one denomination, there must be at least enough offsetting net liabilities in the other denomination to keep total net debt positive.

Government debt evolves according to:

$$b_{t+1} = d_{t+1} + \tilde{r}_t b_t \tag{2}$$

where d_t is the primary budget deficit in real terms (again, deflated by the *domestic* price level), and:

$$\tilde{r}_t \equiv r_t \gamma + r^* \frac{e_{t+1}}{e_t} (1 - \gamma) \tag{3}$$

is the effective *domestic* real interest rate on the total net debt of the government, according to its composition in terms of currency denomination. This interest rate depends on both the expected and the realized trajectories of the real exchange rate. The realized trajectory determines the *ex post* domestic real return on foreign bonds (their nominal return in terms of domestic currency minus the domestic inflation rate). The expected trajectory, due to interest rate parity (equation 1), determines the domestic real return required *ex ante* on domestic bonds. With inflationary surprises ruled out, that domestic real

return on domestic bonds is always confirmed *ex post*, regardless of the actual trajectory of the real exchange rate (which will only affect the *foreign* real return on domestic bonds).

The story starts at a certain date $t-1$ with an overvalued real exchange rate $e_{t-1} = \varepsilon^{-2}$, where $\varepsilon > 1$ and the equilibrium real exchange rate is normalized to unity. The monetary authority contemplates two possible paths for eliminating that misalignment. One, which I call ‘slow’, is to have the correction evenly distributed over a two-period horizon: i.e., to make $e_t = \varepsilon^{-1}$ and $e_{t+1} = 1$. The other path, which I call ‘fast’, is to make the entire ε^2 correction in one gulp between $t-1$ and t : $e_t = e_{t+1} = 1$. After realignment, the real exchange rate is assumed to remain at equilibrium.

The only uncertainty in the model is about e_t , as seen from $t-1$. All later real exchange rates are known, and all uncertainty is resolved by date t . As for the effective real interest rates on net public debt, only \tilde{r}_{t-1} and \tilde{r}_t are at stake: $\tilde{r}_{t+s} = r^*$ for all $s \geq 1$ because the real exchange rate will have stabilized by then. Furthermore, debt management matters only with respect to the composition of b_{t-1} . At every later date, the domestic real rate of return on foreign bonds is perfectly predicted, and must therefore be matched by their domestic counterparts, making debt composition irrelevant.

Fiscal considerations enter the picture in the following way. The government dislikes the fiscal effort necessary to cut primary deficits (or increase surpluses). For simplicity, I distinguish only between the deficit at date t , and a constant level of deficits \bar{d} forever after.³ The government’s preferences over primary budgets are represented by $u(d_t, \bar{d})$, where the function u is increasing in both arguments. Without some constraint, a government enjoying deficits that way would want to make them arbitrarily large. That is prevented by imposing an intertemporal budget constraint: at any date, the present discounted value of all future primary surpluses must equal the initial outstanding debt. With infinite horizons, and discounting by \tilde{r} every period, that constraint would read:

$$b_{t-1} = -\frac{d_t}{\tilde{r}_t} - \frac{\bar{d}}{\tilde{r}_t \tilde{r}_{t+1}} \frac{r^*}{1 - r^*} \quad (4)$$

The intertemporal budget constraint offers a whole menu of combinations of primary deficits at t and in the future, given initial debt and its composition, the foreign interest rate, and the actual and expected trajectories of real depreciation. A choice from that menu could presumably be made jointly with the choice of depreciation trajectory. Instead, I assume that d_t is also predetermined, as if primary budgets could only be changed by a legislative act that required time to pass and to take effect. That is not altogether unrealistic, and it is analytically very convenient. As far as fiscal considerations go, the choice of exchange rate policy should then be made with an eye at maximizing \bar{d} .

³In the government intertemporal budget constraint (considered below), all deficits later than t are discounted back to present value by discount factors that depend on the path of the real exchange rate according to the same multiplicative factor. That is not the case with d_t . That accounts for my decision to distinguish only between d_t , on the one hand, and all later deficits on the other.

In the way they have been described, these fiscal objectives seem to be motivated only by the political ambitions of a spendthrift government. But they might very well arise from more enlightened motives. For instance, the government might recognize the distortionary effect of taxes, and would not want to have to raise them to cover a higher debt service. Also, higher debt service may be undesirable for being regressive in terms of income distribution.

Note that I do not specify the trajectory of any nominal variable. In particular, the real exchange rate realignment may happen either through nominal devaluation or through inflation differentials. Of course, different speeds of real depreciation require different paths of nominal variables, faster depreciation normally requiring greater nominal devaluation. But once the speed of real depreciation is set, the trajectories of nominal variables have no further effect on the fiscal variables of interest, which are themselves all expressed in real terms.

3 Fiscal motives alone

The fiscal cost of defending an exchange rate peg is a traditional theme of second-generation models of currency crises. In Obstfeld (1994), a government that borrows in domestic currency pays a higher *ex post* real interest rate whenever a devaluation is feared but fails to happen. Because the fiscal cost of maintaining the peg increases with the fear of devaluation, the same government who would decide to maintain a peg trusted by the market may prefer to devalue once expectations turn against it. Fundamentals may be exactly the same in both cases, and either way the market sentiment is confirmed. Such currency crises are self-fulfilling prophecies. I shall explore the same type of mechanism here.

If the government cares *only* about maximizing \bar{d} , figure 1 shows the corresponding results in the $(\gamma b_{t-1}, d_t)$ plane (fixing both r^* and ε). The *FF* line:

$$FF : d_t = -r^* \varepsilon^2 \gamma b_{t-1} \quad (5)$$

is the *locus* of fundamentals for which, if private agents expect depreciation to go fast, the government will be indifferent between slow and fast depreciation. Likewise, the *SS* line:

$$SS : d_t = -r^* \varepsilon \gamma b_{t-1} \quad (6)$$

is the *locus* of indifference between the two plans when slow depreciation is expected. With fundamentals at any point northeast (resp. southwest) of the *FF* line, fast (resp. slow) depreciation will be chosen whenever fast depreciation is expected. Likewise, if fundamentals are northeast (resp. southwest) of the *SS* line, then fast (resp. slow) depreciation will be chosen whenever slow depreciation is expected.

To the northeast of both lines, fast depreciation will be the choice of the government regardless of expectations. Accordingly, markets should expect depreciation to be fast. To the southwest of both lines, slow depreciation would be chosen regardless of expectations, and markets should expect that to happen. If fundamentals lie between the two lines in the *southeast* quadrant, fast depreciation will be chosen if fast depreciation is expected, and slow depreciation will be

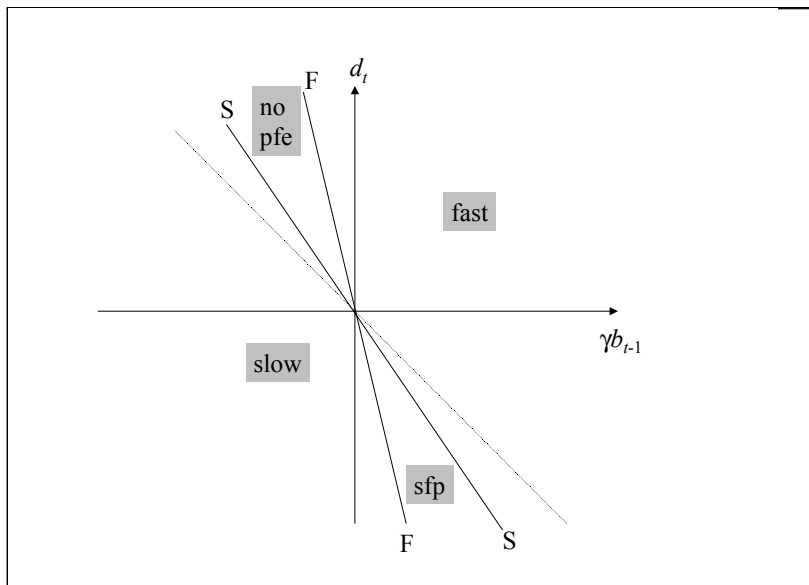


Figure 1: Fiscal motives alone

chosen if slow depreciation is expected. Either outcome will be a self-fulfilling prophecy. Between the two lines in the northwest quadrant, the government would act as a ‘contrarian’, doing exactly the opposite of what was expected in the first place, and there would be no perfect foresight equilibrium.

These results can be better understood by rewriting the intertemporal budget constraint as follows:

$$-\bar{d} \frac{r^*}{r^* - 1} = d_t r^* \frac{e_{t+1}}{e_t} + (1 - \gamma) b_{t-1} r^* \frac{e_t}{e_{t-1}} r^* \frac{e_{t+1}}{e_t} + \gamma b_{t-1} r^* \frac{\hat{e}_t}{e_{t-1}} r^* \frac{e_{t+1}}{e_t} \quad (7)$$

On the left-hand side, one finds the present value of all primary surpluses dated $t + 1$ or later, discounted back to date $t + 1$. Given r^* , minimizing that is equivalent to maximizing \bar{d} . On the right-hand side is the net debt stock at that same date, excluding the newly contributed primary deficit (which was counted on the other side). That debt stock is the sum of three terms: the primary deficit at t , with the interest accrued on it since then; and the amounts of debt that were foreign and domestic denominated at $t - 1$, with the interest accrued on each in the meantime. The portion originating in debt that was initially foreign denominated does not depend on the trajectory of depreciation, as long as the misalignment is exactly corrected over the two periods, that is, as long as $\frac{e_{t+1}}{e_{t-1}}$ is the same in both possible scenarios. Choice of policy must then minimize the sum of the other two terms appearing on the right-hand side.

In the special case of $d_t = 0$, the objective function reduces to minimizing the value at $t + 1$ of debt that was domestic denominated at $t - 1$. That decision

cannot depend on expectations, because expectations appear as a mere scaling of the objective function. It depends only on the sign of γb_{t-1} : for any given $\frac{\hat{e}_t}{e_{t-1}}$ built into required real returns on domestic denominated bonds between $t-1$ and t , slow depreciation, which leaves more to be done in the later period (when it will be fully reflected in expectations and built into real returns), inflates more that debt stock, which is good if that stock was negative to start with, but bad if it was positive (unlike the case of the initial foreign denominated debt, for which more growth later would be precisely compensated by less growth earlier).

In the case of $\gamma b_{t-1} = 0$, expectations are again irrelevant for policy decisions since they do not even appear in the objective function. Slow depreciation implies that a higher interest rate will accrue on d_t 's contribution to the debt stock, which is bad if that contribution is positive but good if it is negative. Along the axes in figure 1, the decision depends only on fundamentals and not on expectations, which is why one never faces equilibrium multiplicity or nonexistence.

The possibility of self-fulfilling prophecies and contrarian behavior opens up as one moves away from the axes. In general, the objective function of the government can be represented by:

$$\left(d_t + \gamma b_{t-1} r^* \frac{\hat{e}_t}{e_{t-1}} \right) r^* \frac{e_{t+1}}{e_t} \quad (8)$$

The decision about how much depreciation to leave for later will depend on the sign of the term in brackets.⁴ If $d_t < 0$ or $\gamma b_{t-1} < 0$ (but not both!), that sign may change according to expectations about early depreciation. If that happens, the outcome may change simply because expectations changed, with all the fundamentals unaltered, resulting in self-fulfilling prophecies or contrarian behavior. Because these expectations can only be either ε or ε^2 , there are additional restrictions on the relative sizes of d_t and γb_{t-1} for expectations to be able to switch the sign of the term in brackets and affect the outcome. These are represented by the areas between the *FF* and *SS* curves in the northwest and southeast quadrants of figure 1.

Thus, fundamentals may either be 'good' or 'bad' enough to determine the outcome entirely, or by lying in an intermediate range they may expose the economy to the effects of expectations. That is indeed the usual result of second-generation models of currency crises, including those that contemplate the fiscal effects of alternative paths for the exchange rates. What is not common is the ability to generate all that range of possibilities from fiscal considerations *alone*. The conventional result is that fiscal considerations invariably suggest depreciation, more or less strongly so depending on how adverse expectations are. The verdict can only hinge on expectations, opening the way for self-fulfilling prophecies, if there is some 'credibility' cost of devaluing to be deducted from the fiscal benefits.

⁴By manipulating the term in brackets under different assumptions for $\frac{\hat{e}_t}{e_{t-1}}$, the expressions for the *FF* and *SS* lines of figure 1 (equations 5 and 6) can be easily obtained.

4 Non-fiscal motives

Although our model can at this point generate that whole range of results, adding non-fiscal objectives helps compose a more realistic picture of the motives behind macroeconomic policymaking. Furthermore, the fiscal-only version presented so far may require stringent conditions on fundamentals to deliver expectations-sensitive decisions. Contrarian behavior, itself hardly a compelling phenomenon, requires the initial net stock of domestic denominated public debt to be unrealistically negative. Self-fulfilling prophecies, in turn, are a sought after result in this class of models, and they arise only when that stock is positive but the primary budget is in surplus at date t . The surplus needs to be quite large: larger, as a matter of fact, than the whole initial stock of domestic denominated debt (the region of equilibrium multiplicity lies below the negative 45° line). For that to be satisfied in a country with a large stock of public debt, much of which domestic denominated, one would need to stretch the calendar equivalent of the model's 'period' unreasonably long (to tilt the relation between stocks and flows). The restriction would be less outlandish if the government borrowed mainly in foreign currency, but positive primary deficits of any magnitude would still rule out the possibility of multiple equilibria.

I introduce other considerations in the form of a non-fiscal *net* benefit of the slow crawl over a fast depreciation, as perceived by the government. Specializing to the case $u(d_t, \bar{d}) \equiv v(d_t) + \bar{d}$, one can represent that non-fiscal benefit as an equivalent addition δ to the feasible later deficits \bar{d} that does not depend on the value taken by \bar{d} itself. Fast depreciation is optimal whenever:

$$\bar{d}_{fast} \geq \bar{d}_{slow} + \delta \quad (9)$$

Otherwise, slow depreciation is optimal.

The value of δ is a subjective call on two counts: it depends on several forecasts made under each depreciation scenario, and also on the relative weights accorded to the fiscal and to the various non-fiscal policy targets. For simplicity, δ is assumed not to depend on the state of expectations. The output loss associated with maintaining the peg should increase as expectations turn more adverse, since that increases the *ex ante* domestic real interest rate. The perceived benefits of maintaining the peg in terms of price stability may also increase as expectations turn unfavorable if the government subscribes to the notion that devaluation is more likely to turn disorderly under speculative pressure. For expositional convenience, I choose to ignore the balance of these conflicting influences of expectations on the value of δ .

Figure 2 reproduces the same analysis as in figure 1, now including the non-fiscal considerations. The *FF* and *SS* lines are now described by:

$$FF : d_t = -r^* \varepsilon^2 \gamma b_{t-1} + \frac{\delta}{(\varepsilon - 1)(r^* - 1)} \quad (10)$$

$$SS : d_t = -r^* \varepsilon \gamma b_{t-1} + \frac{\delta}{(\varepsilon - 1)(r^* - 1)} \quad (11)$$

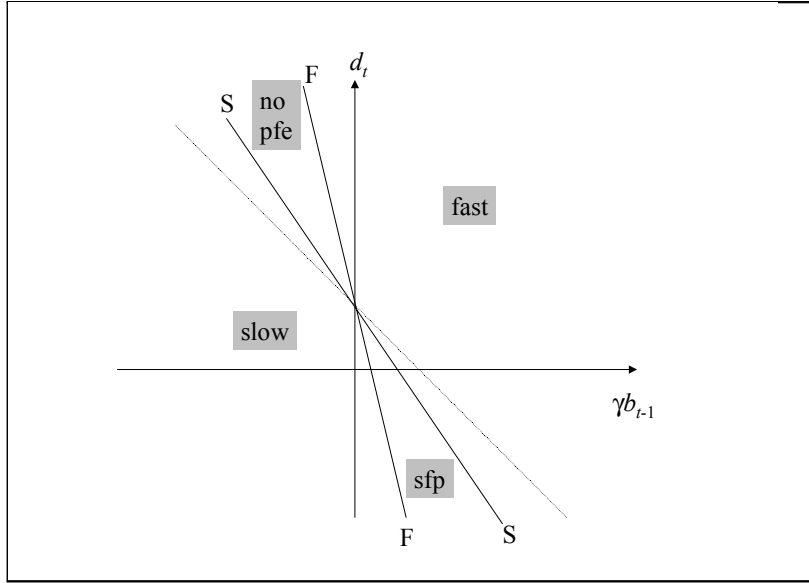


Figure 2: Non-fiscal motives

Both suffer an upward parallel shift proportional to δ , which is shown in the picture as being positive (as typically assumed in second generation models of currency crises). The shift is actually the same for both because δ is assumed to be independent of the state of expectations. The higher is δ , the greater are the non-fiscal virtues the government sees in the slow crawl. Given the state of expectations, the crawl will now prevail given fundamentals at which it would fold if δ were lower. As a result, the region of multiple equilibria becomes much more plausible. In particular, it now includes cases in which the primary budget is in equilibrium or even in deficit.

5 Incomplete information

All perfect foresight equilibria in this model must display, from $t - 1$ to $t + 1$, the same compounded rate of return $(r^* \varepsilon)^2$ on the entire preexisting stock of government bonds, regardless of its currency composition. Even with the same fundamentals, however, the debt stock at $t + 1$ may differ across equilibria, since earlier depreciation implies that a lower rate of return will accrue on the half-way contribution from d_t .

But there are other potential mechanisms that would allow for different equilibria sharing the same fundamentals to produce different values of b_{t+1} , involving departures from perfect foresight. Fearing fast depreciation between $t - 1$ and t , markets would demand a high interest rate on domestic bonds.

If depreciation turns out to be slow, that leaves more depreciation to be expected between t and $t + 1$. Part of the necessary realignment enters twice into the compounded domestic real return on domestic bonds. That mechanism, if consistent with equilibrium, is potentially more powerful since it multiplies the entire initial net stock of domestic bonds, as opposed to one time primary deficits only.

To formalize that possibility, I allow for incomplete information about the government's preferences. The market does not know the true value of δ , about which it holds a prior described by c.d.f. F . Confronted with any fundamentals and market expectations, the government (who knows its own type δ) must still choose between slow and fast depreciation. Let p denote the probability, according to the prior F for δ and depending on the fundamentals, that depreciation will be fast. Then:

$$\frac{\hat{e}_t}{e_{t-1}} = p\varepsilon^2 + (1-p)\varepsilon \quad (12)$$

Obviously, \hat{e}_t increases with p , and so does r_{t-1} (equation 1). Fixing the fundamentals, define the following function of p :

$$\Delta(p) \equiv (r^* - 1)(\varepsilon - 1) \{r^* [p\varepsilon^2 + (1-p)\varepsilon] \gamma b_{t-1} + d_t\} \quad (13)$$

Facing a market sentiment represented by p , that is the trigger value for the true δ at which the government switches between slow and fast depreciation: one can verify that fast depreciation will be optimal if and only if:

$$\delta \leq \Delta(p) \quad (14)$$

But the subjective probability p must be consistent with that fact, that is:

$$F[\Delta(p)] = p \quad (15)$$

Existence of a fixed point of $F \circ \Delta$ is easy to establish if the prior is an absolutely continuous probability distribution. If $\gamma b_{t-1} \leq 0$, then Δ is a non-increasing function of p , and there must be precisely one p solving equation 15, say \bar{p} . If $\delta < \Delta(\bar{p})$, then equilibrium must involve fast depreciation; likewise, depreciation must be slow whenever $\delta > \Delta(\bar{p})$. Equilibrium is thus entirely determined by fundamentals (except for the non-generic case of $\delta = \Delta(\bar{p})$, in which the outcome consistent with the *same* given expectations is entirely indeterminate).

In the more interesting case of $\gamma b_{t-1} > 0$, the left-hand side of equation 15 is an increasing function of p . Depending on the functional form of F , there may be multiple \bar{p} solving that equation. These characterize multiple equilibria, which may or may not involve different paths of real depreciation. If the true δ lies between possible values of $\Delta(\bar{p})$, then pessimistic enough expectations (high \bar{p}) lead to fast depreciation while optimistic enough expectations would support the slow crawl.

Whenever the fundamentals are aligned within the multiple equilibrium region of figure 2, then $\Delta(0) \leq \delta \leq \Delta(1)$ – in other words, the non-fiscal benefit

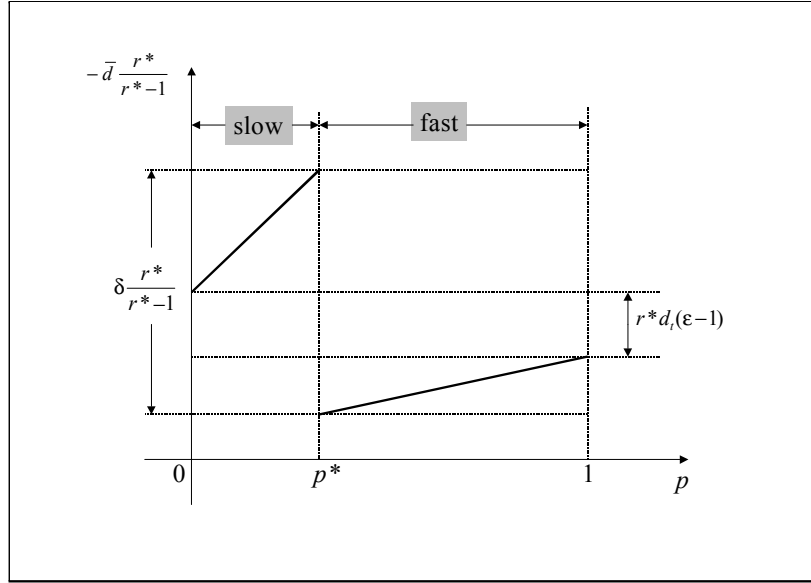


Figure 3: Market sentiment and fiscal burden

of the slow crawl is large enough to justify sticking with it ($\Delta(0) \leq \delta$) if that is what the market is sure the government will do ($p = 0$), but small enough to permit a collapse ($\delta \leq \Delta(1)$) if it is instead a collapse that the market expects with certainty ($p = 1$). In that case, one can always find some c.d.f. F such that certain \bar{p}_{lo} and \bar{p}_{hi} are among the fixed points of $F \circ \Delta$, and $\Delta(\bar{p}_{lo}) \leq \delta \leq \Delta(\bar{p}_{hi})$. Those would be two sets of model-consistent beliefs leading to different depreciation paths. With such fundamentals, it is also possible to find a prior F such that only one \bar{p} is a fixed point of $F \circ \Delta$, and that would be the unique equilibrium consistent with the model and the arbitrary prior. A prior of that kind actually kills the multiplicity of equilibria that would be present under the same fundamentals if the markets only knew the true δ . A prior F might also be chosen to produce multiple fixed points \bar{p} whose corresponding $\Delta(\bar{p})$ all lie on the same side of the true δ , case in which the multiple corresponding equilibria would differ only for their trajectories of real interest rates and public debt, and share the same trajectory of real exchange rates.

For the rest of the $\gamma b_{t-1} > 0$ half-plane in figure 2, if the fundamentals are in the fast (resp. slow) depreciation region, then fast (resp. slow) depreciation will be preferred no matter what the market sentiment p happens to be. Multiple model-consistent \bar{p} different from 0 or 1 are still allowed because the market, not knowing the true δ , cannot tell for sure in what region of the *true* figure 2 the fundamentals lie. These multiple equilibria involve the same path of depreciation, but different trajectories for real interest rates and the public debt.

Figure 3 describes how the fiscal outcomes change with market sentiment p , still assuming that fundamentals belong to the multiple equilibrium region of figure 2. The cutoff probability p^* is implicitly (and uniquely) defined by $\Delta(p^*) = \delta$: facing any p higher (resp. lower) than p^* , the government with preferences described by δ will choose fast (resp. slow) depreciation. In any equilibrium $0 < p < p^*$, the domestic real return on domestic assets in the first period is higher than would be required if agents had been totally confident in slow depreciation ($p = 0$). That results in a compounded return over the two periods that is higher than the perfect foresight return of $(r^*\varepsilon)^2$. In any equilibrium $p^* < p < 1$, the domestic real return on domestic assets in the first period is lower than would be the case if investors were certain of fast depreciation ($p = 1$). The compounded return over the two periods is therefore lower than the $(r^*\varepsilon)^2$ associated with perfect foresight. The compounded domestic return on foreign assets does not change with expectations or the path of depreciation. Debt accumulation, as evidenced by the required future primary surpluses, only differs between the two perfect foresight equilibria ($p = 0$ and $p = 1$) because of their different real returns on d_t (figure 3 is drawn for the case $d_t > 0$).⁵

As the figure makes clear, deterioration of market confidence in the slow crawl worsens the post-realignment fiscal conditions, for as long as it is not enough to persuade the government to let go of the crawl. As the degree of confidence crosses the cutoff level beyond which the government abandons the peg, the post-realignment fiscal picture makes a discontinuous improvement. Further deterioration of confidence will again make fiscal situation gradually worsen, but it will remain uniformly better than under the peg.

6 About-faces

A number of countries that fall victim of speculative attacks against their currencies put up only a half-hearted and short-lived defense before caving in. But there are also cases of dogged defense despite the high costs of such course of action. The latter behavior is particularly likely in the wake of disinflation programs, when it is often presumed that abandoning the nominal anchor represented by the peg will undo all progress made in the inflation front. Incidentally, those are also the cases in which the currency crisis is most likely to be associated with a serious appreciation of the real exchange rate, itself a common by-product of exchange-rate-based stabilization (Rebelo and Végh, 1995). Since the likely outcome is nevertheless a collapse, with the defending government eventually caving in after having paid the high cost of an ultimately frustrated defense, currency realignment crises highlight the issue of policy reversals regarding exchange rates.

⁵If fundamentals were in the $\gamma b_{t-1} > 0$ half-plane but outside the region of multiple equilibria, the cutoff probability $p^* \in [0, 1]$ would not be formally defined. Figure 3 would still describe the fiscal consequences of any market sentiment $p \in [0, 1]$ if drawn with $p^* < 0$ for fundamentals in the fast depreciation region, and with $p^* > 1$ for the slow depreciation region.

Policy reversals of that sort might seem to need little rationalization. If policymakers have a genuine change of heart, or if they are toppled, old and new policies need not be mutually consistent. Although reversals tend to be accompanied by replacement of key officials, that does not necessarily mean a complete discontinuity in the administration. One may still wonder whether the entire observed course of action could be made consistent with a single set of rational preferences of a policymaker.

One might intuit from the simple model developed so far that, as debt accumulates, the balance of gains and losses tips in favor of faster depreciation. The model indeed suggests that, of two countries equal in every other respect, the one with higher debt is more likely to choose faster depreciation. But that begs the question of whether the two decisions – first to defend, then to let go – are *sequentially* consistent. In other words, can later conditions be such as to favor fast depreciation when adherence to the slow crawl was preferred earlier, even if one requires the early decision to take into proper account the *expected* evolution of fundamentals in the meantime, and how that evolution will impinge on later decisions?

If abandonment of the peg is certain to happen sooner or later, there is no point in bearing the fiscal costs of delaying the inevitable, unless, of course, there is an explicit non-fiscal motive for postponement. Postponement motives may come in the form of pure procrastination (the policymaker prefers a small step today and a large step tomorrow to a large step today and a small step tomorrow), or may be motivated by convex adjustment costs (better two small steps than one large). Pure procrastination is sometimes associated with the electoral calendar, or with the notion, frequent in disinflation programs, that the country could use more time to let ‘inflationary memories’ fade. Convex adjustment costs reflect the notion that a big jolt to the nominal exchange rate may have higher pass-through coefficient and higher probability of turning disorderly than a continuous sequence of small devaluations – the motto could be ‘discreet, not discrete’.

Postponement motives aside, it may also be the case that later abandonment of the peg is not certain, creating some extra slack for sequentially rational policy reversals. Policymakers might decide to hang on in the hope of encountering relatively favorable market sentiment at later times, that would allow the peg to be maintained to the end. If later market sentiment is more adverse than had been expected, they may reasonably decide to change course at that point, and in so doing not invalidate the rationality of their earlier decision.

To analyze that problem formally, I consider what happens in the period before the story described so far takes place, so that two sequential decisions about the speed of real depreciation need to be made. In this setting, I explore jointly the two conjectured explanations for a decision to defend to be followed by a decision to abandon the peg. First, the government may value postponement *per se*, even if it knows that it will not be able to maintain the peg beyond the next period. Second, even if it does not value postponement, it may base its early decision on an optimistic outlook for market sentiment next period, which however turns out to be worse than anticipated.

The story now starts at $t - 2$. For simplicity, assume that $d_{t-1} = d_t = 0$, to avoid keeping track of how the returns on deficits observed along the way change from one depreciation trajectory to another. Assume also that $\gamma = 1$, so that:

$$b_{t-1} = r^* \frac{\hat{e}_{t-1}}{e_{t-2}} b_{t-2} \quad (16)$$

does not depend on the *actual* depreciation trajectory between $t - 2$ and $t - 1$. As a result, it is possible to condition the choice of e_{t-1} on b_{t-1} , just as I have been doing for the choice of e_t . I will also not need to take a stand on the magnitude of the real misalignment at $t - 2$.

The government has two choices regarding e_{t-1} . One is to enter $t - 1$ with a realigned exchange rate, $e_{t-1} = 1$. With no further real exchange rate fluctuation in the horizon, $r_{t-1} = r_t = r^*$, and real debt accumulates to:

$$-\bar{d} \frac{r^*}{r^* - 1} = b_{t-1} r^{*2} \quad (17)$$

The alternative is to make $e_{t-1} = \varepsilon^{-2}$, thus entering the two-period game described above. I restrict the outcomes of that game to perfect foresight equilibria as seen from $t - 1$. Regardless of the depreciation trajectory within the two period model, the economy will emerge from that game with debt:

$$-\bar{d} \frac{r^*}{r^* - 1} = b_{t-1} (r^* \varepsilon)^2 \quad (18)$$

The latter will be optimal whenever it offers non-fiscal benefits that are greater than its clear fiscal costs. Let λ denote the non-fiscal benefit of maintaining the crawl *all the way* to complete realignment, compared to making $e_{t-1} = 1$. Therefore, $\lambda - \delta$ is the benefit of merely *postponing* the abandonment of the crawling peg from $t - 1$ to t . Denote by q the probability, as perceived by the government at $t - 2$, that the two-period game, if played, will be resolved with a fast devaluation. So, $e_{t-1} = \varepsilon^{-2}$ is optimal whenever:

$$\lambda - \delta + (1 - q) \delta \geq b_{t-1} r^* (r^* - 1) (\varepsilon^2 - 1) \quad (19)$$

Here the non-fiscal benefits are split between the benefit of merely postponing depreciation, and the expected benefit of sticking with the peg to the end if one has kept it into $t - 1$. The fiscal costs, for comparison with the non-fiscal benefits, are measured in units of \bar{d} , according to equations 17 and 18.

Of course, q is not a completely free parameter. Assuming that $\delta > 0$, figure 4 shows how the perfect foresight solution to the subgame depends on the value of fundamentals, notably b_{t-1} . If fundamentals are such that the subgame must be solved by fast depreciation, then the government ought to recognize this fact and hold $q = 1$. If the subgame must be solved by slow depreciation, then $q = 0$. Only if fundamentals admit either solution as a perfect foresight equilibrium in the subgame will q be free to take any value in $[0, 1]$ – in this case, it will represent the government's priors at $t - 2$ about how the expectations of investors will coordinate at $t - 1$.

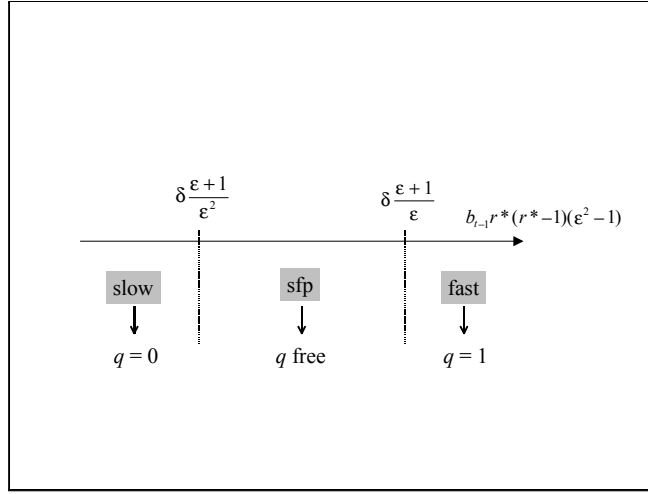


Figure 4: Restrictions on q

One can only account for a change of heart – an early decision to defend and later to abandon the peg – if equation 19 is satisfied and also:

$$\delta \frac{\varepsilon + 1}{\varepsilon^2} \leq b_{t-1} r^* (r^* - 1) (\varepsilon^2 - 1) \quad (20)$$

which is the condition for a fast depreciation to be a perfect foresight equilibrium of the subgame. But the two conditions can only be simultaneously satisfied by some level of fundamentals if:

$$\frac{\lambda}{\delta} \geq q + \frac{\varepsilon + 1}{\varepsilon^2} \quad (21)$$

From this condition, some conclusions emerge immediately. First, if λ is sufficiently large compared to δ (mere postponement of depreciation is highly valued), then the policy reversal can always be justified by the right level of b_{t-1} . On the other hand, if postponement is not valued at all ($\lambda = \delta$), and fundamentals place the economy at the fast depreciation region of figure 4 (forcing $q = 1$), then inequality 21 cannot be satisfied. Reversal can only be justified if there is enough value in merely postponing the realignment, or if the fundamentals will place the economy in the indeterminacy region and the government is confident enough that market sentiment will then be favorable – but ends up disappointed in that forecast.

But the latter possibility, if the perceived gains from postponement are very small, still requires the satisfaction of a very strong restriction on the degree of exchange rate misalignment. For even if q can vary freely, some $q \in [0, 1]$ satisfying inequality 21 with $\lambda = \delta$ will only exist if:

$$\frac{\varepsilon + 1}{\varepsilon^2} \leq 1 \Leftrightarrow \varepsilon \geq 1.6180 \quad (22)$$

That lower bound is already a quite formidable misalignment (remember that the subgame starts with a misalignment of the order of ε^2). Furthermore, any departure from extreme optimism about future market sentiment (i.e., from $q = 0$) would require ε to be even larger.

The conclusion is that explicit postponement motives may indeed be essential to rationalize the exchange rate policy reversal as a sequence of mutually consistent decisions. Purely fiscal considerations, working through an ultimately frustrated display of optimism about upcoming debt dynamics, can only generate the result under stringent restrictions on fundamentals. That result shares the spirit of our previous conclusion about the ability of fiscal considerations alone to generate equilibrium multiplicity: it is possible but unlikely. That previous conclusion actually reinforces the need for non-fiscal considerations backing policy reversals, since the optimism-disappointment story would only be operative if fundamentals were to enter the region of multiple equilibria.

7 Conclusion

Some observers would insist that it is not a major dereliction of duty on the part of economic theorists to leave real exchange rate fluctuations out of currency crisis models. Real exchange rates movements associated with currency crises may be large, but would neither invalidate the key insights derived from PPP-based models nor generate interesting new ones.

This paper suggests that there may be insights to be gained from moving to an analysis centered on real variables, even if doing so at the cost of glossing over the determination of nominal variables altogether. The analysis then focuses on a real depreciation that is inevitable, rather than on the usual problem of a nominal devaluation that may or may not occur. The crucial dimension of the inevitable realignment is its pace – and it is only through their effect on the pace of real depreciation that the trajectories of nominal variables is allowed to have any effect. Because realignment is inevitable, and real exchange rate premia on domestic denominated debt are paid once every time depreciation is expected, not fulfilling these expectations generates a sunk cost in terms of debt accumulation. From next period onwards, the depreciation that failed to materialize will reappear as part of the ground that still needs to be covered, being fully reflected in the forthcoming real exchange rate premia.

The pace of real depreciation is subject to multiple equilibria, if fundamentals are neither good nor bad enough to make fast or slow depreciation the best policy choice regardless of the state of expectations. With incomplete information, there may be multiple equilibria with different outcomes for the paths of debt accumulation and real interest rates, even if these equilibria share the same path of real exchange rates (and also if they do not). The role of interim cash flows – in the model, primary budget deficits – in informing the choice between different time paths of real returns is also highlighted in an explicitly intertemporal analysis.

One particular aspect of the question is whether fiscal considerations alone

are enough to deliver a rich enough range of results, including equilibrium multiplicity or rational policy reversals – something they cannot do in conventional currency crisis models. Here, it turns out that they might be capable of such things, but only under quite stringent conditions. Quantitative lessons derived from such a stylized model should be taken with a grain of salt, but the indication is that, after all, non-fiscal considerations in favor of slow depreciation, and in favor of postponing the abandonment of the slow crawl, may be crucial to justify self-fulfilling crises and rational policy reversals.

Besides revealing potentially interesting aspects of the problem and providing the comfort of a model that incorporates salient features of reality, focusing on real variables may qualify certain conclusions reached with an eye on nominal quantities only – or, to be precise, without an eye on *all* relevant nominal quantities. For instance, it is often claimed that countries whose inhabitants are heavily indebted in foreign currency are prevented from realigning their exchange rates through nominal devaluation, for the severe negative impact that devaluation would have on the net worth of domestic agents.⁶ However, inasmuch as it is the real interest rate that matters for the financial health of domestic producers, then the alternative course of action – letting the realignment happen through differential inflation – may not be much gentler to financial statements, except for spreading the time of reckoning over a longer period. Instead of seeing debts explode compared to the prices of their wares and real assets (and, thus, the value of their stock), domestic producers will witness prices implode – slowly, perhaps, but inexorably – compared to the value of their debt.⁷

The strategy followed in this paper, of shutting down every channel through which nominal variables might have an impact of their own outside the pace of realignment (for instance, assuming away inflationary surprises, disregarding interest-free government liabilities), may actually be too stark. One might want to relax such assumptions somehow – for starters, say, allowing inflationary surprises to be associated with real exchange rate surprises, in order to capture some pass-through of unanticipated nominal devaluations. That could be done in an agnostic manner, without fully specifying the model of determination of nominal variables. Indeed, there are other fringes of the model that invite extension before reintroducing a full blown monetary block: allowing the non-fiscal benefits of the slow crawl to depend on the state of expectations; allowing for fiscal policy to be chosen jointly with exchange rate policy; allowing the state of the economy to affect current deficits, given the fiscal policy stance; relaxing the debt composition and subgame equilibrium assumptions in the modelling of

⁶A recent statement of the problem can be found in Mishkin and Savastano (2000), p. 11: “Given the substantial ‘liability dollarization’ of households, firms and banks in those economies, the depreciation will tend to have a major negative impact on the net worth of the private sector, including banks, which will then amplify the asymmetric information problems in financial markets and exacerbate the financial crisis.”

⁷Of course, that equivalence breaks down for agents with an important component of *domestic denominated* nominal assets in their net worth, the value of which would be protected against the drop of domestic prices. The most likely candidates to be in that exposed position are financial intermediaries relending foreign funds in domestic currency.

policy reversals. These are only a few real aspects of the problem that might take precedence over nominal considerations as directions for future research.

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