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Losing Credibility: The Stabilization Blues

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Abstract

In exchange rate-based stabilization programs, credibility often follows a distinct time pattern. At first it rises as the highly visible nominal anchor provides a sense of stability and hopes run high for a permanent solution to the fiscal problems. Later, as the domestic currency appreciates in real terms and the fiscal problems are not fully resolved, the credibility of the program falls, sometimes precipitously. This paper develops a political-economy model that focuses on the evolution of credibility over time, and is consistent with the pattern just described. Inflation inertia and costly budget negotiations play a key role in the model.

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I. Introduction

Resorting to the exchange rate as the nominal anchor in inflation stabilization programs often proves irresistible. Even after painful failures, policymakers keep coming back to a fixed exchange rate claiming--like a jilted lover making his case for one more chance--that everything will be different this time around. The pervasiveness of the exchange rate as the nominal anchor is not hard to understand since the idea of achieving price stability by pegging the domestic currency to a hard currency sounds simple, attractive, and efficient. Simple, because not much more is involved than the notion that, in a relatively open economy, purchasing power parity should ensure price stability within a reasonable period of time. Attractive, because it is easy to implement, easy for the public to understand, and, if credible, provides a visible anchor for inflationary expectations. Efficient, because pegging to a hard currency country should enable domestic policymakers to earn almost instantaneously and effortlessly the anti-inflation reputation that took the hard currency country policymakers decades to build.

When put into practice, however, exchange rate-based stabilizations have frequently ended in costly balance of payment crises. The convergence of domestic inflation to the rate of devaluation (which can be zero) has been a long and tortuous road. The expectation of a devaluation to correct large real appreciation of the domestic currency has hung above the programs like Damocles' sword, becoming more often than not a self-fulfilling prophecy. Moreover, even successful programs, such as the 1985 Israeli stabilization, have been subject to the same real dislocations as failed stabilizations (see Kiguel and Liviatan (1992) and Végh (1992)).

More subtle--but equally fascinating--is the pattern that credibility seems to follow in many exchange rate-based stabilizations. Even in programs that eventually fail, credibility seems to increase in the first stages of the program, as the highly visible nominal anchor provides a sense of stability, inflation begins to fall, and an agreement between different pressure groups on how to close the fiscal gap on a permanent basis seems within reach. As time goes by, however, the continuing real appreciation of the domestic currency, together with the apparent inability of the political process to deal with the fiscal problems, begin to erode credibility, and speculation about a possible devaluation arises. Furthermore, the public realizes that, since the fiscal problems have yet to be resolved, a devaluation would put an end to the program, because it would fuel speculation of further devaluations. Eventually, the loss of credibility is such that the "blues" set in and the question becomes not if but when the program will end. 1/

There can be little doubt that the time pattern of credibility just described reflects important economic considerations. Attempts at formalizing it, however, have proved elusive. This is hardly surprising considering that any attempt at modeling such a credibility pattern must

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1/ Agénor and Taylor (1991) estimate a measure of credibility for the Brazilian Cruzado plan and find that it follows this inverted-U pattern.

first answer the fundamental question of what is "credibility". Furthermore, credibility must be an endogenous variable if any interesting dynamics are to come out of the model. This paper can be viewed as an attempt at formalizing this dynamic pattern of credibility. It develops a political-economy model that provides a natural definition of credibility, and shows how economic and political variables influence credibility in such a way that it increases at the beginning of the program and then falls rapidly.

The model incorporates two important characteristics of major stabilization plans. The first, which has been somewhat neglected in the theoretical literature, is that exchange rate-based programs often follow a two-stage approach. In the first stage, a nominal anchor is established and some partial measures toward reducing the fiscal deficit are adopted. In a second stage, which may take several years or may in fact never occur, the rest of the fiscal adjustment is carried out. Examples of two-stage exchange rate-based stabilizations can be found in both low and high inflation countries. 1/ The reasons behind the two-stage approach are not hard to understand. Pegging the exchange rate—assuming that reserves are available—can be done overnight. In sharp contrast, establishing the political consensus that is needed to take tough fiscal measures is a slow, difficult, and uncertain endeavor. Moreover, policymakers often argue (or, at least, hope) that pegging the exchange rate in a first stage will actually help to resolve the fiscal conflict (the "straightjacket" theory). The idea is that the pegged exchange rate, by forcing the government to forego inflationary finance, leads to an accumulation of public debt. The potential for an explosive path of the public debt acts like a straight-jacket, thus forcing the different parties to sit down and negotiate until an agreement is reached.

A second feature of exchange rate-based stabilizations that is incorporated into our model is the sustained real appreciation of the

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1/ In low inflation countries, the cases of the successful Danish and 1982 Irish stabilizations stand out (see Giavazzi and Pagano (1990)). In the Danish case, it took four years to balance the budget, while in Ireland a balanced budget has yet to be achieved. In high inflation countries, cases in which the fiscal gap was initially reduced but the second stage never materialized include the Argentine Tablita (1978), the Austral Plan (1985), and the Cruzado plan (1986). This two-stage approach has also characterized successful plans, such as the Bolivian (1985), Israeli (1985), and Mexican (1987) programs. In Bolivia and Israel, the fiscal gap has not been closed yet. In Mexico, a surplus was achieved only three years into the program. (See the fiscal figures reported in Végh (1992).) The current Argentine plan, implemented in March 1991, is yet another example of a two-stage program, as the fiscal adjustment is not scheduled to be completed until 1993.

domestic currency. 1/ The real appreciation originates in the sluggish adjustment of the inflation rate to the devaluation rate, as a result, for example, of inflation inertia due to backward-looking indexation (Dornbusch and Simonsen (1987), Edwards (1991)). The real appreciation puts policymakers in a dilemma. If they choose to make adjustments in the nominal exchange rate without having solved the fiscal problem, it may be the beginning of the end. If policymakers do not adjust the nominal exchange rate, the recessionary effects of the real appreciation may also prove deadly for the program. In successful programs, such as those of Israel and Mexico, there have been nominal adjustments along the way. 2/

In this paper, we analyze the combined effects on the eventual success or failure of stabilization plans and the time pattern of credibility (defined below) first, of incomplete fiscal adjustment, and second, of expectations of a devaluation that arise from sustained real appreciation of the domestic currency. As suggested above, political-economy considerations play a key role in the process that follows the exchange rate pegging. Hence, following Alesina and Drazen (1991), we model the negotiating process over the budget as a "war of attrition." 3/ As is well known, a war of attrition is a game of timing and thus is well suited to capture a negotiating process in which it is costly for each group to concede.

Formally, we consider a stabilization plan that consists of (1) fixing the exchange rate, and (2) implementing a fiscal package that reduces, but does not completely eliminate, the fiscal deficit. The presence of inflation inertia implies that the inflation rate does not fall immediately in response to the drastic reduction in the devaluation rate. The resulting real appreciation of the domestic currency generates expectations of a step devaluation that would restore the equilibrium real exchange rate. This expected devaluation increases the nominal interest rate, thus reducing real money demand, and forcing the central bank to lose reserves. As a result, there exists the possibility that a balance of payments crisis will develop. As far as the public is concerned, the timing of such a crisis is uncertain because it does not know the level of reserves at which the central bank would abandon the fixed exchange rate.

In the meantime, pressure groups negotiate over which group will bear the cost of the taxes needed to close the remaining fiscal gap (i.e., they

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1/ The real appreciation that takes place in exchange rate-based stabilizations is by now a well-documented stylized fact; see, for instance, Kiguel and Liviatan (1992) and Végh (1992).

2/ Israel's new shequel was first devalued by 9.2 percent in January 1987 (the plan was implemented in July 1985) and by 4.8 and 8.0 percent in December 1988 and January 1989, respectively since then there has been a band of 3 percent around a central rate, which was again devalued in June 1989. In Mexico, the nominal exchange rate remained fixed during the first year of the program after which a crawling peg was established.

3/ See Fudenberg and Tirole (1986) and Bliss and Nalebuff (1984).

engage in a war of attrition). Conceding is costly because the group that concedes will bear the burden of the taxes needed to close the budget gap. Thus, the benefit of waiting another instant is the present value of all future taxes times the probability intensity (i.e., the hazard rate) that the other player will concede in the next instant. Pressure groups dislike inflation and real appreciation, albeit to different degrees. When a group's cost of waiting is at least equal to the cost of conceding, it will concede. For simplicity, we assume that, if and when a budget agreement is reached, a devaluation to restore the equilibrium real exchange rate will also take place.

The dynamics of the stabilization plan are thus characterized by real appreciation of the domestic currency, an increasing nominal interest rate, and rising public debt. Interestingly, this scenario characterizes both successful and unsuccessful stabilizations. This is an attractive feature of the model because it has been argued, most notably by Dornbusch (1989), that it is difficult to tell at the beginning of a plan whether it will be successful or not. In contrast, Sargent (1982) argues that the difference should be very clear from the outset because this is precisely why a program succeeds in the first place.

The interaction between the war of attrition and the balance of payments crisis model provides a natural definition of credibility. 1/ Specifically, the credibility of a program is defined as the conditional probability that the budget agreement takes place before a balance of payments crisis develops. Credibility so defined is an endogenous variable and depends on all the parameters of the model. In particular, it depends positively on the hazard rate of a budget agreement and negatively on the hazard rate of a balance of payment crisis. In the first stages of the program, credibility increases, as the nominal rate is still relatively low (which implies that the hazard rate of a balance of payments crisis is small), and the public debt has yet to increase substantially (which implies that a fiscal agreement is more likely since the costs of conceding are

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1/ Numerous definitions of credibility can be found in the literature. In Calvo (1986) and Calvo and Végh (1991), lack of credibility is modeled as temporary policy. While this definition proves useful in understanding the macroeconomic effects of lack of credibility, it cannot shed any light on the nature and evolution of credibility. Credibility has also been identified with time-consistency or "incentive-compatibility" (see, for instance, Persson and Tabellini (1990)). While, under this definition, credibility is endogenous, it does not follow any dynamic pattern since a program is either credible (i.e., time-consistent) or it is not. In other words, credibility cannot be "quantified." The definition used by Dornbusch (1991) is more in the spirit of this paper. In his model, a program fails if reserves fall below a certain level. The level of reserves, in turn, depends on a random variable and the adjustment effort. Credibility is defined as the probability that the program will succeed (i.e., that reserves do not fall below a certain level).

small). Later, however, credibility begins to fall and does so at an increasing rate, as the rising nominal interest rate increases the hazard rate of a balance of payments crisis, and the rising public debt reduces the hazard rate of a budget agreement. Hence, the model suggests that if a budget agreement is not reached in the early stages of the plan, the program may quickly lose credibility because of the intrinsic dynamics of a two-stage plan.

In our model, two main scenarios may unfold. In the successful scenario, a budget agreement is reached before a balance of payments crisis develops. In the unsuccessful case, the balance of payments crisis unfolds before a budget agreement is concluded. We show that the more drastic the initial fiscal adjustment, the more likely it is that the stabilization will be successful. Intuitively, a more drastic fiscal adjustment results in less public debt accumulation, which reduces the level of monetary financing that would result if a balance of payments crisis were to occur. Hence, the nominal interest rate is lower, which delays any potential balance of payments crisis. On the other hand, since the initial fiscal adjustment is more comprehensive, the taxes needed to close the remaining gap are lower, which, by reducing the benefit of waiting, makes it more likely that the budget agreement will take place sooner rather than later.

The paper proceeds as follows. Section II introduces the two building blocks of the general model: the balance of payments crisis model and the war of attrition. Section III simulates the model to gain further insights. Section IV discusses the main implications of the model. Section V concludes.

II. The Model

The basic analytical framework is composed of two building blocks: (1) a balance of payments crisis model, and (2) a political economy model. The next subsection presents a number of preliminaries about the determination of inflation and the fiscal situation accompanying the stabilization program that are necessary to introduce the model's building blocks.

1. Inflation-inertia and fiscal situation: preliminaries

Consider a small open economy that undergoes a price stabilization program. Two main policies define the stabilization program that is to be implemented, say, at time 0: (1) the nominal exchange rate, which was being devalued at a rate ϵ_0, is fixed at the level S, and (2) a possibly significant, although incomplete, fiscal adjustment is undertaken. (A subscript "0" denotes that the variable takes its pre-stabilization value.)

It is assumed that, because of structural reasons not addressed in this paper, domestic inflation exhibits stickiness or "inertia". 1/ Thus, domestic inflation does not adjust instantaneously to the rate of nominal devaluation--i.e., zero--at the time the stabilization plan is implemented. Consequently, in response to the fixing of the nominal exchange rate, the economy must necessarily undergo a period of real appreciation. The presence of a period of real appreciation is indeed a stylized fact of the aftermath of price-stabilization programs (see Kiguel and Liviatan (1992) and Végh (1992)).

To keep matters as simple as possible, it is assumed that at time 0 domestic inflation--denoted by π_t--falls from π_0 to $\alpha\pi_0$, where π_0 is the pre-stabilization rate of inflation and $\alpha \in [0,1]$ is a constant, which measures the degree of inflation inertia. If $\alpha=1$, then domestic inflation is not affected by the fixing of the nominal exchange rate. If $\alpha=0$, then domestic inflation exhibits no inertia.

Let e_t denote the natural logarithm of the real exchange rate (i.e., the relative price of traded goods in terms of nontraded goods). By definition, $e_t = S_t - P_t$, where S_t and P_t denote the natural logarithms of the nominal exchange rate and the domestic price level at time t, respectively. (We assume that the foreign price level is exogenous and constant over time, and that its natural logarithm is equal to zero.) By previous assumptions:

$$e_t = \bar{e} - \alpha\pi_0 t, \tag{1}$$

since $S_t = S$ as a result of the stabilization program. It is assumed, furthermore, that the initial real exchange rate level, e_0, is also its equilibrium level, denoted by $\hat{e}$. (It is assumed that $\epsilon_0 = \pi_0$, so that the pre-stabilization equilibrium is a steady-state equilibrium.) Thus, equation (1) implies that the real exchange rate falls below its equilibrium level in the aftermath of stabilization, capturing in the simplest way the stylized fact of real appreciation of the domestic currency. Because of considerations that will be addressed below, the process of real appreciation of the domestic currency described by equation (1) will not persist indefinitely. Hence, equation (1) will not be assumed to hold forever.

We now turn briefly to the fiscal situation that accompanies the fixing of the nominal exchange rate. It is assumed that, at the time the exchange rate is fixed, a political agreement on the fiscal adjustment required to

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1/ Inflation inertia may reflect the presence of backward indexation of wages. A previous version of this paper uses a simple model of backward indexation to characterize the dynamic behavior of domestic inflation. Inflation inertia may also result from the belief that policies are temporary, as in Calvo and Végh (1991).

make the stabilization plan sustainable in the long run has not yet been reached. The second building block of the model will deal precisely with the political-economy process concerning such an agreement. It is assumed that some--possibly substantial--fiscal adjustment is undertaken at the time the exchange rate is fixed. However, the fiscal adjustment at that time is not complete, so political negotiations are necessary to implement the additional fiscal measures. For the time being, it is enough to define R(t) as the increase in tax revenue required to finance government expenditure and to service the stock of public debt outstanding in period t. A political agreement will involve a decision about how the required tax revenue increase, R(t), will be distributed across different constituencies.

As mentioned earlier, inflation inertia implies a growing real appreciation following the fixing of the nominal exchange rate. It is often the case that, as this real appreciation takes place, the exchange rate policy loses credibility because the public expects a step devaluation with some positive probability. Such loss of credibility develops from increasing political pressure on the central bank to "do something" about the real appreciation which is building up as a result of the resilience of domestic inflation.

To take account of these considerations in a simple way, it is assumed that the political agreement regarding the fiscal situation is also expected to involve a devaluation of the domestic currency that reestablishes the equilibrium real exchange rate. It is assumed, moreover, that, as the fiscal position is consolidated and the real exchange rate is brought back to equilibrium, the system remains in a steady-state equilibrium, in which $e_t=\bar{e}$ and $\pi_t=0$--this last assumption can be thought of as if the structural factors that generated inflation inertia were removed as part of the political agreement.

The decision involving the timing of the step devaluation may be rationalized as follows. If a fiscal agreement has not yet been reached, a step devaluation would be interpreted as a signal that the stabilization is being abandoned. Thus, we assume that policymakers are able to resist the pressure to devalue until agreement on a fiscal package is reached. Once taxes are raised and the public is convinced that the conditions for permanent price stabilization are met, the central bank is then able to reestablish the real exchange rate level without loss of credibility. 1/ The nominal devaluation, in turn, avoids a costly period of deflation that would otherwise be necessary to restore the initial real exchange rate level.

1/ The assumption that the central bank devalues precisely at the time the agreement is reached is made for simplicity. Of course, the same results would follow if there is a probability distribution associated with the timing of the devaluation--as long as no devaluation is expected to occur before an agreement is reached and there is some positive probability that a devaluation will occur at the time of agreement.

The above scenario is consistent with the following determination of R(t). Suppose that, at the initial steady-state equilibrium (i.e., before the implementation of the stabilization plan), government expenditure and the service of the public debt are being financed by conventional taxes and seigniorage. At the time the exchange rate is fixed, there is some (although incomplete) adjustment of taxes, but at least a portion of the loss of seigniorage, as well as any exogenous shocks to existing sources of tax revenue, have to be financed through debt accumulation until an additional increase in taxes is agreed upon. For simplicity, it is assumed that the public sector borrows abroad. 1/ Formally, assume that real tax revenue after the initial fiscal adjustment, τ, is given by

$$\tau = g + \rho b_0 - \eta[\epsilon_0 m(\epsilon_0)], \tag{2}$$

where g denotes government expenditure, which is constant over time, b_0 denotes the initial public debt level, ρ is the (constant and exogenous) foreign interest rate, $\epsilon_0 m(\epsilon_0)$—where $m(\bullet)$ is the demand for money—denotes seigniorage, and η is the fraction of seigniorage that is not covered by an initial increase in taxes (if $\eta=1$; then there is no initial fiscal adjustment). (The price of traded goods—namely, S—is taken as the numeraire.) Thus, the required increase in taxes at time t, if an agreement is reached at that time, is given by

$$R(t) = \rho\,(b_t - b_0) + R(0), \tag{3}$$

where b_t denotes the public debt in period t. According to equation (3), $R(t)$ is an increasing function of time. The growth of $R(t)$ reflects the rate of accumulation of the public debt. In addition, $R(0) = \eta[\epsilon_0 m(\epsilon_0)]>0$.

Assuming that agents are risk-neutral and that bonds are pure assets in their portfolios, the following interest parity condition holds in equilibrium under perfect capital mobility:

$$i_t = \rho + E(\Delta S_t), \tag{4}$$

where $E(\Delta S_t)$ denotes the expected devaluation at time t. With the nominal exchange rate fixed by the stabilization program, the nominal interest rate can differ from the foreign interest rate, ρ, only if the public expects that the announced exchange rate policy will be abandoned or corrected. In this framework, the timing of the expected exchange rate devaluation is uncertain since, by previous assumptions, its occurrence is linked to the

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1/ One could assume that the government issues nonindexed domestic debt. This may imply that debt accumulation—and, hence, the time-path of R(t)—would also be affected by changes in the real interest rate paid on the public sector debt.

timing of the fiscal agreement. Let h_t be the hazard rate associated with a step devaluation of size $e_t - \bar{e}$ at time t, which brings the real exchange rate back to $\bar{e}$. Later on, the hazard rate h_t will be derived from a political economy model, but, for the time being, it is convenient to assume it as exogenously given. The instantaneous nominal interest rate associated with such an expected exchange rate devaluation is

$$i_t = \rho + h_t(\bar{e} - e_t) = \rho + h_t \alpha \pi_0 t. \tag{5}$$

If, for instance, h_t is constant over time—which implies that the stochastic process of the devaluation has an exponential distribution—then, the nominal interest rate moves inversely with the real exchange rate. As the real exchange rate falls, the nominal interest rate increases.

With these preliminaries at hand, we proceed to the first building block of the analysis.

2. A balance of payments crisis model

An important concern of policymakers after they initiate a price stabilization program is the possibility of a balance of payments crisis that could force them to devalue the currency or abandon the adjustment effort even if the evolution of fiscal fundamentals did not warrant such a policy reversal. In this subsection, we show that a balance of payments crises may develop if a credibility problem arises in connection with the appreciation of the domestic currency. As discussed in the previous subsection, loss of credibility may imply that the nominal interest rate rises over time as the real exchange rate falls, inducing a fall in the demand for money. The fall in the demand for money may generate a balance of payments crisis.

In order to analyze this issue more formally, consider the following demand for money:

$$M_t - S = \bar{m} - \delta i_t, \tag{6}$$

where M_t denotes the money supply at time t, and $\bar{m}$ is a constant. It is assumed that, at the time the nominal exchange rate is fixed, domestic credit growth is also set equal to zero. Thus, changes in the quantity of money occur only as a result of changes in foreign exchange reserves. Moreover, since domestic credit is constant, changes in foreign exchange reserves reflect changes in money demand occurring from variations in the nominal interest rate. In particular, if the nominal interest rate increases over time as a result of an increase in the expected devaluation, then the stock of foreign exchange reserves will fall over time.

The central bank is assumed to stick to the announced exchange rate policy as long as foreign exchange reserves do not fall below a certain threshold, corresponding to a money supply level of M^c—where c stands for "crisis". If M_t reaches M^c, then a balance of payments crisis occurs and the exchange rate policy collapses. It is assumed that the collapse of the exchange rate policy is associated with a resumption of domestic credit expansion. The post-collapse regime, thus, is one in which the nominal exchange rate is devalued at the rate ϵ, this rate being, for instance, the result of domestic money creation at the rate ϵ with a floating exchange rate regime. The post-collapse rate of devaluation reflects the resumption of monetary financing of the government budget. For simplicity, we assume that ϵ is exogenous. 1/

The public is assumed not to know the precise level of reserves at which the central bank abandons the exchange rate peg. Rather, it is assumed that the public's beliefs about M^c are described by a probability distribution, $W(x)=\text{Prob}\{M^c<x\}$ with a corresponding density function $w(x)\equiv dW(x)/dx$.

As time goes by, agents revise their beliefs about M^c according to Bayes's Law. Both the public's beliefs about M^c and the behavior of the nominal exchange rate at the time of the balance of payments crisis affect the nominal interest rate through the expected devaluation. In turn, the path of the nominal interest rate is crucial to determining the time of collapse of the exchange rate policy.

To determine the time of collapse and to characterize the nature of the balance of payments crisis, it is useful to define the time of collapse, T^c, as a monotonic decreasing function of the threshold level M^c when the nominal interest rate increases over time; i.e., $T^c=\mathrm{T}^c(M^c)$ if M_t is decreasing. The function $\mathrm{T}^c(\bullet)$ is obtained from the demand for money equation (6) and, therefore, is invertible. By inverting $\mathrm{T}^c(M^c)$, we can define $V(t)\equiv\text{Prob}\{T^c<t\}$ and the associated density function $v(t)$—note that $V(t) = 1 - W(M_t)$ and $v(t) = - w(M_t)\partial M_t/\partial t$.

Incomplete information about the timing of the balance of payments crisis has implications for the nature of the regime switch, which differ significantly from those emphasized by traditional balance of payments crisis models (see, for instance, Krugman (1978), Flood and Garber (1984), and Obstfeld (1986)). In particular, it is easy to show that incomplete information about M^c—and, therefore, about T^c—implies that the exchange rate may jump at the time of collapse. Reserves, on the contrary, may not

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1/ The post-collapse rate of devaluation, ϵ, could be endogenous. For instance, it could be assumed that a balance of payments crisis produces a breakdown in the negotiations about the fiscal package, and leads therefore to the monetary financing of $R(t)$ or a fraction of it. It would be exogenous if ϵ denoted, for instance, the rate that maximizes seigniorage.

jump in the transition. 1/ The step devaluation that occurs at time t, if $t=T^c$, equals—using equation (6)—$M_t - \bar{m} + \delta(\rho + \epsilon) - S$ (note that, assuming that M_t does not jump at $t=T^c$, implies that the nominal interest rate must increase at T^c). 2/ 3/ The nominal devaluation that occurs in the event of a balance of payments crisis is larger the higher is ϵ.

The precise time of collapse is obtained by computing the time path of the demand for money, using equation (6), where the nominal interest rate takes into account the public's expectations that a collapse may occur. Specifically,

$$M_t-S=\bar{m}-\delta\left[\rho+h_t(\bar{e} - e_t)\frac{\text{Prob}\{T^c>t+dt\}}{\text{Prob}\{T^c>t\}}+\frac{(M_t-\bar{m}+\delta(\rho+\epsilon)-S)}{dt}\frac{\text{Prob}\{t<T^c<t+dt\}}{\text{Prob}\{T^c>t\}}\right], \qquad (7)$$

where the public's beliefs about M^c, conditional on the crisis not having occurred until time t, and on M_t being a decreasing function of time, are given by:

$$\text{Prob}\{M_t<M^c<M_{t+dt}\,|\,t\} = \begin{cases} \dfrac{\text{v}(t)\,dt}{1-\text{V}(t)}, & \text{T}^c(M^c) \geq t, \\[2ex] 0, & \text{T}^c(M^c) < t. \end{cases} \qquad (8)$$

Of course, whenever M_t is increasing or constant over time, Bayesian updating of beliefs implies that $\text{Prob}(M_t<M^c<M_{t+dt}|t)=0$.

1/ Technically, there may exist a continuum of equilibria in which both the exchange rate and reserves jump at the time of the crisis, along lines similar to those discussed by Obstfeld (1986). For the sake of analytical tractability, we rule out equilibria in which reserves (or the money supply) jump at the time of collapse.

2/ To see that the nominal devaluation in the event of a balance of payments crisis equals $M_t - \bar{m} + \delta(\rho + \epsilon) - S$, note that M_t does not jump at the time of the crisis. Hence, the nominal exchange rate at the crisis has to jump to satisfy $S_t = M_t - \bar{m} + \delta(\rho + \epsilon)$, the post-crisis initial money market equilibrium condition.

3/ Note that the nominal interest rate has to be below the post-collapse nominal interest rate at all times before T^c. This is so because, since the pre-crisis nominal interest rate is a continuous function of time, a situation in which the nominal interest rate falls at T^c would have required that a balance of crisis occur before T^c, contradicting the definition of T^c.

Using equations (7) and (8), the demand for money is given by:

$$M_t = S + \overline{m} - \delta\left\{\rho + \frac{1}{1 + \delta\lambda_t}\left[h_t(\overline{e} - e_t) + \lambda_t\delta\epsilon\right]\right\}, \tag{9}$$

where $\lambda_t \equiv v(t)/[[1-V(t)]$ is the hazard rate of a balance of payments crisis.

Since, in this model, a balance of payments crisis is what causes the stabilization plan to fail, the hazard rate λ_t constitutes one of the two essential components of the credibility of the stabilization plan—the other component being the hazard rate of a fiscal agreement. While a full discussion of what determines the credibility of the stabilization program in this model is postponed until Section IV, it is clear that a higher λ_t—other things being equal—results in a loss of credibility. There are, thus, two important issues with regard to λ_t: first, its behavior over time (if λ_t increases over time, for instance, one would say that--other things being equal—credibility diminishes with the passage of time) and, second, its level. Both the level and the time path of λ_t are functions of the parameters of the demand for money and of those that enter the determination of the real exchange rate, as well as of the distribution function W(•), since these enter in the determination of the distribution function V(•). 1/

Consider, for instance, the effects of an increase in h_t on λ_t. An increase in h_t raises, ceteris paribus, the expected rate of devaluation, inducing a fall in the demand for money. (It can be observed in equation (7) that, even though the fall in the demand for money reduces the step devaluation associated with the balance of payments crisis, the net effect--for given λ_t—is an increase in the nominal interest rate.) It can be shown that, under suitable conditions, the fall in the demand for--and, hence, the quantity of—money results in an increase in λ_t. Thus, factors that result in an increase in the nominal interest rate also result in an increase in λ_t, thereby contributing to a loss of credibility.

An Example. To gain intuition on the evolution of money balances and on the hazard rate of a balance of payments crisis, it is useful to present an example of the model described above. This example will also be used in the numerical simulations presented in Section III.

1/ This is further illustrated in an example presented below.

Using the relationship that exists between V(•) and W(•), equation (9) may be written as:

$$M_t - S = \bar{m} - \delta\left\{\rho + h_t(\bar{e} - e_t) - [M_t - \bar{m} - S + \delta(\rho + \epsilon)]\frac{w(M_t)\dot{M}_t}{W(M_t)}\right\}. \tag{10}$$

Furthermore, suppose that M^c is uniformly distributed with lower and upper supports $[M_l, M_h]$, so that

$$\frac{w(M_t)}{W(M_t)} = \frac{1}{M_t - M_l}. \tag{11}$$

It is assumed, in addition, that 1/

$$M_l = \bar{m} + S - \delta(\rho + \epsilon). \tag{12}$$

By equations (11) and (12), equation (10) becomes the following linear differential equation:

$$M_t - S = \bar{m} - \delta\left[\rho + h_t(\bar{e} - e_t) - \dot{M}_t\right]. \tag{13}$$

For the purpose of this example, where a uniform distribution for M^c is used, we want to ensure that M_t never reaches M_l. 2/ Consequently, we assume that the expected devaluation associated with a fiscal agreement, $h_t(\bar{e} - e_t)$, is bounded from above. This may imply, for instance, that the

1/ This assumption allows an explicit solution of differential equation (10). The drawback of making this assumption is that we cannot use this example to either (1) make ϵ endogenous, or (2) do comparative statics with the parameters entering the right-hand side of equation (12)--since these would also imply a change in M_l. As will become clear, however, the analytical simplicity obtained pays significant dividends insofar as economic intuition is concerned.

2/ In the general case, since M_t is expressed in logs, there may be no finite lower support for the distribution of M^c. In that case, as the expected devaluation goes to infinity the money supply goes to zero--namely, M_t goes to minus infinity. Thus, no bound needs to be imposed on, say, the extent of the real appreciation.

real exchange rate reaches a lower bound for some arbitrarily large t—i.e., after time T, the real appreciation stops at $\alpha\pi_0 T$. 1/

Equation (13) may be solved to yield:

$$M_t = \overline{m} + S - \rho\delta - \int_t^{\infty} h_s(\overline{e} - e_s)\, e^{-\frac{s-t}{\delta}}\, ds, \tag{14}$$

where $\bar{e} - e_t = \alpha\pi_0 t$ for $t \in [0,T)$, and $\bar{e} - e_t = \alpha\pi_0 T$ for $t \in [T,\infty)$. (Recall that we assume that $M_t > M_l$.) Equation (13) shows that, because the hazard rate of a balance of payments crisis depends on the rate of change of the money supply, the level of money balances is determined by the entire expected future path of the fundamentals driving the expected rate of nominal devaluation.

To gain additional insight, let us assume that h_t is time-invariant. In this case, equation (13) boils down to:

$$M_t = \overline{m} + S - \delta\{\rho + h\alpha\pi_0[t + \delta(1 - e^{-\frac{T-t}{\delta}}]\}. \tag{15}$$

Differentiating equation (15) with respect to time, we obtain:

$$\dot{M}_t = -\delta h\alpha\pi_0[1 - e^{-\frac{T-t}{\delta}}] < 0. \tag{16}$$

Equation (16) shows that M_t falls over time for all $t \in [0,T)$, and remains constant over time for all $t \in [T,\infty)$. Moreover, for t sufficiently far away from T, the rate of decline of M_t is approximately constant and equal to $\delta h\alpha\pi_0$. As t approaches T, the rate of decline of M_t slows down and reaches zero at $t=T$.

Consider next the dynamic behavior of λ_t that is implied by this example. By equation (11),

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1/ Imposing an upper bound on the size of the real appreciation may be plausible for economic reasons. For instance, it may be thought that a large real appreciation will eventually produce a fall in aggregate demand, which in turn may eventually force inflation to fall.

$$\lambda_t = -\frac{\dot{M}_t}{M_t - M_l}, \tag{17}$$

where M_l is given by equation (12). 1/ Assume, in addition, that T is large enough to make M_T arbitrarily close (but greater than) M_l. The condition that $M_T > M_l$, implies that $\epsilon > h\alpha\pi_0 T$. Thus, it is assumed that:

$$\epsilon = h\alpha\pi_0(T + \phi), \tag{18}$$

where ϕ is an arbitrarily small (but positive) constant. By equations (12), (15), (17), and (18), we obtain:

$$\dot{\lambda}_t = \delta\left[\frac{h\alpha\pi_0}{M_t - M_l}\right]^2 \Omega(T-t), \tag{19}$$

where,

$$\Omega(T-t) \equiv \delta(1 - e^{-\frac{T-t}{\delta}}) - (T - t + \phi)e^{-\frac{T-t}{\delta}}. \tag{20}$$

It can be shown that Ω is positive except for an arbitrarily small period of time, in which t is arbitrarily close to T. Thus, the model implies that λ_t increases over time as M_t falls over time. (Numerical simulations of λ_t that take into account an endogenous h_t will be presented in Section III.)

We are now ready to turn to the second building block of the model. It characterizes, first, the process by which the fiscal adjustment required to make price stabilization sustainable is reached and, second, the factors that determine the public's expectations about the timing of a nominal devaluation.

3. A political economy model

In the previous subsections we have assumed that, as the real exchange rate falls below $\bar{e}$ after the initial fixing of the nominal exchange rate, the public expects a nominal devaluation that will bring the real exchange rate back to its long-run equilibrium level. The hazard rate associated with such a devaluation, h_t, was assumed to be exogenous. The purpose of this subsection is to derive h_t endogenously and, more generally, to present

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1/ It is worth noting that equation (17) illustrates how the parameters of the demand for money enter in the determination of λ_t and, hence, V(•).

a theory of how pressure groups influence policy that yields the above-mentioned scenario.

We characterize policymaking as a process in which decisions emerge as the outcome of negotiations between representatives of the relevant constituencies of a democratic society. These groups exert pressure on policymakers by investing resources in lobbying and in presenting to them their views about what impact alternative courses of action will have on the welfare of their constituencies. Since the effects of policies varies across constituencies, a negotiation process arises in which a policy package is designed. Ultimately, the policy package that emerges from this process is the result of an agreement between the various parts.

To be more specific, we assume that there are two constituencies, or pressure groups that must agree on the policy decisions. It is assumed that the position of constituency i at the negotiation table is given by:

$$U(t\ ,\ \theta_i) = y_t - H\left[\theta_i(\bar{e} - e_t)\ ,\ \pi_t\right], \tag{21}$$

where y_t denotes income net of taxes at time t and $H(\bullet)$ denotes a cost function that increases with the level of real appreciation relative to its long-run equilibrium level, and increases with inflation. The parameter θ_i, which affects the relative cost of a real appreciation compared to inflation for group i, is exogenously given and is the only parameter that differentiates the two constituencies from each other. Since the position of constituency i over particular policy issues may depend at any given point in time on a variety of reasons not explicitly explored here, it is assumed that $\theta_i \in [\underline{\theta}, \bar{\theta}]$ is a random variable, drawn from a distribution $G(\theta)$ with density function $g(\theta)$. Utility function (21) implies that the two constituencies dislike both real appreciation and inflation, as well as taxes. The fact that both constituencies dislike a real appreciation of the domestic currency implies that pressure builds on the central bank to devalue whenever e_t falls below $\bar{e}$.

At the time the exchange rate is fixed, the level of taxation is assumed to be divided equally across constituencies; thus, let the initial value of y_t be y for both constituencies. Moreover, y_t will remain at its initial level until an agreement is reached. The subsequent path of taxes and, especially, the distribution of any additional taxation is a matter of negotiation between the two constituencies.

Since at the start of the stabilization plan the fiscal situation is not consolidated, an agreement needs to be reached over a policy package that includes, first, a nominal devaluation designed to eliminate the real appreciation and, second, the distribution of the additional taxes, $R(t)$, required for the long-run sustainability of price-stabilization.

The decision process is modeled as a war of attrition with incomplete information (see, for instance, Bliss and Nalebuff (1984), Fudenberg and

Tirole (1986), Hendricks, Weiss, and Wilson (1986), Alesina and Drazen (1991)). As is well known, a war of attrition is a game of timing. Hence, it is a useful device to characterize a period of stalemate in which constituencies test how costly it is for their political opponents to postpone policy actions. When the costs of postponing the implementation of the policy package become unbearable for one group, this group concedes in the sense that it is willing to accept the larger share of the new taxes.

Constituencies know the value of their own parameter θ. However, they are assumed not to know the precise value of the opponent's parameter θ, knowing only the distribution $G(\theta)$. Each constituency's strategy consists in maximizing the group's intertemporal expected utility by the choice of a concession time, T_i. Formally, the pair of functions $\{T_1 = T(\theta_1), T_2 = T(\theta_2)\}$ define a symmetric, Bayesian-perfect equilibrium. (The equilibrium is symmetric because θ_1 and θ_2 are assumed to be drawn from the same distribution.)

It will be shown that $T(\theta)$ is strictly decreasing with a differentiable inverse function, $\Phi(t) \equiv T^{-1}[T(\theta)]$. The function $\Phi(t)$ provides, for any point in time t, the value of θ for which t is a time of concession. Therefore, one can define a distribution for the concession time, $F(T_i)$, such that

$$F(T_i) = 1 - G(\theta_i)$$

$$f(T_i) = - g(\theta_i)\Phi'(T_i), \tag{22}$$

where $\Phi'[T(\theta_i)] = [T'(\theta_i)]^{-1}$.

In order to obtain $T(\theta_i)$, we first solve for the optimal choice of T_i ignoring, for the time being, the possibility of a balance of payments crisis. Later on, the balance of payments crisis will be incorporated into the analysis. Constituency i maximizes expected utility over T_i; namely, it maximizes:

$$\text{Prob}\{T(\theta_j) \geq T\}\left[\int_0^T U(t,\theta_i)e^{-\rho t}dt + \frac{U^{\ell}(T)}{\rho}e^{-\rho T}\right] + \int_{\{\theta_j|T(\theta_j)<T\}}\left[\int_0^{T(\theta_j)} U(t,\theta_i)e^{-\rho t}dt + \frac{y_0}{\rho}e^{-\rho T(\theta_j)}\right]g(\theta_j)\,d\theta_j, \tag{23}$$

where $U^{\ell}(T)$—ℓ stands for "low"—denotes the utility level at time T if constituency i concedes. It is assumed, for simplicity, that the group that concedes bears all the cost of new taxes. (It is useful to recall that, once the policy package is implemented, the system remains in a steady state equilibrium in which there is no inflation and the real exchange rate is brought back to its long-run equilibrium level, $\bar{e}$.) Thus, $U^{\ell}(T)=y-R(T)$. Moreover, if $R(t)$ is given by equation (9), then $U^{\ell}(T)=y-R(0)-\rho(b_T-b_0)$; i.e., additional taxes are required to finance the initial fiscal gap plus the servicing of the higher stock of public debt incurred between times 0 and T (since we are assuming that $b_T>b_0$).

The first-order condition associated with the above maximization problem implies that

$$\Phi'(T_i) = -\frac{G(\Phi(T_i))}{g(\Phi(T_i))}\left[\frac{U(T_i,\Phi(T_i)) + \frac{U^{\ell\prime}(T_i)}{\rho} - U^{\ell}(T_i)}{\frac{U^{\ell}(T_i) - y_0}{\rho}}\right], \tag{24}$$

which, using equation (22), may also be expressed as

$$T'(\theta_i) = -\frac{g(\theta_i)}{G(\theta_i)}\left[\frac{\frac{U^{\ell}(T(\theta_i)) - y_0}{\rho}}{U(T(\theta_i),\theta_i) + \frac{U^{\ell\prime}(T(\theta_i))}{\rho} - U^{\ell}(T(\theta_i))}\right]. \tag{25}$$

In obtaining equations (24) and (25), we have used the fact that since the equilibrium is symmetric, then $G(\theta_1)=1-G(\theta_2)$ and, hence, $F(T_1)=1-F(T_2)$. The equilibrium strategies $T(\theta_i)$, i=1,2, are obtained by solving the differential equation (25). 1/

The interpretation of equations (24) and (25) follows from the standard trade-off faced by each of the players in a war of attrition. Using (22), the trade-off is expressed in terms of the costs and benefits from waiting another instant before conceding to the other group; at an optimum, these are equal to each other. On the one hand, the benefit of not conceding at any point in time T_i is given by

$$\frac{f(T_i)}{1 - F(T_i)}\left[\frac{y_0 - U^{\ell}(T_i)}{\rho}\right] = \frac{f(T_i)}{1 - F(T_i)}\left[\frac{R(T_i)}{\rho}\right]. \tag{26}$$

The benefit of not conceding equals the present discounted value of additional taxes, $R(T_i)/\rho$, times the hazard rate that the other group concedes at time T_i, $f(T_i)/[1-F(T_i)]$. On the other hand, the cost of not conceding at any given time T_i is given by

$$U^{\ell}(T_i) - \frac{U^{\ell\prime}(T_i)}{\rho} - U[T_i, \Phi(T_i)] = H[\Phi(T_i)(e_{T_i} - \bar{e}), \pi_{T_i}] - R(T_i) + \frac{R'(T_i)}{\rho}, \tag{27}$$

where $R'(T_i)>0$. The cost of not conceding consists of (1) the difference, at time T_i, between the cost associated with the real appreciation and inflation, H(•), and the additional taxes incurred if one concedes, $R(T_i)$, and (2) the present discounted value of the increase in R(•) if concession does not occur at T_i.

If, during the stalemate period, taxes are given by equation (2), and the government borrows at the international interest rate, then

1/ Note that, since the equilibrium is symmetric, there is only one function T(·) to be determined. In the case of an asymmetric equilibrium, each group would have its own $T^i(\cdot)$ functions, obtained from solving a system of differential equations, as pointed out by Fudenberg and Tirole (1986).

$$\dot{b}_t = g - \tau + \rho b_t = R(0) + \rho(b_t - b_0) = R(t), \tag{28}$$

which implies that 1/

$$R'(t) = \rho R(t). \tag{29}$$

If equation (29) holds, then, by equation (27), the cost of not conceding is simply given by H(•).

Equations (22) and (24) may be used to obtain the hazard rate associated with reaching a political agreement, h_t, which, by previous assumptions, is also the hazard rate associated with a step devaluation that brings the real exchange rate back to its equilibrium level—i.e., a devaluation of size $\bar{e} - e_t$. Denoting by $Z(T)$ the cumulative probability that agreement is reached by time T, and by $z(T)$ the associated density function that provides the probability of an agreement at each point in time, one obtains—following Drazen and Grilli (1990), for instance—the hazard rate of one constituency conceding. Since it can be shown that $1-Z(T)=G(\theta)^2$ and $z(T)=-2G(\theta)g(\theta)\Phi'(T)$, then—using (24), (26), and (27)—the following expression for h_t obtains:

$$h_t = \frac{z(t)}{1 - Z(t)} = -\frac{2g(\theta)\Phi'(t)}{G(\theta)} = \frac{H(t,\Phi(t)) - R(t) + \frac{R'(t)}{\rho}}{\frac{R(t)}{\rho}}, \tag{30}$$

where $\Phi(t)$ solves equation (24). 2/ If equation (29) holds, then

$$h_t = \frac{H(t,\Phi(t))}{\frac{R(t)}{\rho}}. \tag{30'}$$

1/ Note that equation (29) would not hold if, say, there were shocks to taxes during the stalemate period or if the government was forced to pay a different interest rate on its debt. Equation (3), of course, would hold even under these circumstances because we assume that, once a fiscal agreement is reached, the government is able to borrow at the international interest rate in the new steady-state equilibrium. Thus, debt service at the international interest rate—plus, of course, R(0)—is what needs to be financed by taxes, should an agreement be reached.

2/ An earlier version of this paper presents an example in which specific functional forms are chosen for R(•), H(•), and G(•), so that h_t is time-invariant and equation (24) is solved explicitly.

In order to explore how h_t depends on the parameters of the model, consider the effect of a higher real appreciation at time t on h_t. For given $\Phi(t)$, a higher real appreciation--i.e., a lower e_t--increases H(•) and, hence--by equation (27)--raises the cost of not conceding at time t for both constituencies. For given $\Phi(t)$, the benefit of not conceding remains unchanged. Thus, for given $\Phi(t)$, there would be an increase in h_t. As intuition suggests, an increase in the cost of not conceding can be shown to reduce the time of concession associated with any value of parameter θ. 1/ Thus, since $\Phi(t)$ is a monotonic and decreasing function, a higher real appreciation at time t induces a decrease in $\Phi(t)$. (Note that, if for all $\theta<\bar{\theta}$ the time of concession falls, then, for any t, $\Phi(t)$ must fall.) Of course, even though the higher real appreciation reduces $\Phi(t)$, the net effect is an increase in H(•), which--by equation (30)--implies an increase in h_t. Similarly, it can be shown that an upward shift in $R(t)$--leaving $R'(t)$ unchanged--induces a fall in h_t.

In the absence of additional considerations, it can be shown that the length of the stalemate period (in which no agreement is reached) may extend ad infinitum. The assumption that $R'(t)>0$, however, implies that, at some point in time, the government may simply become insolvent--i.e., further increases in $R(t)$ are infeasible. Alesina and Drazen (1991) use this condition to impose a somewhat artificial end to the war of attrition by assuming that a policy package, which contains an exogenous distribution of taxes, is implemented at the time the government runs into insolvency. In this model, however, the balance of payments crisis provides an end to the war of attrition.

Let us now incorporate the balance of payments-crisis model presented earlier into the political-economy model. To keep the analysis as simple as possible, it is assumed that the two constituencies negotiating the fiscal package know M^c--while M^c is not known by individual consumers. If M^c is known, then the precise time at which a balance of payments crisis occurs (provided it occurs), T^c, is also known for the war of attrition. 2/

1/ The formal proof follows Alesina and Drazen (1991). As can be observed from equations (25) and (30), a shift in H(•), for given θ, increases $T'(\theta)$ (i.e., $T'(\theta)$ decreases in absolute value). Since $T(\bar{\theta})=0$ always, then the fall in the absolute value of $T'(\theta)$ implies that concession time falls for any given $\theta<\bar{\theta}$.

2/ If M^c were to be unknown to the players in the war of attrition, T^c would be uncertain. The assumption that M^c is known to the players in the war of attrition is made for the purpose of simplifying the analysis. Making T^c uncertain should not alter any of the results.

It is assumed that T^c precedes the point in time at which the government becomes technically insolvent. 1/ A balance of payments crisis implies that $e_t = \bar{e}$ and $\pi_t = \epsilon$. Two possibilities unfold at this time. On the one hand, if the utility loss associated with the balance of payments crisis is large enough—because the post-collapse inflation rate is high—then T^c acts as a mass point for the war of attrition. Thus, both groups will concede with probability 1 at T^c; i.e, agreement will be reached before the balance of payments crisis takes place. This is a case in which the prospect of a balance of payments crisis shortens the period of political stalemate by increasing the costs of not agreeing on the fiscal adjustment. As shown by Alesina and Drazen (1991), if a tie-breaking rule—for instance, the flip of a coin—is used in the event both groups concede at T^c, then the presence of a mass point at T^c does not alter the optimal strategy, $\Phi(T)$, for all constituencies with $\theta > \hat{\theta}$, where $\hat{\theta}$ denotes the parameter level at which a constituency is indifferent between conceding or waiting up to T^c. Define $\hat{T} = T(\hat{\theta})$. 2/

On the other hand, if the utility loss associated with a balance of payments crisis is not high enough, then it is possible that no group concedes. It is clear from (26) and (27) that, if the benefit of not conceding is high enough, both constituencies will find it optimal to let the crisis occur, since the costs of conceding for each individual constituency outweigh the costs associated with a resumption of inflation. Hence, from its own perspective, each constituency will find it optimal to let the balance of payments crisis happen, even though it is a suboptimal strategy if the two constituencies could cooperate and avoid the war of attrition.

III. Simulation of the Model

In order to illustrate and provide further insights into the workings of the model, this section undertakes some simulation exercises. These simulations will also prove useful for the next section where the main economic implications of the model are discussed.

Formally, the function $\Phi(t)$, given by solving equation (24), is not affected by the parameters of the balance of payments crisis model. Hence, we first simulate the war of attrition and study the dynamic behavior of $\Phi(t)$, $H(t)$, and h_t. Given the path for h_t, the path of λ_t will be simulated

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1/ This assumption may be rationalized along the lines that it is difficult for creditors to determine the precise point of bankruptcy for sovereign governments. Hence, it is reasonable to expect that lending to the central bank will stop before actual insolvency is reached.

2/ Alesina and Drazen (1991) show that, by appropriate choice of parameters, $\hat{T}$ can be made arbitrarily close to T^c.

using the linear example developed in Section II. Suppose that the cost function takes the form:

$$H[\theta(\bar{e} - e_t),\pi_t] = \theta|\bar{e} - e_t| + \frac{\pi_t^2}{2}. \tag{31}$$

Recalling that the inflation rate during the stabilization is $\alpha\pi_0$, which implies that the real exchange rate falls linearly over time (equation (1)), it follows that

$$H[\theta(\bar{e} - e_t),\pi_t] = \theta\alpha\pi_0 t + \frac{(\alpha\pi_0)^2}{2}. \tag{32}$$

Assuming that equation (29) holds, and taking into account equations (28) and (32), equation (30) can be rewritten as

$$h_t = \frac{\rho\left[\Phi(t)\alpha\pi_0 t + \frac{(\alpha\pi_0)^2}{2}\right]}{R(0)\ e^{\rho t}}. \tag{33}$$

Furthermore, let us assume that $G(\theta)$ follows a uniform distribution with support $[\underline{\theta},\bar{\theta}]$; that is:

$$G(\theta) = \frac{\theta - \underline{\theta}}{\bar{\theta} - \underline{\theta}}. \tag{34}$$

Taking into account equations (30′) and (34), equation (24) becomes:

$$\Phi'(t) = -(\bar{\theta} - \underline{\theta})\ h_t. \tag{35}$$

Equation (35), taking into account (33), constitutes a nonautonomous, nonlinear differential equation in $\Phi(t)$. Given the initial condition $\Phi(0)=\bar{\theta}$, this differential equation can be solved numerically. The solution can then be substituted into equation (33), to obtain the path of h_t.

Figure 1 illustrates the paths for $\Phi(t)$, $H(t)$, and h_t, respectively, for a benchmark case in which α=0.32. 1/ As expected, Panel A in Figure 1 shows that $\Phi(t)$ decreases over time. Intuitively, recall that $\Phi(t)$ indicates, for a given t, the value of θ that would make a group concede. As time goes by, only groups with a lower θ (for which it is less costly not to concede) remain in the war of attrition, which makes $\Phi(t)$ a decreasing function of time.

Panel B in Figure 1 illustrates the time path of $H(t)$, the cost of waiting, which is given by equation (32). Since the inflation rate remains constant at $\alpha\pi_0$, the path of $H(t)$ depends on the cost of the real appreciation given by the first term on the right-hand side of equation (32). As time goes by, the real exchange rate falls linearly (recall equation (1)), which calls for an increasing H. However, the relative weight carried by the real appreciation of the domestic currency, θ, falls over time, which tends to reduce H over time. Panel B in Figure 1 shows that for the benchmark case in which α=0.32, the effects of the real appreciation prevail at the beginning and $H(t)$ increases rapidly. Later, the falling θ offset the real appreciation causing $H(t)$ to reach a relative maximum. Eventually, the real appreciation takes over once again and $H(t)$ increases, albeit at a slower rate.

Panel C in Figure 1 shows the time path of h_t. Given the behavior of $H(t)$ depicted in Panel B, it should not come as a surprise that the path of h_t is also non-monotonic. Recall that h_t, given by equation (33), depends positively on the cost of waiting, H, and negatively on the present value of the additional stock of debt that results from the incomplete initial fiscal adjustment. In the beginning, h_t increases over time and reaches a relative maximum, mirroring the behavior of $H(t)$. Afterwards, however, the effects of the accumulated debt, which makes it more costly to concede, implies that h_t falls over time.

Let us now illustrate several comparative-dynamics exercises. Suppose that there is a lower degree of inflation inertia in the economy (i.e., a lower α). 2/ As Panel A in Figure 1 illustrates, the new time path of $\Phi(t)$ lies above the one corresponding to the benchmark case. Intuitively, at any point in time, the cost of waiting has decreased because the domestic currency is less appreciated in real terms. Therefore, a group with a higher θ will now concede. Panel B shows that the path of $H(t)$ lies below the benchmark path. This is to be expected since the lower (constant) inflation rate during the stabilization--which is reflected in a reduction in the second term on the right-hand side of equation (32)--results in a "scale" effect on $H(t)$. The effect on the cost of the real appreciation is ambiguous because the higher real exchange rate at any point in time is

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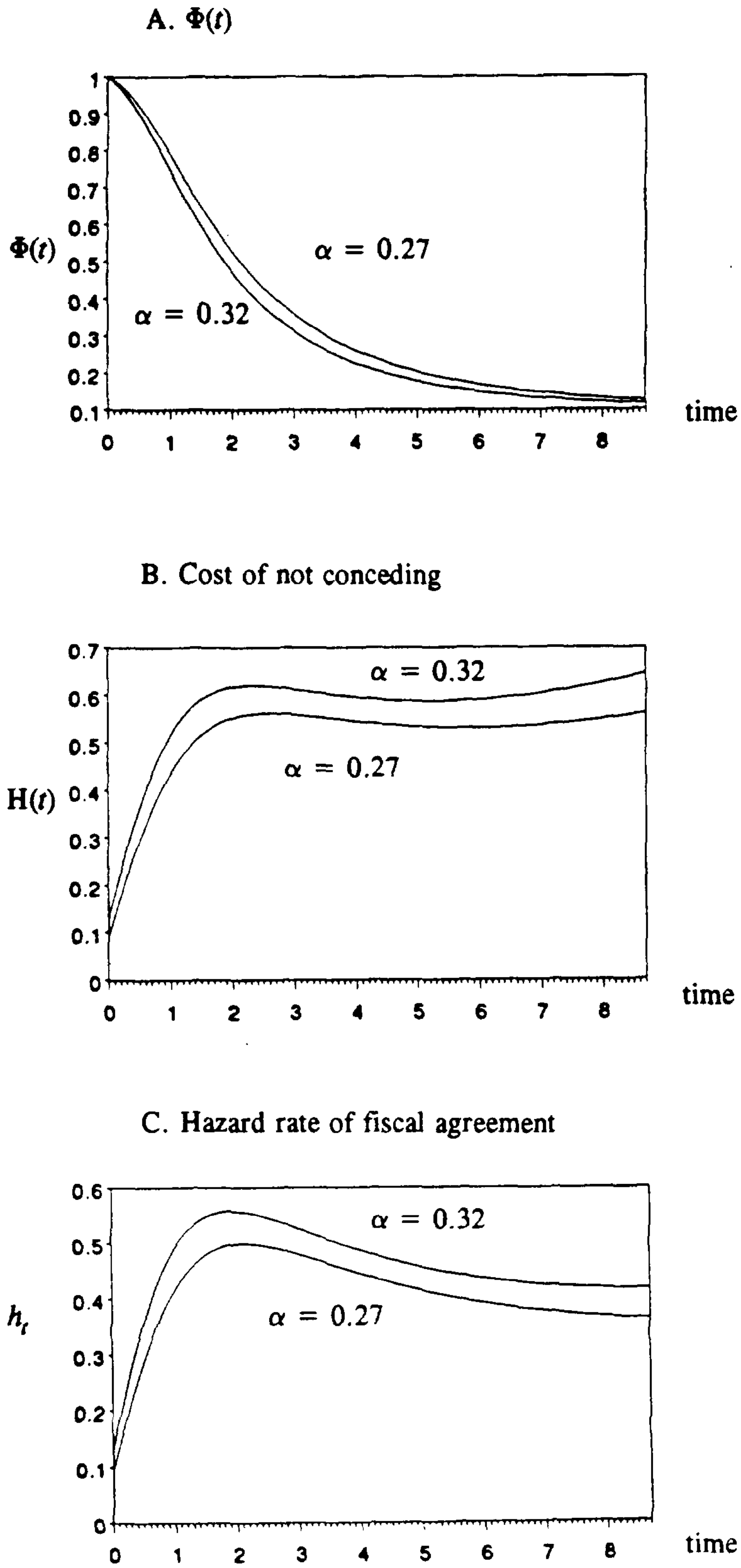
1/ The other parameter values for the benchmark case are: $\pi_0 = 1.6$; $\rho = 0.05$; $R(0) = 0.05$; $\underline{\theta} = .1$; $\bar{\theta} = 1$.

2/ Specifically, it is assumed that α now equals 0.27 rather than 0.32 as in the benchmark case.

FIGURE 1. WAR OF ATTRITION: EFFECTS OF A FALL IN α



offset by a higher θ. 1/ Panel C in Figure 1 shows that the path of h_t also shifts downward, since the cost of waiting is now lower. In this sense, therefore, better initial conditions may be detrimental because, by making it less costly to wait, they reduce the conditional probability that an agreement will be reached. (Of course, it may also decrease the probability that a balance of payments crisis may occur, as discussed below). 2/

Consider now the effects of a less severe initial fiscal adjustment. Specifically, assume that the parameter configuration corresponding to the benchmark case is retained but $R(0)$ is increased from 0.05 to 0.1. Panel A in Figure 2 shows that the new path of $\Phi(t)$ lies above the original path. At any given point in time, the cost of conceding has increased because the present value of the accumulated debt is higher. Hence, only groups with a higher θ will now concede. A higher $R(0)$ has no effect on $H(t)$, the cost of waiting. Hence, as Panel B in Figure 2 illustrates, the impact of a higher $R(0)$ on h_t derives exclusively from the fact that the higher present value of the additional stock of debt increases the cost of conceding, thus shifting downward the whole path of h_t. Hence, the less drastic the initial fiscal adjustment, the more likely it is that the final budget agreement will be delayed.

We now turn to the simulation of the balance of payments crisis. In particular, we are interested in how λ, the hazard rate associated with the balance-of-payment crisis, evolves over time. The simulation will be carried out using the linear example presented in Section II. Thus, the hazard rate is given by equation (17), reproduced here for convenience:

$$\lambda_t = - \frac{\dot{M}_t}{M_t - M_l}, \tag{17}$$

where $\dot{M}_t$ and M_t are given by equations (13) and (14) respectively. As discussed above, the path of M_t, and thus that of λ_t, is affected by h_t. The reason is that if and when a budget agreement is reached, a nominal devaluation will restore the real exchange rate to its initial equilibrium value. Thus, other things being equal, a higher h_t increases the expected devaluation and hence the nominal interest rate. Panel A in Figure 3

1/ Note, however, that a fall in α must always result in a lower $H(t)$. For suppose, to the contrary, that the increase in θ was so high as to outweigh the fall in α and induce an increase in $H(t)$. Then, by the arguments put forward in section II, an increase in $H(t)$ would induce a fall in θ. Thus, a contradiction would arise, since both α and θ would be falling while $H(t)$ would be increasing, which is inconsistent with equation (32).

2/ Note that the effects of a higher initial inflation, π_0, are the same as those of a higher α, so that they need not be explicitly discussed.

illustrates the path of λ_t in the benchmark case in which α=0.32. 1/ To understand the behavior of λ_t , it is useful to consider the path of the nominal interest rate, illustrated by Panel B in Figure 3, which is given by:

$$i_t = \rho + h_t \alpha \pi_0 t - \dot{M}_t. \tag{36}$$

Two factors determine the behavior of the nominal interest rate over time. The first is the expected devaluation associated with a budget agreement (the second term on the right-hand side of equation (36)). This term increases unambiguously whenever h_t is increasing, which occurs in the first phase of the stabilization, as illustrated in Panel C in Figure 1. The second factor, given by $\dot{M}_t$ in equation (36), reflects the fact that as the stock of money decreases the critical level at which the central bank abandons the fixed exchange rate, which implies a discrete devaluation of the exchange rate, gets closer. Panel B in Figure 3 shows that the nominal interest rate always increases over time.

Consider now the path of λ_t. As the nominal interest rate increases over time, money demand falls, which makes it more likely that a balance of payments crisis will occur as the money stock gets closer to the critical level. This effect is captured by the denominator in equation (17). The speed at which money demand falls also affects the behavior of λ_t (which is captured by the numerator in equation (17)). The faster money demand falls (i.e., the greater in absolute terms is $\partial^2 M/\partial t^2$), the more likely it is that a balance of payments crisis will occur. As can be seen from Figure 3, Panel A, λ_t increases at first. Then, owing to the fall in h_t (recall Panel C in Figure 1), the speed at which the money stock falls decreases, causing λ_t to fall for a while. 2/ Eventually, as the stock of money gets closer to its critical level, λ_t increases exponentially.

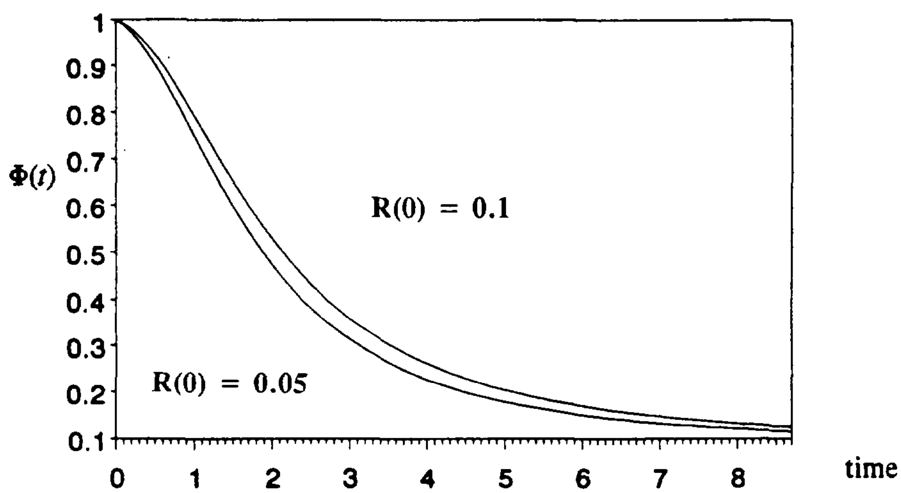
Consider now the effects of a fall in α from 0.32 to 0.27. Since this reduces the inflation rate during the stabilization, the real appreciation of the domestic currency is lower at each point in time. Hence, the devaluation that would take place if a budget agreement were reached is smaller, which reduces the nominal interest rate at any point in time, as illustrated by Panel B in Figure 3. The lower nominal interest rate gets reflected in a downward shift in the path of λ_t (see Figure 3, Panel A). Money demand is higher at each point in time, which reduces the likelihood of a balance of payments crisis.

1/ In addition to the parameters values used in the war of attrition, δ=0.05, ϵ=5, and M_f=0.05.

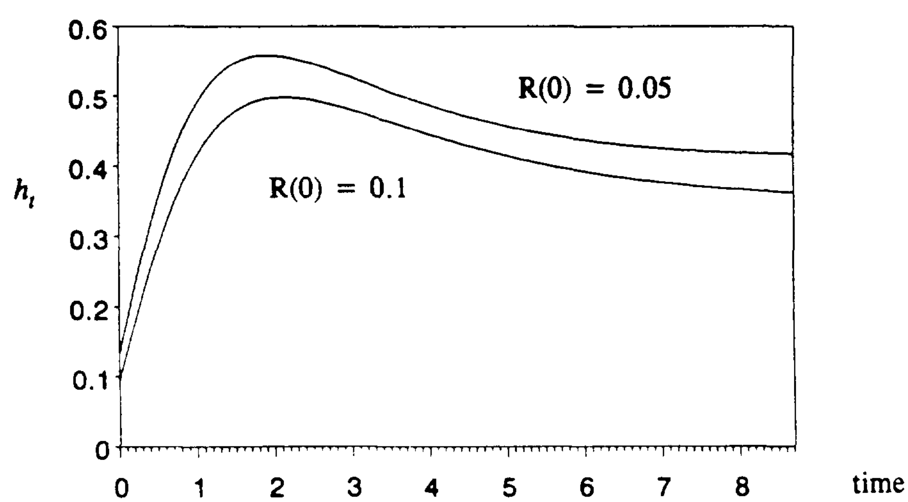
2/ Under other parameter configurations, λ_t increases over time monotonically.

FIGURE 2. WAR OF ATTRITION: EFFECTS OF AN INCREASE IN R(0)

A. $\Phi(t)$



B. Hazard rate of fiscal agreement



IV. Discussion

The previous sections introduced the key building blocks of the model and simulated a particular specification to gain further insights. We are now in a position to address the issues raised in the Introduction in the context of the present model.

Suppose that policymakers announce a stabilization plan that consists of, first, fixing the exchange rate and, second, implementing a fiscal package that partially reduces the fiscal imbalance. The inflationary process displays inertia, so that the inflation rate remains above the rate of devaluation (which is zero in this case). As argued in the Introduction, many stabilization plans, whether successful or unsuccessful, fit this pattern. In terms of the model described in Section II, three main features characterize the dynamics of such a stabilization plan. First, the presence of inflationary inertia causes the domestic currency to appreciate in real terms, thus creating the expectation that there will be a devaluation at some point in time to restore the equilibrium real exchange rate. Second, since inflationary financing ends when the fixed exchange rate is announced and the fiscal measures are not enough to balance the budget, the remaining fiscal deficit must be financed by issuing public debt. In the meantime, pressure groups negotiate over how the burden of the remaining fiscal measures will be shared. Furthermore, we assume, for simplicity, that if and when a budget agreement is reached, a devaluation that restores the equilibrium real exchange rate is also part of the agreement. Third, since the real exchange rate keeps falling over time, the expected devaluation associated with the restoration of the equilibrium exchange rate increases over time. The increasing nominal interest rate causes real money demand, and thus reserves, to fall over time which, in turn, creates the expectation that a balance of payment crisis may occur.

A key feature of the model is that the difference between success or failure may be a question of "days," in the sense that, at a given point in time, a small delay in reaching a budget agreement may mean that the balance of payments crisis becomes a reality. Interestingly enough, before the plan comes to an end (either successfully as a result of an agreement or unsuccessfully as a result of a balance of payments crisis) both successful and unsuccessful stabilizations look qualitatively the same: inflation is still high, the real appreciation continues, the public debt is increasing, and the nominal interest rate is also increasing. An outside observer may be puzzled at seeing that the same conditions precede in some cases what goes down in history as a successful stabilization, and in other cases a plan whose only claim to fame will be an obscure footnote in a paper stating something like "clearly, the program was doomed to failure from the very beginning for lack of a comprehensive fiscal package." 1/

1/ Dornbusch (1988) has argued that successful and failed stabilizations look very similar at the beginning of the program and cites as an example the Poincare's stabilizations of 1924 and 1926.

A related question is why it would be in the interest of pressure groups to let the balance of payments crisis occur. When the balance of payments crisis occurs, the real exchange rate returns to its equilibrium level (which reduces welfare costs), but inflation jumps to a higher level (which increases welfare costs). Thus, it may well be that the welfare costs associated with inflation and real appreciation do not change. Therefore, the remaining cost associated with the balance of payments crisis is the burden of the inflation tax that will finance the budget deficit. If, say, this burden is shared equally between the different pressure groups, then it may be optimal for no pressure group to concede (in which case it would bear all the burden of the new taxes) and let the balance of payments crisis occur.

Let us now deal explicitly with the notion of credibility. Credibility in this model (as of time t) is defined as the probability of the budget agreement being reached before the balance of payments crisis occurs, given that neither has occurred as of time t. Formally, let X^S denote the time elapsed without a budget agreement and X^C the time elapsed with no balance of payments crisis occurring. Then, 1/

$$\text{Credibility} \equiv \text{Prob}\{X^S < X^C \,/\, \text{Min}(X^S, X^C) = t\} = \frac{h_t}{h_t + \lambda_t}. \tag{37}$$

To gain intuition into the definition of credibility given by equation (37), consider two extreme cases. Suppose that the probability of a budget agreement was zero (i.e., h_t=0), then the credibility of the program would always be zero. Naturally, this makes sense because, by definition, the program cannot be successful. Also, if the hazard rate of a balance of payments crisis becomes very large, credibility tends to zero. If, on the other hand, a budget agreement is perceived as highly likely (so that h_t becomes very large), then credibility becomes close to unity. Credibility is an increasing function of h_t and a decreasing function of λ_t, as one should intuitively expect.

Credibility, as defined in equation (37), is an endogenous variable and depends on all the parameters of the model. Figure 4 simulates the time path of credibility for the benchmark case discussed in the previous section (where α=0.32). Initially, credibility is 0.739; that is, as of time 0, the probability that the budget agreement will be reached before a balance-of-

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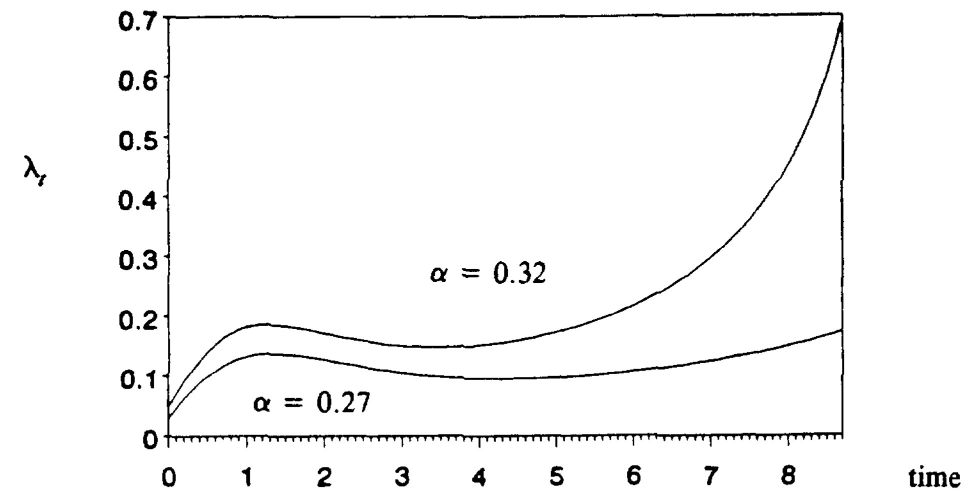
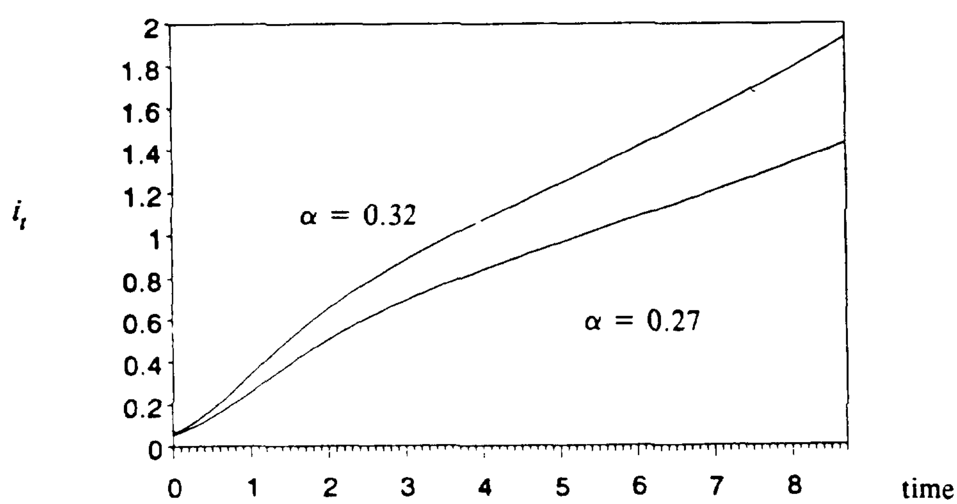
1/ The left-most equality in equation (37) follows from basic probability theory (see, for example, Ross (1983), p. 287), taking into account that X^C and X^S are independent random variables. The assumption that M^C is known to the players in the war of attrition ensures stochastic independence between X^C and X^S. However, note that, by equation (17), λ is functionally dependent on h.

FIGURE 3. BALANCE OF PAYMENTS CRISIS: EFFECTS OF A FALL IN α

A. Hazard rate of balance of payments crisis



B. Nominal interest rate



payment crisis occurs is 73.9 percent. 1/ After a brief period of time at the beginning of the program during which it falls, credibility increases reaching a maximum of 77.8 percent at t=3. Intuitively, the fact that the stabilization is proving costly in terms of the real appreciation and little public debt has accumulated makes it more likely that a budget agreement will be reached, lending credibility to the program. Thereafter, credibility begins to fall at an increasing rate reflecting, first, the sharp increase in λ_t (see Figure 3, Panel A), and, second, a decreasing h_t (Figure 1, Panel C). When the simulation ends, credibility stands at only 37.6 percent, roughly half of what it was at the beginning of the program. This last stage could be identified with the last phase in many exchange rate-based stabilizations in which the public sees the end of the program as basically inevitable and the only question becomes not if but when the program will end.

The main features of Figure 4—namely, that there is an initial period when the stabilization program gains credibility followed by a second period in which credibility falls over time—are robust to the extent that they reflect fundamental characteristics of the war of attrition and of the balance of payments crisis. The initial gain in credibility occurs whenever the forces that make a fiscal agreement more likely dominate. The hazard rate of fiscal agreement increases over time to the extent that the dominating factor is a high and increasing cost of waiting, which results from high inflation and from an increasing real appreciation of the domestic currency. At a later stage, credibility falls as two effects take over. First, the increasing public debt induces policymakers to postpone the fiscal agreement. Second, the increasing exchange rate misalignment and, hence, increasing interest rates make the balance of payments crisis more likely as time goes by.

We are also interested in having a measure regarding the likely duration of the program. It seems natural to take the hazard rate that the program will end—either successfully or unsuccessfully—conditional on having lasted up to now. It is easy to verify that this hazard rate equals $h_t + \lambda_t$. The higher the hazard rates of either a budget agreement or a balance of payments crisis, the higher the hazard rate that the program will come to an end, for good or for bad. The duration of the program so defined is not necessarily related to the credibility of the program. In fact, an increase in λ_t not only decreases the credibility of the program but also reduces the duration of the program (i.e, makes it more likely that the program will end sooner).

Let us now analyze the main factors that affect the credibility of the program and the duration of the stabilization plan.

1/ Note that, unlike h_t and λ_t which are hazard rates, credibility is a probability and hence its value at each point in time has the usual interpretation.

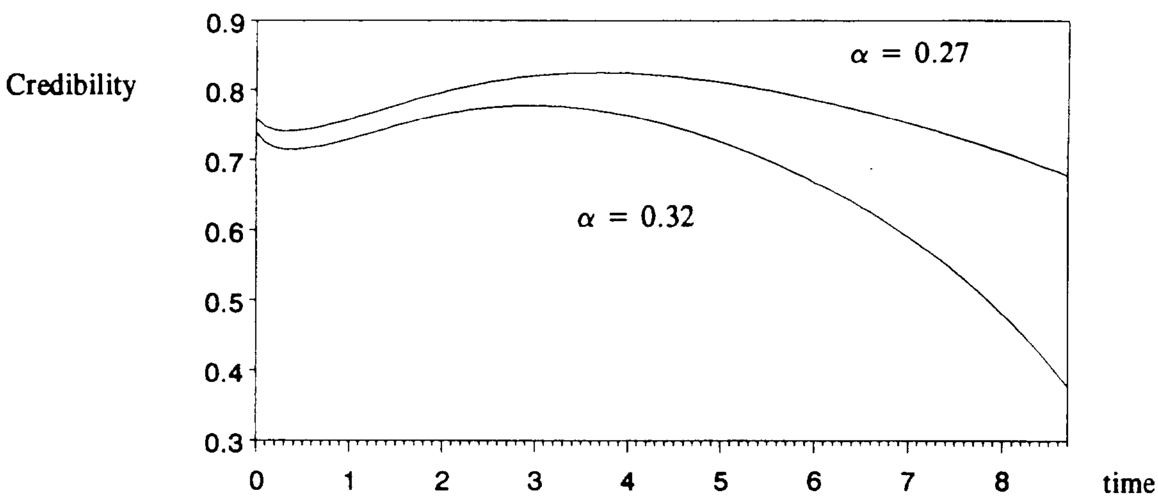
(1) For a given initial fiscal adjustment, a higher degree of inflation inertia and/or a higher initial inflation rate have an ambiguous effect on credibility but shorten the duration of the program. The intuition behind the ambiguous effect on credibility is as follows. The higher the initial inflation, the lower is the real exchange rate at any point in time (i.e., the greater is the real appreciation of the domestic currency), which results in a higher nominal interest rate (Panel B in Figure 3). This shifts up the entire path of λ_t (Panel A in Figure 3), which reduces the credibility of the program at any point in time. On the other hand, both the higher initial inflation and the more appreciated real exchange rate increase the costs of not reaching an agreement (recall equation (27)), which shifts up the entire path of h_t (Panel C in Figure 1), thereby increasing the credibility of the program. In the simulation exercise, a higher degree of inflation inertia and/or a higher initial inflation rate provoke a loss of credibility at any given point in time. As illustrated in Figure 4, the time path of credibility corresponding to α=0.32 lies below the one corresponding to α=0.27.

Although the effect on credibility is ambiguous, the model predicts that higher initial inflation leads to a quicker outcome for good or for bad. At any point in time, the hazard rate that the program will end, $h_t+\lambda_t$, increases. This prediction of the model seems to be in accordance with the evidence, since programs in high-inflation countries such as Argentina and Brazil seem to last not as long as those undertaken in low-inflation countries such as Denmark and Ireland.

(2) The less drastic the fiscal adjustment at the beginning of the program, the less credible is the program. The higher fiscal deficit generates more debt, which increases the required monetary financing if a balance of payments crisis were to occur. This, in turn, increases the nominal interest rate by raising the expected devaluation associated with such a crisis. As discussed in the previous section, an increase in the nominal interest rate makes a balance of payments crisis more likely, and induces a loss of credibility--as indicated by an increase in λ_t. On the other hand, the higher taxes that would result from a budget agreement give political groups an incentive to delay an agreement--as indicated by a fall in h_t (Figure 2, Panel B) thus reinforcing the previous effect of lower credibility. The effect of a less drastic fiscal adjustment on the likely duration of the program is ambiguous since λ_t increases but h_t decreases.

This result gives new meaning to the popular notion that a fiscal adjustment is a necessary condition for a successful stabilization. This notion is usually based on the idea that a fiscal gap will require an expansion in domestic credit which will eventually lead to a balance of payments crisis. In contrast, on the monetary side, our argument rests on the potential for higher nominal interest that results from an expected devaluation to generate a balance of payments crisis sooner, and, on the fiscal side, it rests on the effects that higher future taxes have on the negotiations over a budget agreement.

FIGURE 4. CREDIBILITY: EFFECT OF A FALL IN α



(3) The lower the initial level of reserves, the less credible is the program. The initial level of reserves has no bearing on the negotiation of the budget agreement. Therefore, a lower level of reserves makes it more likely that the critical value of reserves will be reached sooner, thereby lowering credibility. This result implies that an outright grant of reserves (for instance, the Marshall Plan) would indeed make a program more credible. However, lending (by, say, multilateral organizations) would have an ambiguous effect. On the one hand, it provides more reserves, which makes the program more credible. On the other hand, it augments the stock of debt that is part of the negotiations between the political groups thus making the program less credible. The duration of the program also decreases since λ_t increases.

V. Conclusions

This paper has analyzed the process whereby an exchange rate-based program that is characterized by initially incomplete fiscal adjustment eventually succeeds or fails. The analysis has focused on how political-economy considerations interact with the presence of inflation inertia in determining the dynamics of the economy in the aftermath of stabilization. The real appreciation of the domestic currency creates the expectation that there will be a devaluation. The success of the program hinges on whether the budget agreement is reached before a balance of payments crisis unfolds as a result of an increasing nominal interest rate.

The analysis has concentrated on a situation in which the budget is not balanced when the program is implemented. The same analysis could be applied, however, to a fiscally-sound stabilization plan. The basic idea is that the real yield curve at the time the stabilization plan is implemented is upward sloping because of the future expectation of a step devaluation (with the instantaneous real interest rate being negative). If the initial stock of public debt is of a maturity for which the corresponding real interest rate increases on impact, the initially-balanced fiscal position immediately deteriorates throwing the economy into the same dynamic process characterized in this paper.

Finally, note that the analysis does not address the question of why a policymaker would want to launch a stabilization plan based on anything other than a balanced budget. Rather, we take the initial (incomplete) fiscal measures as given, on the basis that it often happens, and proceed with the analysis. However, the mere fact that the model predicts that a stabilization plan may be successful even if the fiscal adjustment is less than complete at the beginning of the program suggests that there may be merit in such a plan. Policymakers sometimes argue that a plan that fixes the exchange rate, even if not all the fiscal measures can be taken at the time the plan is implemented, acts like a straitjacket and will force the different parties to agree on remaining measures in a short period of time. However, the model suggests that an analogy with setting a time bomb may be more appropriate. The stabilization plan is a way for the policymaker to tell the politicians: "The bomb is now ticking. If an agreement is not reached soon, a balance of payments crisis will ensue and the situation will be worse than it was initially." What the policymaker may not always take into account, as countless failed stabilizations suggest, is that it may be in the best interest of the pressure groups to let the bomb explode.

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