Balance of Payments Crises in a Cash-in-Advance Economy

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1. INTRODUCTION

FOR MANY COUNTRIES THAT ARE CHRONICALLY AFFLICTED with relatively high rates of inflation, anti-inflationary policies seem to have much in common with weight-reducing diets: they work for a while, sometimes even dramatically so, but only a minority of patients are able to maintain a lower weight in the long run. The standard conjecture here is that the lack of success must be due to the failure to uproot some of the fundamental causes of inflation or obesity, as the case may be. It is, therefore, interesting to understand the dynamics of these systems when some, but not all the conditions for success are present.

A very neat example of this type of analysis is provided by the balance-of-payments-crises literature, e.g., Krugman (1979), Flood and Garber (1984), Obstfeld (1984 a, b). The basic scenario is one of a "small" open economy subject to perfect capital mobility; a "crisis" develops, for example, because the monetary authority sets the rate of devaluation at a level that, given the path of domestic credit, would call for a permanent drainage of reserves from the Central Bank. Assuming that the Central Bank has an upper bound on the funds that it can borrow internationally, it follows quite trivially that the exchange rate regime will have to be modified in the future.[1]

Much less trivial, however, are the dynamics of the crisis itself. With perfect foresight, examples can be developed where the announcement of an inconsistent stabilization policy (in the above sense of not being sustainable in the long run) displays, in the short run, all the signs of success. For instance, in the case of a reduction in the rate of devaluation, the rate of inflation initially falls and the balance of payments dramatically improves; the regime ends, however, with a speculative attack, when all the "good" signs are suddenly reversed (see Connolly and Taylor 1984). What is remarkable about this type of result is that to the casual observer it looks as if the crisis has taken most people by surprise (given its sudden occurrence), while the fact of the matter is that the crisis is the equilibrium outcome of a model in which all the events are fully anticipated. Although there are still no formal extensions of this literature to incorporate "politicians" into the picture, these remarks suggest how tempting it might be for a politician — especially one who knows that his tenure will be over in the not too distant future — to resort to anti-inflationary policies of this sort, since (a) no "tough" decision has to be taken in the short run, (b) the policy immediately appears to be "successful," and (c) if well calibrated, the "bomb" will explode in the hands of his successor.[2]

Typically this literature has concentrated on the balance of payments, leaving aside equally important aspects such as the current account and the real exchange rate. These aspects are particularly relevant for understanding the recent monetary experiences of Argentina and Mexico where the exchange-rate crises (with symptoms similar to the ones emphasized by the above-mentioned literature) came at the end of a protracted period of "low" real exchange rates and "high" current account deficits (see Blanco and Garber 1983 and Calvo 1986a).

Interestingly, accounting for the above-mentioned aspects of the phenomenon is not a trivial matter. If one works in terms of an extension of Calvo and Rodriguez (1977), for example, and assumes that the government gives back the inflation tax in the form of lump-sum taxes, then one can show that an exchange-rate crisis can occur without current account deficits or surpluses, and without any change in the real exchange rate. The reason for this is simple: aggregate demands in a model like that are assumed to be functions of real private wealth and relative prices; so, if the experiment does not change private wealth, the relative price of tradables with respect to nontradables (i.e., the real exchange rate) that equilibrates the home-goods market remains the same. Thus, our point is shown by noticing that during a balance-of-payments crisis the main action has to do with a reshuffling of assets between the private and the public sector ("capital flight") which, if fully antici-

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[2]This political "trick" is not going to be effective if everyone understands the relevant model. I would like to remind the reader, however, that for the assumption of rational expectations to be empirically relevant, it is enough to assume that those who do not know the model pay heed to the forecasts of those who do. Thus, from a political point of view, the "trick" may enhance the good reputation of the politician that puts it to work to the extent that the "majority" is unable to establish its future implications.

pated, does not change private sector wealth.[3] Therefore, we are faced with a clear instance where, rather than continuing the search for ad hoc models that yield the desired results, our understanding might be better served by examining a simple monetary model with solid microeconomic foundations. This is the task that will be undertaken in the present paper.

We assume that there exists a "representative" infinitely lived family that derives utility from consumption. The family can accumulate assets in the form of noninterest-bearing domestic money, or in the form of an international bond. Money is demanded for cash-in-advance reasons (Clower 1967, Lucas 1980, Stockman 1981, Feenstra 1985), and the minimum necessary holdings of real monetary balances are assumed to be a fixed proportion of intended consumption. Section 2 describes this economy under the assumption that there exists only one fully tradable commodity. The basic results of the paper are presented in section 3, and extended to the case of tradable and nontradable goods in section 4.

The central experiment studied in the paper is one in which the Central Bank sets the rate of devaluation at a level inconsistent with the other fiscal constraints, and reverts to a targets-consistent rate of devaluation when the reserves constraint is binding. The main results can be summarized as follows:

(a) The anatomy of the balance-of-payments crisis confirms previous findings;

(b) As soon as the inconsistent (in the above sense) policy is announced, the level of absorption takes an upward jump, generating a current-account deficit and an appreciation of the real exchange rate. Once the crisis occurs, the system returns to steady state with a permanently higher real exchange rate;

(c) Finally, a relatively more novel qualitative result, during the transition, the current-account deficit is larger and the appreciation of the real exchange rate greater, the "more ambitious" is the (inconsistent) stabilization program (i.e., the lower is the rate of devaluation before the crisis occurs).

2. THE BASIC MODEL: PRELIMINARY RESULTS

We assume that the domestic economy is composed of a single price-taking, Sidrauski-type family, whose utility function at time t, U_t, is represented as follows:

$$U_t = \int_t^\infty u(c_s) e^{-r(s-t)} \, ds \tag{1}$$

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[3]For a discussion of how certain, possibly important, monetary effects are hidden by these types of ad hoc models, see Calvo (1985). Connolly and Taylor (1984) — working in terms of an ad hoc model — obtain effects that are consistent with the experience of Argentina and Mexico. However, a close reading of the paper shows that these realistic effects are essentially due to their implicit assumption that government expenditure (measured in terms of tradables) rises before the crisis occurs. As will be seen, we shall obtain similar results even when we constrain government expenditure (transfers, in our example) to be constant over time.

where c stands for consumption, and r is the (constant and positive) subjective rate of discount. We assume that $u(\cdot)$ is twice differentiable, strictly concave, and that it exhibits a positive derivative for all $c > 0$.

Output is homogeneous (i.e., we assume a one-good world); there are no barriers to international trade; international capital mobility is perfect; and the country is "small" in all international markets. For convenience, we further assume that the international rate of interest is equal to r.

In order to motivate a demand for money, we shall assume, as in the money-in-advance literature, that the level of real monetary balances, m, must satisfy[4]

$$m \geq \alpha c, \qquad \alpha > 0 \qquad (2)$$

meaning that in order to make the c units of consumption effective, the family must hold a stock of monetary balances not smaller than αc.

We assume that money and bonds are the only forms of holding wealth; thus, real wealth at time t, a_t, is given by

$$a_t = m_t + b_t \qquad (3)$$

where b is the family's bond holdings. Furthermore, a evolves according to the following relationship:[5]

$$\dot{a} = y + rb + g - \varepsilon m - c \qquad (4)$$

where y is a constant flow of output produced by the family per unit of time (the equivalent to the gross domestic product, g is real lump-sum government transfers, and ε is the rate of domestic inflation. If we further assume that the international price level (i.e., the price of output in terms of foreign currency) is constant over time, our previous assumptions permit us to identify ε with the rate of devaluation. Alternatively, taking (3) into account, we can express (4) as follows:

$$\dot{a} = y + ra + g - (r + \varepsilon)m - c. \qquad (4')$$

Integrating (4'), and imposing the condition that $a_t e^{-rt} \to 0$ as $t \to \infty$, we note that under perfect foresight the following overall budget constraint must hold:

$$\int_t^{\infty} [y + g_s - (r + \varepsilon_s)m_s - c_s]e^{-r(s-t)} ds + a_t = 0. \qquad (5)$$

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[4]The following assumption would be perhaps more natural in the context of a discrete-time model. Fortunately, however, this is of no major concern to us here, because our results can be extended to the discrete-time version of the model. Our preference for continuous time has to do with its greater analytical simplicity. Some of the complications one might encounter in using the discrete-time framework are discussed in Obstfeld (1984b).

[5]As customary, a dot on a variable denotes its time derivative. In what follows, time subscripts are going to be deleted unless they are strictly necessary for clarity.

This is the familiar condition that the present value of future expenditure (i.e., consumption, c, plus the opportunity cost of holding money, $r + \varepsilon$) should be equal to the all-inclusive measure of wealth (i.e., a plus the present discounted value of net future receipts, $y + g$).[6]

At time t the family chooses the paths of c and m in order to maximize (1) subject to (2) and (5), given a_t. Assuming the existence of an interior solution for c (this assumption will be maintained in what follows[7]), this yields the following first-order condition:

$$u'(c) = \lambda[1 + \alpha(r + \varepsilon)] \tag{6}$$

where λ is the associated (time-invariant) Lagrange multiplier. In (6) we implicitly assume that money is not held in excess of the minimum requirement given by (2). This will, in fact, be an implication of an optimal individual plan if money is return-dominated by the bond, i.e., if $r + \varepsilon > 0$. Thus, (6) is the correct expression for our experiments, given that we will assume that the above inequality (i.e., $r + \varepsilon > 0$) holds at all times. Notice that (6) is just the familiar first-order condition, "marginal utility equals price times the marginal utility of wealth"; in our application, the "price" of consumption equals its direct cost (1) plus the opportunity cost of money held against that unit of consumption ($\alpha(r + \varepsilon)$); the latter term plays a key role in our analysis (for related examples, see Obstfeld 1986 and Calvo 1986b).

We shall assume that the government is committed to maintaining a constant positive level of real lump-sum transfers,[8] g, and to following a given path of the rate of devaluation, ε. At each point in time, the government stands ready to exchange domestic for foreign money at the predetermined exchange rate (more on this in section 3).

The only net asset available to the government for the purpose of wealth accumulation is the bond (there exists foreign exchange but it is return-dominated by the bond); we denote the government's bond holdings by k. At points in time where m is smooth, the rate of accumulation of k is given by

$$\dot{k} = rk + \dot{m} + \varepsilon m - g \tag{7a}$$

where ($\dot{m} + \varepsilon m$) is the revenue collected by the government on account of the family's accumulation of real monetary balances and the inflation tax. On the other hand, at points where m takes a "jump" Δm, we have

$$\Delta k = \Delta m, \tag{7b}$$

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[6]It would be more general to write (5) as a weak inequality; however, due to the nonsatiation assumption, the results of this paper would be unchanged.

[7]This will always be the case if we further assume, for example, that $u'(c) \to \infty$ as $c \to 0$.

[8]In this literature it is customary to assume that the monetary authority is committed to set the time derivative of domestic credit equal to a constant proportion of money supply. The implicit understanding is that the domestic-credit constraint reflects "fiscal" commitments. The present paper makes the latter explicit, a natural procedure given our interest in the microfoundations of the problem.

since, by hypothesis, the only way available for the private sector to increase, say, its holdings of domestic money instantaneously is to sell foreign bonds.

In line with the balance-of-payments-crises literature (e.g., Krugman 1979; Flood and Garber 1984; Obstfeld 1984a, b) we will assume that there is a lower bound on k, which, for the sake of definiteness, is assumed to be zero;[9] thus,

$$k_s \geq 0 \qquad \text{for all } s \,. \tag{8}$$

Denoting the total holdings of bonds in the economy by f, we have

$$f = b + k \tag{9}$$

and, by (3), (4), (7), and (9), we get

$$\dot{f} = y + rf - c \,, \tag{10}$$

which simply says that the net accumulation of assets by the economy as a whole is equal to the current-account balance, as should be the case in any well-defined open-economy model.

We are going to be particularly interested in perfect-foresight situations where ε is a constant over certain intervals of time. Clearly, by (6), c is a constant over each one of those intervals (but not necessarily the same constant in any two disjoint intervals.) Thus, by (2) and (7a), and recalling that we have ensured that (2) holds with equality, in any interval of time where ε is a constant, we have

$$\dot{k} = rk + \varepsilon \alpha c - g. \tag{11}$$

This formula will come in handy for calculating the timing of crises.

We close this section by studying the case where ε is constant over the interval $[T, \infty)$ under the assumption that T is the "present", so that we do not have to bother about the "transition" until T, a subject that will be the focus of the next section. Since c and ε are constant forever, we can integrate (5) to yield

$$c[1 + \alpha(r + \varepsilon)] = y + g + ra_T. \tag{12}$$

That is, expenditure (consumption, c, plus the inflation tax, $\varepsilon m = \varepsilon \alpha c$) equals disposable income. This implies, of course, that

$$m\varepsilon = \varepsilon \alpha c = (y + g + ra_T)\frac{\alpha \varepsilon}{1 + \alpha(r + \varepsilon)}. \tag{13}$$

Hence, by (11) and (13), given g, k_T and a_T, there exists a unique value of ε such that k remains constant at its initial level (k_T in the present notation). If ε is assumed

[9]See Obstfeld (1984b) for a discussion of this assumption.

to be less than this critical level, then $\dot{k} < \omega$ for some $\omega < 0$; thus, by (8), the assumed rate of devaluation would be sustainable only over a finite interval. This is going to be a useful result for the ensuing analysis.

3. BALANCE OF PAYMENTS CRISES

For the sake of definiteness we will assume that up to time zero (the "present"), the economy has been traveling along a perfect-foresight steady-state path with a constant rate of devaluation $\bar{\varepsilon}$, and that along this path $\dot{k} = 0$ and $k > 0$. At time zero a new, unanticipated regime takes place; it is fully understood by all participants that from $t = 0$ to $t = T > 0$, $\varepsilon_t = \varepsilon_o$, where $0 \leqslant \varepsilon_o < \bar{\varepsilon}$. (The non-negativity of ε_o simplifies the exposition.) From time T onwards ε will be set at the constant rate of devaluation that locks the economy at the steady state with $\dot{k} = 0$. The point in time T is chosen so that the constraint (8) is binding; thus, $k_t = 0$ for all $t > T$.

To give an alternative description of the above situation one could say that initially the rate of devaluation is set at a level which is "unsustainable" in the long run; when reserves are depleted, the authorities withdraw from the foreign exchange market and let the exchange rate float freely without changing real transfers.[10] Under this interpretation, it is quite natural to call the events at time T "a crisis."

By the concluding remarks of the previous section, we know that given k_0 and a_0, there exists a unique value of ε ($\bar{\varepsilon}$, as denoted above) which is consistent with the economy being at a steady state with $\dot{k} = 0$; so the situation before $t = 0$ is well defined. Let us now consider the above-described policy that sets $\varepsilon = \varepsilon_o$ until official reserves, k, are "depleted" (this is a delicate point that will be fully explained below). In the first place, note that $\varepsilon = \varepsilon_o$ cannot be maintained without depleting official reserves (i.e., without making $k_t = 0$ for some finite t); for if it were to be maintained, it follows, by (11) and (13), that $\dot{k} < \omega$ for some negative number ω, contradicting (8). Therefore, the crisis must occur in finite time (i.e., T is finite).

We will denote the rate of devaluation after T by ε_∞. By our discussion in the previous section, we know that consumption is a constant on $[0, T)$, and on $[T, \infty)$. We will denote consumption in the former interval by x, and in the latter by z. Since, by hypothesis, ε_∞ is chosen so that $k = \dot{k} = 0$ after time T, it follows from (11), that

$$0 = \varepsilon_\infty \alpha z - g; \tag{14}$$

i.e., after T the inflation tax must equal government transfers. Hence, by (6) and (14),

$$u'(x) = [1 + \alpha(r + \varepsilon_o)]u'(z)/[1 + \alpha(r + \varepsilon_\infty)]$$

$$= [1 + \alpha(r + \varepsilon_o)]u'(z)/(1 + \alpha r + g/z). \tag{15}$$

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[10]This is essentially the scenario described in Krugman (1979). It is equivalent to our scenario partly because the demand for money is interest-inelastic; otherwise, maintaining a constant g with a floating exchange rate may give rise to indeterminacy; see, for example, Farmer and Woodford (1984).

Consequently, if we further assume that the right-hand side of (15) decreases with z, (15) implies a positive relationship between x and z (depicted as curve AA in Figure 1).[11] In the Appendix we will show that, as in Figure 1, the curve AA lies below the 45° line at $x = y + rf_0$.

We now study the behavior of k; if the crisis occurs at T, then it should be the case that $k_T = 0$. However, there are *two* values of k_T that concern us: the value "right before" the crisis, denoted by $\bar{k}_T$, and the value "right after" the crisis, denoted by $\underline{k}_T$; by hypothesis,

$$\underline{k}_T = 0. \tag{16}$$

On the other hand, integrating (11) over the interval $[0, T)$, we get

$$\bar{k}_T = (k_0 + \Delta k_0)e^{rT} + (\alpha \varepsilon_o x - g)(e^{rT} - 1)/r \tag{17}$$

where Δk_0 is the initial (stock) accumulation of reserves following the announcement of the reduction in the rate of devaluation to ε_o. Clearly, since the economy started at a steady state, we have, recalling that (2) is binding,

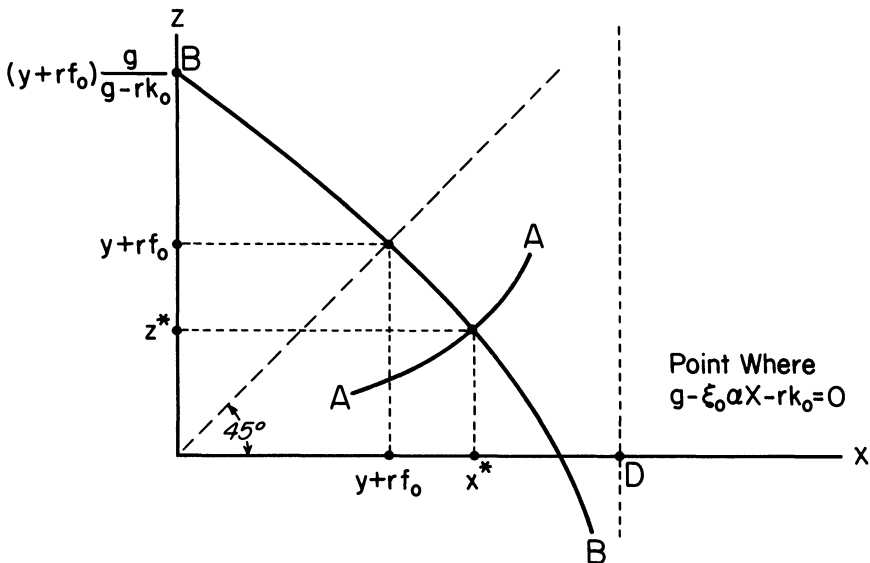$$\Delta k_0 = \alpha(x - y - rf_0). \tag{18}$$

FIG. 1. Determination of Equilibrium x and z

[11] Notice that $u'(z)/(1 + ar + g/z)$ is a decreasing function of z if $u(\cdot)$ belongs to the family of constant-relative-risk-adversion utility functions.

Integrating (10) over the interval $[0, T]$, we get

$$y + rf_T = (y + rf_0 - x)e^{rT} + x. \tag{19}$$

Furthermore, since beginning at time T the economy locks itself into a steady state where $k_t = 0$, it follows that, for $t > T$ consumption, z, must equal gross national product or, in other words,

$$y + rf_T = z. \tag{20}$$

Hence, by (19) and (20),

$$x - z = (x - y - rf_0)e^{rT}. \tag{21}$$

In order to satisfy (16), it is necessary that $\bar{k}_T$ be such that it equals the sudden change in the demand for money which occurs at $t = T$ — which, recalling (2), is, in turn, equal to $\alpha(x - z)$. Thus, by (21),

$$\bar{k}_T = \alpha(x - z) = \alpha(x - y - rf_0)e^{rT}. \tag{22}$$

Hence, by (17), (18), and (22)

$$0 = k_0 e^{rT} + (\varepsilon_o \alpha x - g)(e^{rT} - 1)/r.$$

Hence,

$$e^{rT} = (g - \varepsilon_o \alpha x)/(g - \varepsilon_o \alpha x - rk_0). \tag{23}$$

Combining (21) and (23), we get

$$z = x + (y + rf_0 - x)(g - \varepsilon_o \alpha x)/(g - \varepsilon_o \alpha x - rk_0). \tag{24}$$

The above relationship is depicted as curve BB in Figure 1. It is immediate to show that BB is downward sloping for $x \geq y + rf_0$; one can in fact show that the slope is negative on the entire relevant range[12] (see the Appendix). Thus, curve BB together with curve AA determines the unique equilibrium levels of x and z. This information and (23) can in turn be used to determine T. It is clear from Figure 1 that at equilibrium (denoted by asterisks on the respective variables), we have $x^* > y + rf_0 > z^*$.

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[12]The relevant range of x is the interval $[0, D]$ — see Figure 1; for, we know that $T > 0$, and, thus, for the ratio in (23) to be positive when $D > 0$, we must have $g - \varepsilon_o \alpha x < 0$, which, by (11), implies that the crisis will never occur, contradicting our previous results.

To summarize, we have found that if the economy begins at a situation where there is no accumulation or decumulation of bonds by the government, and the monetary authority decides to lower the rate of devaluation, a crisis will develop in finite time. Furthermore, and more central for our analysis, before the crisis occurs, the country will run a current account deficit, i.e., during the period $[0, T]$ absorption will rise above the original level. After the crisis, the system locks itself into another steady state with a permanently higher rate of devaluation, and a permanently lower level of absorption.

What happens as ε_o is further reduced? This is an interesting question because it is a way of asking what happens as the monetary authorities become "more ambitious" in their attempt to lower the rate of inflation in the short run (without, of course, attacking any of the fundamental causes of inflation). Figure 2 depicts the shift of the AA and BB curves as ε_o is reduced. Clearly, this leads to an increase in x (absorption during the transition). Consequently, we have found that a more ambitious short-term stabilization program will lead to a bigger current account deficit. As seen from (23), however, we do not seem to be able to ascertain whether the crisis will happen sooner as ε_o is lowered. The reason for this is that the timing of the crisis depends on the ability to collect the inflation tax, which is proportional to $\varepsilon_o x$, and not just to x.[13]

4. THE REAL EXCHANGE RATE

In this section we will show that the previous analysis can readily be extended to account for the existence of tradable and nontradable goods. The presentation will
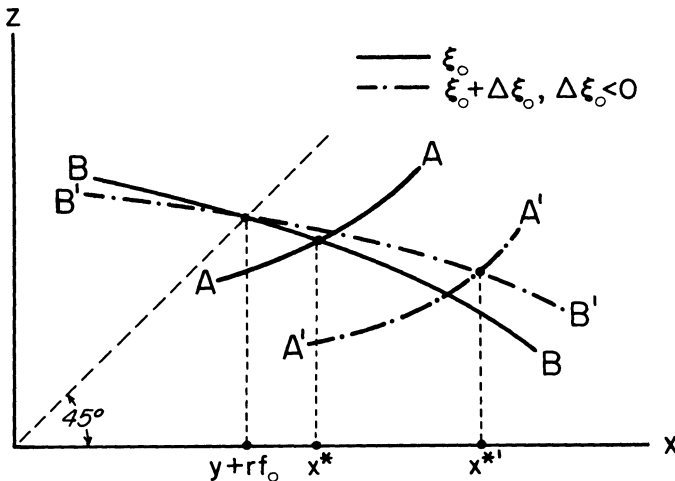

FIG. 2. Effect of a Smaller ε_o

[13]If $u(c) = \ln c$, then T would always be an increasing function of ε_o.

be sketchy, leaving out finer points that could be easily derived by the interested reader.

For the sake of simplicity, we will assume that domestic consumption, c, is produced with tradable consumption, c^T, according to the following production function:

$$c = h(c^T), \qquad h' > 0 \tag{25}$$

where $h(\cdot)$ is assumed to be strictly concave and nonnegative for all $c^T \geq 0$. (Notice that the analysis of the previous section can be thought of as being conducted under the assumption that $h(\cdot) \equiv 1$.)

Denoting by p the relative price of domestic (or home) consumption with respect to tradable consumption (i.e., the relative price of c with respect to c^T), we get in competitive equilibrium that $p = 1/h'$. Thus, recalling (25),

$$p = [h'(c^T)]^{-1} = [h'(h^{-1}(c))]^{-1} \equiv \Phi(c). \tag{26}$$

Clearly,

$$\Phi' > 0. \tag{27}$$

Consequently, we get the perfectly natural implication that the relative price of home goods with respect to tradable goods (the inverse of what is sometimes called the "real exchange rate"), is an increasing function of the level of home consumption, c.

The natural extension of (2) is

$$m \geq \alpha pc. \tag{28}$$

Thus, (14) becomes, recalling (26),

$$0 = \varepsilon_\infty \alpha \Phi(z) z - g. \tag{29}$$

(Note that we have implicitly assumed that government transfers are denominated in terms of tradables.) Therefore, the first-order condition (6) becomes

$$u'(c) = \lambda[1 + \alpha(r + \varepsilon)]p = \lambda[1 + \alpha(r + \varepsilon)]\Phi(c). \tag{30}$$

Hence, relationship (15) that defines curve AA in Figure 1 takes now the following form:

$$u'(x)/\Phi(x) = [1 + \alpha(r + \varepsilon_o)]u'(z)/[(1 + \alpha r)\Phi(z) + g/z]. \tag{31}$$

Consequently, recalling (27), the assumption we made in section 3 that $u'(z)/(1 + \alpha r + g/z)$ declines with z is, again, sufficient to ensure that curve AA is upward sloping.[14]

The derivation leading to curve BB is slightly more involved. Following the steps of previous section, we have, instead of (17),

$$\bar{k}_T = (k_0 + \Delta k_0)e^{rT} + [\alpha\varepsilon_o x\Phi(x) - g](e^{rT} - 1)/r, \tag{32}$$

and, instead of (18),

$$\Delta k_0 = \alpha[x\Phi(x) - (y + rf_0)\Phi(y + rf_0)]. \tag{33}$$

Finally, instead of (21), we have

$$h^{-1}(z) = [y + rf_0 - h^{-1}(x)]e^{rT} + h^{-1}(x), \tag{34}$$

and, instead of the first equality in (22),

$$\bar{k}_T = \alpha[x\Phi(x) - z\Phi(z)]. \tag{35}$$

By (32), (33) and (35), we get

$$e^{rT} = \frac{g - \alpha\varepsilon_o\Phi(x)x - \alpha r[\Phi(x)x - \Phi(z)z]}{g - \alpha\varepsilon_o\Phi(x)x - rk_0 - \alpha r[\Phi(x)x - \Phi(y + rf_0)(y + rf_0)]} \tag{36}$$

[cf. (23)]. Using (36) in (34), we obtain an expression in x and z that corresponds to (24), and can be shown to give rise to a downward-sloping BB curve.

Consequently, the above findings together with (26) and (27) allow us to conclude that if we start from a noncrisis steady state with constant official reserves over time, and the rate of devaluation is lowered as described in the previous section, a crisis will eventually develop. The real exchange rate will exhibit an *immediate* appreciation, and will remain at the appreciated level until the moment that the crisis actually occurs. At the time of the crisis, there is a *sudden* permanent depreciation of the real exchange rate that drives p to a level below that prevailing prior to the stabilization experiment.[15]

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[14]One can adapt the proof given in the Appendix to show that this curve lies below the 45° line at x such that $h^{-1}(x) = y + rf_0$.

[15]In the present context the downward jump of p is brought about by a fall of the nominal price of home goods. This suggests that in more realistic setups, where wages/prices are downward inflexible, the crisis may be associated with a rise in the rate of unemployment. We plan to pursue this line of research in the near future.

APPENDIX

We first show that the curve AA in Figure 1 must lie below the 45° line at $x = y + rf_0$. At $x = y + rf_0 = z$ (note the last postulated equality) we have

$$\varepsilon_o < \bar{\varepsilon} = (g - rk_0)/\alpha x < g/\alpha z = \varepsilon_\infty. \tag{A1}$$

The first inequality is an hypothesis of the crisis scenario; in turn, $\bar{\varepsilon}$ is, by definition, the permanent level of ε that keeps $\dot{k}_t \equiv 0$ for $0 \leqslant t \leqslant \infty$; thus, by (11), $\bar{\varepsilon} = (g - rk_0)/\alpha x$ at $x = y + rf_0$. The last inequality in (A1) follows trivially due to the assumption that $rk_0 > 0$ and $x = z$, while the last inequality follows from (14). Thus, at $x = z = y + rf_0$, we have

$$u'(x) > [1 + \alpha(r + \varepsilon_o)]u'(z)/(1 + \alpha r + g/z). \tag{A2}$$

Hence, since we assume that $u'(z)/(1 + \alpha r + g/z)$ is a decreasing function of z, it follows that at $x = y + rf_0$, the value of z that solves for (15) must be such that $z < x = y + rf_0$. Q.E.D.

Next, we are going to show that the curve BB in Figure 1 is downward sloping over the relevant range (i.e., for x such that $g - \varepsilon_o \alpha x - rk_0 > 0$, see footnote 10.) By (24), on curve BB,

$$\text{sgn}\partial z/\partial x = \text{sgn}\left[\alpha\varepsilon_o(y + rf_0) - g\right] < 0. \tag{A3}$$

The inequality in (A3) follows from the first inequality in (A1), recalling that in (A1) $x = y + rf_0$. Q.E.D.

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