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FISCAL DEFICITS, EXCHANGE RATE CRISES AND INFLATION: ON THE INFLATIONARY CONSEQUENCES OF ANTI-INFLATIONARY EXCHANGE RATE POLICIES

by

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1. INTRODUCTION

This paper deals with inflation, fiscal deficits and exchange rate policy in high-inflation countries. Recent inflationary experience in countries such as Israel, Argentina, and Brazil cannot be explained using traditional views on the relation between macroeconomic policy and inflation. Those views coagulate around Keynesian demand pressure or a monetarist focus on the rate of money growth. Keynesian views cannot explain the peculiar "plateau" character of inflation in those countries: Inflation is often stable at a given rate for several years, suddenly jumps to a new plateau, stays there for some years, then jumps again and so on, a pattern documented in Bruno (1984), Bruno and Fischer (1984) and Cardoso (1985). Demand pressure would lead one to expect accelerating inflation.

Simple monetarist views are discounted by the absence of a clear link between increases in inflation and prior or simultaneous increases in the money supply. Indeed there is evidence of occasional perverse links, with inflation accelerating after a tightening of monetary conditions (Turkey 1984).

A final puzzle concerns the unhappy experience of countries attempting to stabilize inflation through an exchange rate freeze or, similarly, a preannounced slowdown in its rate of change. The experiments along those lines in Latin America in the late seventies and in Israel in 1982/1983 not only ended in failure, but all countries involved saw inflation accelerate after the collapse of the experiment to levels well above those observed before the stabilization program started.

A case in point is the Israeli experience in 1982-1984. Inflation before the initiation of the exchange rate freeze was 7 percent per month (125 percent annually, continuously compounded). Then, in September, 1982, a preannounced crawling peg policy was instituted under which the nominal exchange rate was devalued at a rate of five percent per month independent of domestic price developments. The stabilization program collapsed in October 1983, after which the inflation rate rapidly increased to reach 12-15 percent per month (15 percent per month implies a 435 percent annual rate.).

In this paper we suggest an explanation for these phenomena drawing on the "public finance approach" to inflation introduced by Phelps (1970), without any recourse to irrational behaviour or arbitrary expectation mechanisms and without introducing unexplained "inertia" into the system.

Our approach draws on several strands in the recent literature which have until now remained separate. First of all, several closed economy applications of the Phelps approach to inflation have analyzed the effects of unsustainable monetary policies under the assumption of an exogenous future regime switch, restoring consistency between fiscal and monetary policy (Sargent and Wallace (1982), Liviatan (1984) and Drazen and Helpman (1985, a,b). We introduce open economy considerations and exchange rate policy, and, in a departure from this literature, we endogenize the regime switch by linking it to rational speculative behavior.

The introduction of rational speculators forcing a regime switch links our paper to the literature on speculative attacks started by Krugman (1979). (See, in addition to Krugman (1979), Flood and Garber (1984) and Bianco and Garber (1986)). That literature, however, typically ignores the intertemporal budget constraint faced by the public sector, a constraint that plays a crucial role in our analysis and drives several of the results.

Finally since I analyze a switch to a fixed exchange rate (or preannounced crawling peg) regime, I should mention the "crawling peg" literature instigated by Diaz Alejandro's description of the Southern Cone experience (Diaz Alejandro (1979); Calvo (1986), Dornbusch (1980), Obstfeld (1985), van Wijnbergen (1979) and many others). That literature in a step backwards from Krugman (1979) to which it is obviously related, invariably assumes an exogenous switching point if consistency between different policy instruments is analyzed at all. Consistency problems through the intertemporal budget constraint have not received attention in that part of the literature.

We present a simple open economy model where consumers base intertemporal expenditure plans and asset market demand on rational optimizing behavior. They have perfect foresight and fully incorporate their budget constraint and the budget constraint faced by the public sector.

We use this model to analyze the response of the economy under a floating exchange rate regime to various policy induced and external shocks; we then analyze the transition to a fixed exchange rate regime, discuss sustainability, and demonstrate what happens when policy measures are inconsistent and the fixed regime unsustainable.

Within the context of a floating regime, we show how higher world real interest rates will increase inflation in the presence of external government debt (Brazil, 1981-85); we also show how restrictive monetary policies inconsistent with the intertemporal budget constraint will lead to a discrete depreciation and permanently higher inflation, similar to the closed economy results of Sargent and Wallace (1982).

Our main conclusions, however, concern the exchange rate freeze experiment. We analyze conditions under which a collapse will occur and show that, if a collapse occurs, post-collapse inflation will exceed the inflation rate that obtained just before the start of the stabilization experiment.

We also show that restricting domestic credit growth to a rate that will prevent reserve outflows during a freeze is not sufficient to prevent a speculative attack, contrary to suggestions in Krugman (1979) and Flood and Garber (1984). In fact we demonstrate that the post-collapse inflation will be even higher when the public sector follows such a credit policy, covering the remainder of the deficit by public debt issue; higher, that is, than the post-collapse inflation rate that obtains after a policy of covering the deficit through credit creation alone.

The remainder of the paper is organized as follows. In section 2 we present our basic model under the assumption of a floating exchange rate. To demonstrate the structure of the model we analyze the effects on inflation and on the level of the exchange rate of an increase in world interest rates and of a temporary reduction in money growth. In section 3 we set up a fixed exchange rate version. The main part of the paper is section 4. There we analyze the transition to a fixed exchange rate (or crawling peg) regime, discuss sustainability and exchange rate crises and characterize the post-collapse equilibrium.

2. FLOATING EXCHANGE RATES

2.1. Model Structure

The model is simplified as much as is possible without losing what I consider essential for the problem at hand. Generality is sacrificed for analytical clarity. Thus there is only one good whose world price is normalized to one with the domestic price therefore equalling e (= the nominal exchange rate, units of local per unit of foreign currency); home output y is exogenous and constant over time; asset choice for domestic residents is restricted to domestic money $m = M/e$ and foreign bonds b yielding an instantaneous rate of return r; and accumulation of physical capital is ignored.

Consumers derive instantaneous welfare $\tilde{u}$ from consumption of goods, c, and from real money holdings m:

$$\tilde{u} = \frac{u(c,m)^{1-s}}{1-s}$$

where u is homogenous of degree one. In most of the paper we will look at the limiting case

$$\tilde{u} = \lim_{s \to 1} \frac{u^{1-s}}{1-s} = \log u$$

We furthermore assume $u_{cm} = 0$. Note that this implies (for $s = 1$):

$$\tilde{u}_{cm} = \frac{-u_c u_m}{u(c,m)^2} < 0.$$

It is possible to construct transaction technologies that are equivalent to this approach (Chamley (1985), Feenstra (1985).

We follow Blanchard (1985) in assuming a simple overlapping generations structure where each individual alive today faces a time and age independent instantaneous probability of death p.[1] This implies an unconditional rate of time preference $\rho + p$ where p is the rate of time preference conditional on staying alive (Blanchard (1985)). We furthermore follow Blanchard (1985) in assuming that consumers annuitize their non-human wealth at actuarily fair rates.

Consumers maximize the integral of current and discounted future welfare subject to the savings identity, the condition that holdings of money and foreign bonds cannot exceed wealth (of course equality always obtains) and the intertemporal budget constraint. The latter plus the savings identity is equivalent to that savings condition and a limiting condition on wealth w ($\lim_{t\to\infty} e^{-(r+p)t} w(t) = 0$).

The maximization problem then becomes

$$\max_{c,m,b} \int_0^\infty e^{-(\rho+p)t} \frac{u(c,m)^{1-s}}{1-s} dt \tag{1}$$

$$\text{s.t. (a)} \quad \dot{w} = rb + pw + y - \tau - \pi m - c$$

$$= (r+p)w + y - \tau - c - im$$

$$\text{(b)} \quad w = m + b$$

$$\text{(c)} \quad \lim_{t\to\infty} e^{-(r+p)t} w(t) = 0$$

where i is the nominal interest rate and π the inflation rate (note that $\pi = \dot{e}$, the rate of change in the exchange rate e). Thus, $i = r + \pi$.

The first-order conditions to (1) yield, after routine manipulation, the following expressions describing consumer behavior:

$$\frac{u_m(m)}{u_c(c)} = i \tag{2}$$

$$c + im = (\rho+p)(w + \frac{(y-\tau)}{r+p}) \tag{3}$$

$$\dot{w} = (r + p)w + y - \tau - c - im \tag{4}$$

where τ represents tax payments, assumed constant over time. Aggregation over all individuals alive leaves (2) and (3) unaffected but changes (4). Define aggregate wealth V as

$$V(t) = \int_{-\infty}^{t} w(s,t)pe^{p(s-t)}ds$$

with $w(s,t)$ wealth at time t of individuals born at s. It is straightforward to show that (3) and (4) imply

$$\dot{V} = (r-\rho)(\frac{y-\tau}{r+p}) + (r - \rho - p)V \tag{5}$$

where convergence of the integral defining $\dot{V}$ requires $r < \rho + p$ (Blanchard (1985)). Equations (2), (3), and (5) completely describe private behavior. Remains the introduction of the government budget constraint and the description of government policies.

The public sector consists of a government proper and a central bank. The central bank implements the exchange rate policy decreed by the government by not intervening in foreign exchange markets under a floating regime, and by buying and selling foreign exchange as needed under any other regime. Since money is the only domestic asset, sterilized intervention is impossible. It furthermore incurs no administrative costs and transfers its profits to the government. Its profits equal rR with R the level of foreign reserves measured in foreign currency terms. The central bank earns the same rate on its foreign assets as the private sector. (Obstfeld (1981) stresses the importance of properly keeping track of central bank interest earnings).

The government budget constraint equals:

$$g + rd - rR - \tau = \dot{d} + \frac{\dot{M}}{e} \tag{6a}$$

or, after simple manipulation,

$$g + r(d-R) - \tau = \dot{d} + \dot{m} + \pi m \tag{6b}$$

g is real government expenditure and τ real tax revenue, both of which are constant in all policy experiments discussed in this paper.[2] Under floating rates, R too is constant. d is the foreign debt of the government. We assume, for simplicity only, that the government issues no domestic interest bearing liabilities. As in Drazen and Helpman (1985a,b) there is a maximum level of government debt that can be supported in steady state since g cannot fall below zero and there are limits to the revenues that can be raised through τ and the inflation tax in steady state. Call this level d^*. We will assume, following Drazen and Helpman (1985a,b), that no rational lender will lend beyond d^*. The intertemporal budget constraint for the government is therefore always satisfied (that constraint implies $\lim_{t \to \infty} e^{rt} d(t) = 0$).

We can analyze the workings of the model once we have specified the funding policy of the government. We will, throughout this paper, assume g and τ to remain constant. Government policy within the context of the floating rate regime therefore implies a choice of $\dot{d}$. Consider first the case of $\dot{d} = 0$, i.e. full monetary financing of the deficit $g - \tau + r(d-R)$.

In that case the model boils down to:

$$u_m(m)/u_c(c) = r + \pi, \quad c + im = (\rho+p)(V + (y-\tau)/(r+p)) \tag{7a,b}$$

and the two dynamic equations

$$\dot{V} = (r-p)\left(\frac{y-\tau}{r+p}\right) + (r - \rho - p)V \tag{8}$$

$$\dot{m} = g - \tau + r(d-R) - \pi m \tag{9}$$

(7a,b) can be used to derive expressions for c and π conditional on m, V, and r:[3]

$$c = c(\underset{\pm}{m},\underset{+}{V};\underset{-}{r}) \tag{10a}$$

$$\pi = \pi(\underset{-}{m},\underset{+}{V};\underset{-}{r}) \tag{10b}$$

"+" or "−" indicates the sign of the corresponding partial derivatives. Analytical expressions are in Appendix A.

Insertion of (10a,b) finally yields two dynamic equations:

$$\dot{V} = V(\underset{0}{m},\underset{-}{V};\underset{+}{r}) \tag{11}$$

$$\dot{m} = m(\underset{\pm}{m},\underset{-}{V};\underset{+}{r}) \tag{12}$$

Once again, analytical expressions are in appendix A, but note from those expressions that

$$\dot{m}_m \; \alpha(1 - \varepsilon_\pi^m)$$

with ε_π^m the general equilibrium elasticity of real money demand with respect to π. Here we only discuss the equilibrium where $\varepsilon_\pi^m < 1$ and $\dot{m}_m > 0$, i.e. where the economy operates on the upward part of the inflation tax curve. The stability problems that arise around the other equilibrium (where $\varepsilon_\pi^m > 1$) are briefly discussed in Appendix A, but will not concern us in the main text.

Consider then equations (11) and (12) around the equilibrium where $\varepsilon_{\pi}^{m} < 1$. Equation (11) represents a vertical curve in m – V space (cf. Fig.1), steady-state non-human wealth $\bar{V}$ depends exclusively on human wealth $(y-\tau)/(r+p)$, the real interest rate,the rate of time preference ρ and the decay parameter p. Note that $\bar{V}$ may be negative or positive, depending on whether ρ is greater or smaller than r (this is also pointed out in Blanchard (1985)). $\bar{V} < 0$ corresponds to external debt in excess of the real value of the monetary base. Since $\dot{V}_V < 0$ unambiguously, V is falling to the right of the VV-locus and rising to the left of it (see Fig.1).

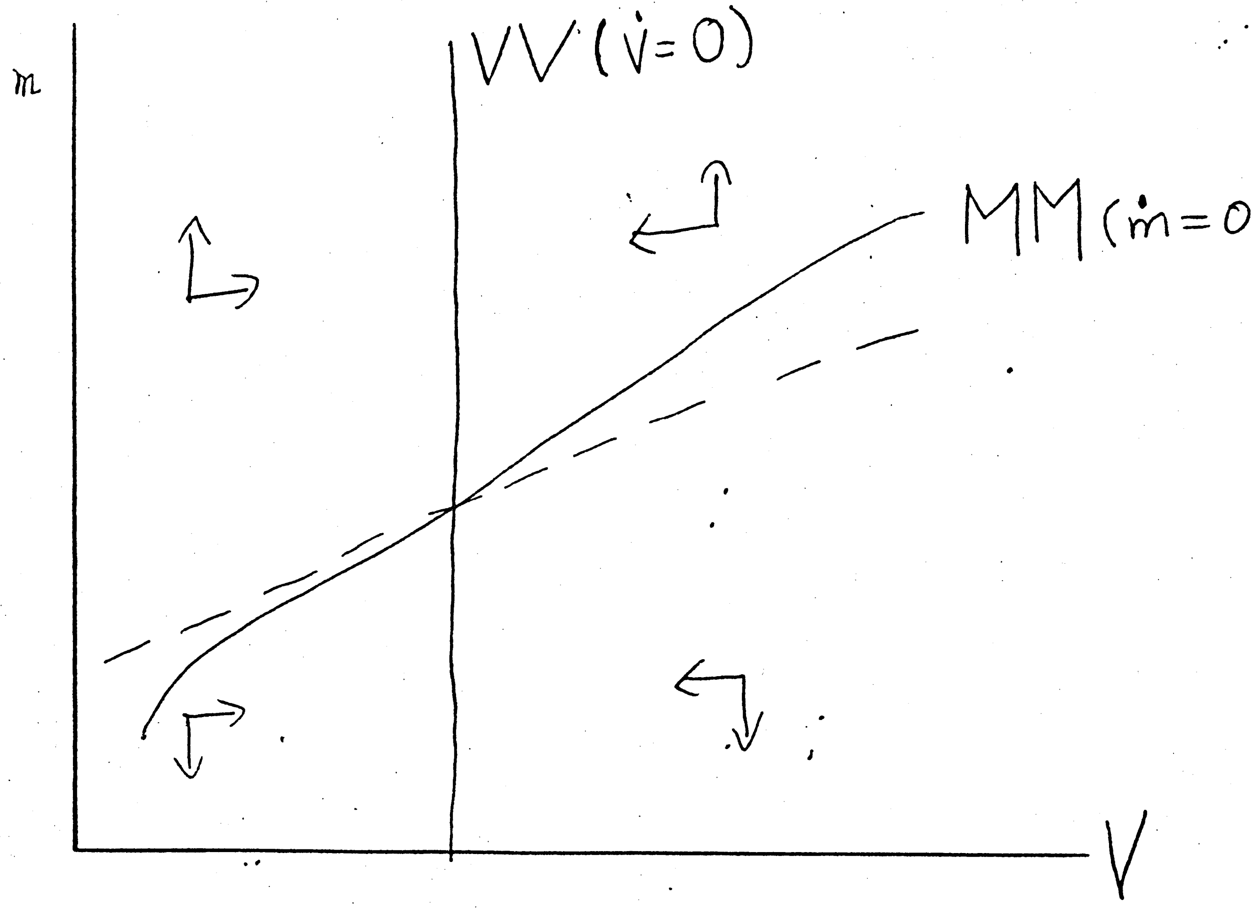


FIGURE 1: DYNAMICS OF THE MODEL UNDER FLOATING EXCHANGE RATES

The slope of the MM curve (along which $\dot{m} = 0$) is unambiguously positive as long as $\varepsilon_\pi^m < 1$:

$$\left.\frac{\partial m}{\partial V}\right|_{MM} = \frac{-\dot{m}_m}{\dot{m}_V} \tag{13}$$

$$= -\frac{\pi_m}{\pi_V}(1 - \varepsilon_\pi^m)$$

Also, as long as $\varepsilon_\pi^m < 1$ and MM therefore slopes up, $\dot{m}_m > 0$, and real money balances will be rising above and falling below MM (see Figure 1). The system is thus saddlepoint stable around the equilibrium E (see Appendix A for a formal analysis).

Standard techniques show that the slope of the saddlepath is positive and less than the slope of MM around E. The slope will be less than one for $\varepsilon_i^m < 1$, a slightly stronger condition than $\varepsilon_\pi^m < 1$ (again see the appendix for formal analysis).

2.2. Response to external and to policy induced shocks.

Partly to see the mechanics of the model and partly for their own right, consider two shocks to the system. First an increase in world interest rates, $dr > 0$.

A permanently lower interest rate will shift MM down and VV out:

$$\left.\frac{\partial m}{\partial r}\right|_{\substack{MM \\ V=\bar{V}}} = \frac{-\dot{m}_r}{\dot{m}_m} < 0; \quad \left.\frac{\partial V}{\partial r}\right|_{\substack{VV \\ m=\bar{m}}} = \frac{-\dot{V}_r}{\dot{V}_V} > 0 \tag{14}$$

where we used the expression for partials listed in Appendix A2. Accordingly in steady-state $\bar{V}$ will increase and $\bar{m}$ may go up or down. It is straightforward to show that for a large enough public foreign debt d, $\bar{m}$ will fall, the case depicted in diagram 2.

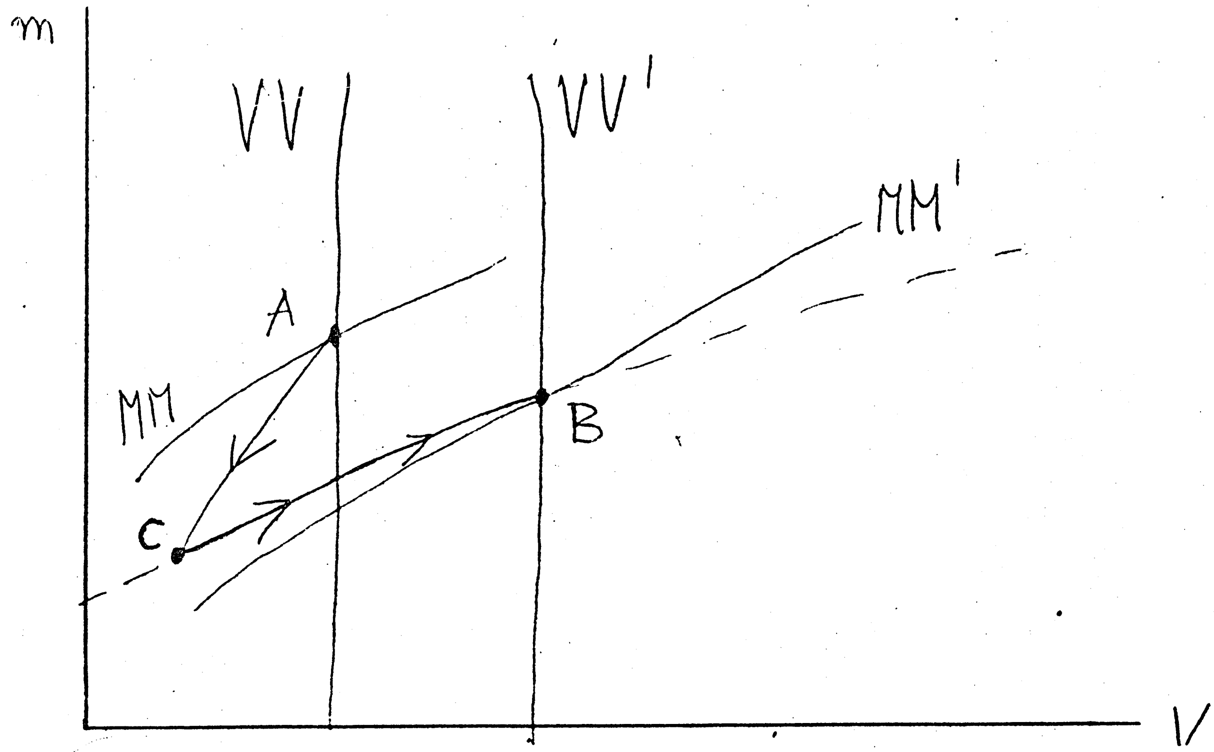


FIGURE 2: EFFECTS OF HIGHER WORLD INTEREST RATES

The original equilibrium was at A, the new one at B in Figure 2, so at the moment of the reform a jump will take place to the new saddle path. Under floating rates, b can only change gradually over time, since changes in b have to match the current account surplus, a flow variable. Hence a jump (a discrete change in the exchange rate e) will affect m and V the same in absolute terms, jumps take place along a 45^0 line. Thus, the economy moves from A to C initially and then along the saddlepath to B.

The downward move in m and V (from A to C) has conflicting effects on the inflation rate: a lower m is compatible with higher inflation since

$u_{mm} < 0$; lower wealth on the other hand lowers consumption and thus increases the marginal utility of consumption. The equilibrium requirement would be a lower inflation rate and nominal interest rate since that has to equal the marginal utility of money in terms of the marginal utility of consumption ($u_m/u_c = i$). We show that inflation rates in excess of around ten percent per annum are sufficient (not even necessary) to guarantee the dominance of the money shift.[4] We are discussing countries with triple digit inflation, so on impact the exchange rate depreciates and the inflation rate jumps up after the increase in world interest rates.

The intuition is straightforward: Higher real interest rates increase the revenue requirements of the government because of increased interest payments on foreign debt (rd). The higher inflation will raise revenues through its effect on the inflation tax.

Consider next a temporary decline in money growth with increased debt issue ($\dot{d} > 0$) covering the resulting funding gap. In particular assume as our experiment:

$$0 \leq t < T : \dot{d} = \gamma$$
$$t \geq T \qquad \dot{d} = 0$$

This has two effects in the diagrammatic analysis. On impact, $\dot{m}$ is reduced by γ one for one through the higher debt issue

$$t = 0 \Rightarrow \dot{m} = g - \tau + r(d(0) - R(0)) - \pi m - \gamma$$

This implies a upward shift in MM of $\gamma\pi(0)\,(1 - \varepsilon^m_\pi)/\varepsilon^m_\pi$:

$$\left.\frac{dm}{d\gamma}\right|_{MM,t=0} = \dot{m}_m^{-1}$$
$$= \frac{\pi(0)}{\varepsilon^m_\pi}\,(1 - \varepsilon^m_\pi) > 0$$

After T, $\dot{d} = 0$ again and the shift will be reversed; however, foreign debt will now have increased by γT and debt service requirements gone up by $r\gamma T$. Hence in the long run ($t > T$), MM shifts <u>down</u> by

$$r\gamma T\, \dot{m}_m^{-1} = r\gamma T\pi(0)(1-\varepsilon_\pi^m)/\varepsilon_\pi^m.$$

The net effect is given in Figure 3. The pre-shock equilibrium is A, the MM curve shifts up on impact to cross VV at B, and down after T to settle at C.

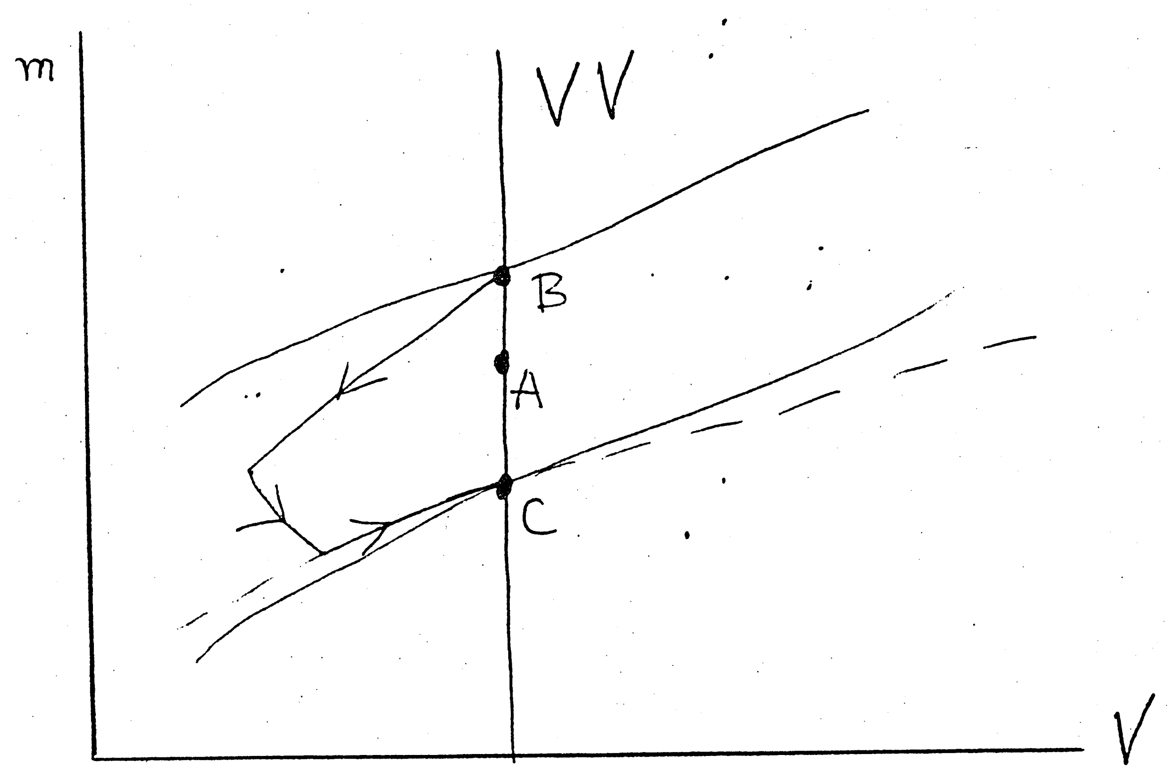


FIGURE 3: A TEMPORARY SLOW DOWN IN MONEY GROWTH

From the dynamics plus the requirement to jump along the 45^0 line, the reader can check that the economy will jump to D, to be able to reach the new "post-T" saddlepath at T (point E in Figure 3). Inflation will accelerate on impact; rise further between 0 and T($\dot{V} > 0$, $\pi_V > 0$; $\dot{m} < 0$ and $\pi_m < 0$); and may rise or fall after T until reaching a new steady state at C at a permanently higher inflation rate than that obtained at A (Figure 4).

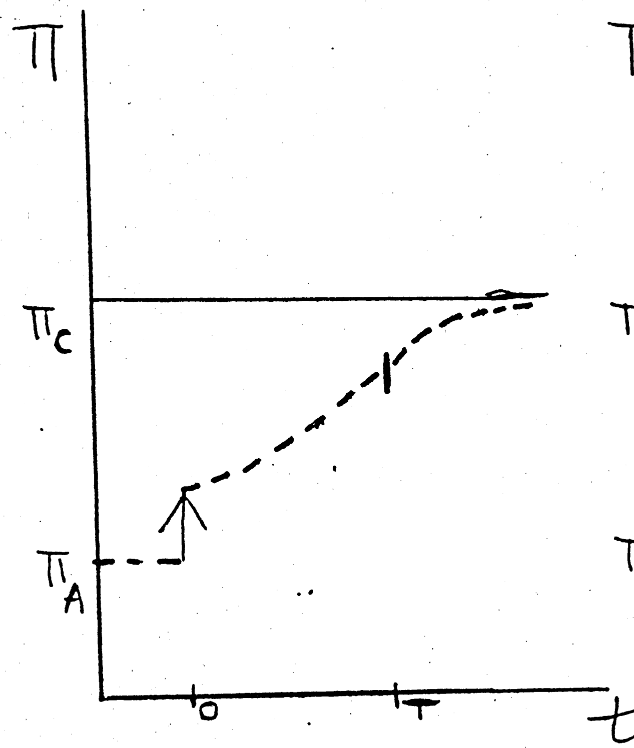


FIGURE 4a

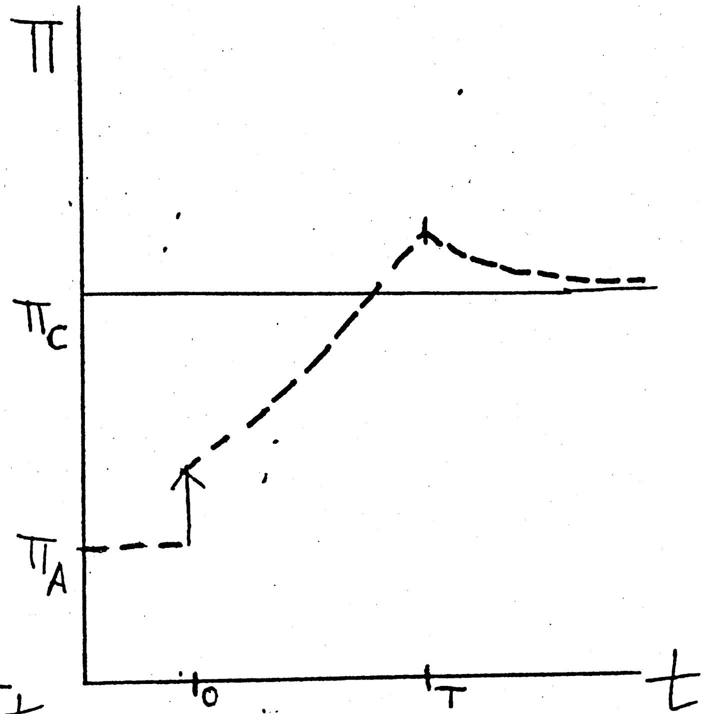


FIGURE 4b

INFLATION RESPONSE TO TEMPORARY TIGHTENING OF MONETARY POLICY. BOTH 4a and 4b ARE POSSIBLE

We thus mimic the surprising Sargent-Wallace result of an increase in inflation (rate of depreciation of the exchange rate) both on impact and permanently, in response to temporary tight money accompanied by increased issue of interest bearing debt. Moreover, the exchange rate depreciates discretely on impact.

3. THE MODEL UNDER FIXED EXCHANGE RATES

If we could ignore sustainability issues (and, of course, we cannot; that is the subject of section 4), the model equations would need only minor adjustment to describe developments under a fixed exchange rate regime. This is because we use a competitive framework where consumers are pricetakers; whether prices are supported by one or another type of exchange rate regime is of no importance. Sustainability introduces Krugman (1979) type speculative attack issues and the regime switch such as attacks force. In this section we will show how to check whether such attacks will take place or not but not yet introduce the attack itself in the analysis; that will be done in section 4 where we discuss the use of an exchange rate freeze as an anti-inflation device.

However, since consumers are pricetakers, equations (7a, 7b and 8) will continue to describe private behavior. I will repeat them here for convenience.

$$\frac{u_m(m)}{u_c(e)} = r + \pi \tag{15a}$$

$$c + im = (\rho+p)[V + (y-\tau)/(r+p)] \tag{15b}$$

$$\dot{V} = (r-\rho)\frac{(y-\tau)}{r+p} + (r-\rho-p)V \tag{16}$$

Note, however, that now (15a), for any given value of consumption c, determines the equilibrium moneystock m. This is because under a fixed exchange rate regime, π is exogenous (under a preannounced crawling peg regime it might be non-zero, but the point is that it is fixed). Hence we can use (15b) to substitute out c from (15a) and obtain an equilibrium relation between m and V that has to hold for the value of π implied by the choice of exchange regime (fixed with $\pi = 0$, or crawling peg at rate ρ where $\pi = 0$):

$$\frac{u_m(m)}{u_c((\rho+p)(V+cy-\tau)/(r+p)) - im)} = r + \pi \tag{17}$$

(17) defines what I call the MD locus in Figure 5; as long as the fixed exchange regime lasts, the economy has to be on that locus. The slope of that locus equals the marginal propensity to hold money out of wealth, a propensity that most empirical studies put at zero. Theoretically we obtain through differentiation of (17):

$$\left.\frac{\partial m}{\partial V}\right|_{MD} = \frac{(\rho+p)u_{cc}/u_c}{(r+\pi)u_{cc}/u_c + u_{mm}/u_m} > 0 \tag{18}$$

where we repeatedly used $u_m/u_c = r + \pi$.

Of course, the location of the curve shifts if the preannounced rate of crawl is changed, changing π for one:

$$\left.\frac{\partial m}{\partial \pi}\right|_{\substack{MD\\ V=\bar{V}}} = \frac{-[(r+\pi)Am + 1]}{[(r+\pi)(A(r+\pi)-u_{mm}/u_m)]} < 0 \tag{19}$$

with $A = -u_{cc}/u_c > 0$. Note that (19) is simply the inverse of the expression for π_m derived in Appendix A.1.

Finally, as to the intersection of MD and VV, let us anticipate the experiment performed in section 4, a transition from a high inflation floating regime to a low inflation (say zero) fixed rate regime. In that case we know that (17) will not be satisfied at the old equilibrium values for m and V (say m_A and V_A; see Figure 5). At A, $u_m(m_A)/u_c(c(m_A,V_A))$ will equal $r + \pi_A$, but during the freeze $\pi = 0 << \pi_A$. Accordingly, for given V, m will increase as π decreases (App.A.I). Hence after a freeze reducing π to zero instantaneously, MD shifts up from A to, say, B in Figure 5.

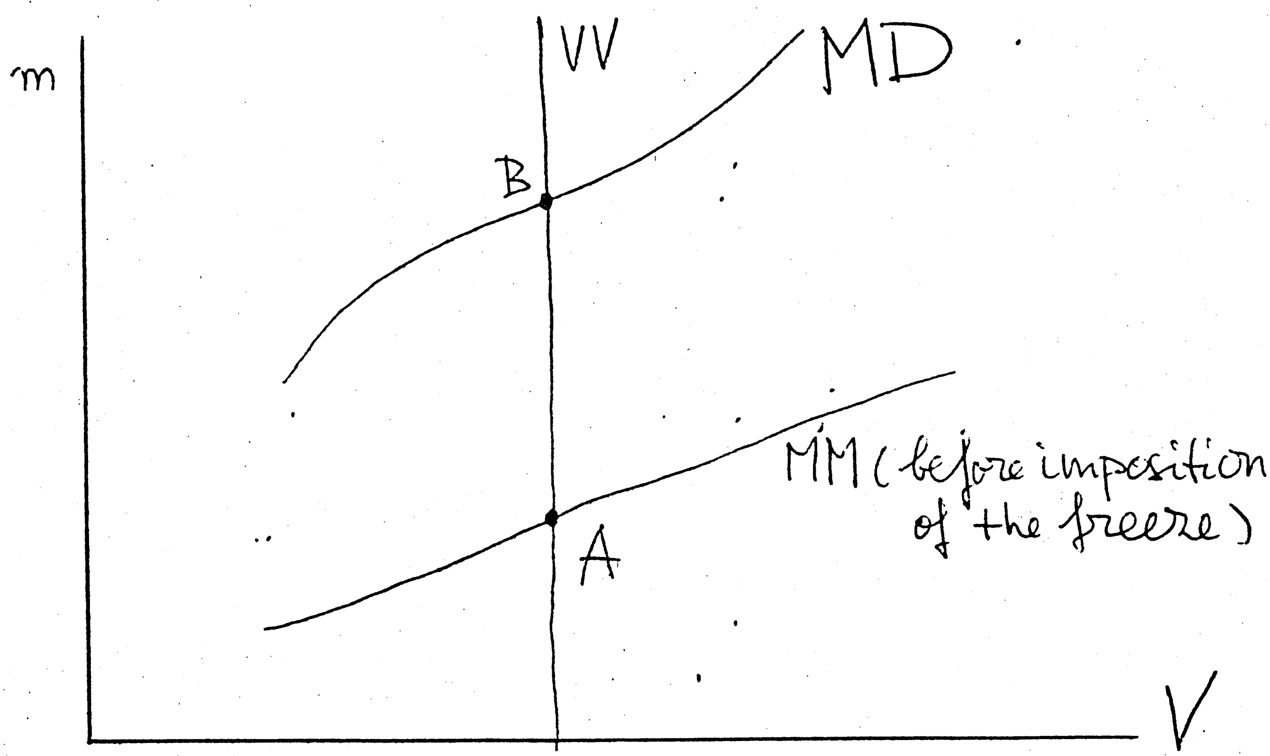


FIGURE 5: THE FIXED EXCHANGE RATE REGIME

The government budget constraint will tell us whether the exchange rate freeze is feasible or not. It needs a minor amendment, since under fixed exchange rates the issue of new non-interest bearing government liabilities does not necessarily equal the increase in the nominal money stock anymore: Central Bank foreign assets may change and so drive a wedge between changes in nominal money and changes in credit to the government.

Call the stock of non-interest bearing domestic government liabilities D. The government budget constraint then becomes:

$$g - \tau + r(d - R) = \dot{d} + \frac{\dot{C}}{e} \qquad (20)$$

Note that R now may vary over time.

Equations (15a, b) and (16), however, fully specify the dynamic path of m. The desired (and actual, given our assumptions of perfect capital mobility and, in this section, predetermined exchange rates) nominal increase in money hence equals

$$\frac{\dot{M}}{e} = \dot{m} + \pi m \qquad (21)$$

with $\dot{m}$ and πm determined from (15a,b) and (16) and the policy choice of the rate of crawl.

Reserve changes are determined as the difference between $\dot{M}$ and $\dot{D}$ as they are given in (20) and (21):

$$\dot{R} = \frac{\dot{M}}{e} - \frac{\dot{C}}{e} \qquad (22)$$

A fixed exchange rate regime needs to pass two tests of sustainability. The first test states that for any debt policy defining a time path for $\dot{d}$ and thus d, reserve losses cannot continue indefinitely. Although a central bank can borrow, it too will face a debt ceiling for the same reason that d cannot exceed d^* (see section 2).

The second test is that even where the time path of R satisfies the first test, the time path of $\dot{d}$ and d that supports it should not imply that d will eventually exceed d^*. In the next section we will consider both types of sustainability failures and show that they lead to different post-collapse inflation rates; both, however, will be in excess of the inflation rate prevailing before the collapse.

4. AN EXCHANGE RATE FREEZE, SPECULATIVE ATTACKS AND THE POST-COLLAPSE INFLATION RATE

We will now use the machinery developed so far to examine the economic effects of freezing the exchange rate in an attempt to shake the economy out of a high inflation equilibrium. We will do so under two alternative assumptions about the mix of interest bearing debt and non-interest-bearing liabilities the public sector uses to fund its "basic deficit" $g-\tau+r(d-R)$. Under the first assumption, no further increase in external public debt is allowed ($\dot{d} = 0$) and the entire basic budget deficit is funded through issuing domestic credit. In the second case we assume that domestic credit policy is designed to avoid gradual reserve losses during the period that the freeze is operating, rather along the lines of a standard IMF program. External borrowing is used to fill the gap. We show that the two strategies lead to different post-collapse equilibria: the tight-credit approach will lead to higher inflation eventually, through the eroding effect of higher external debt on the basic budget balance of the public sector.

4.1. An exchange rate freeze with $\dot{d} = 0$ imposed.

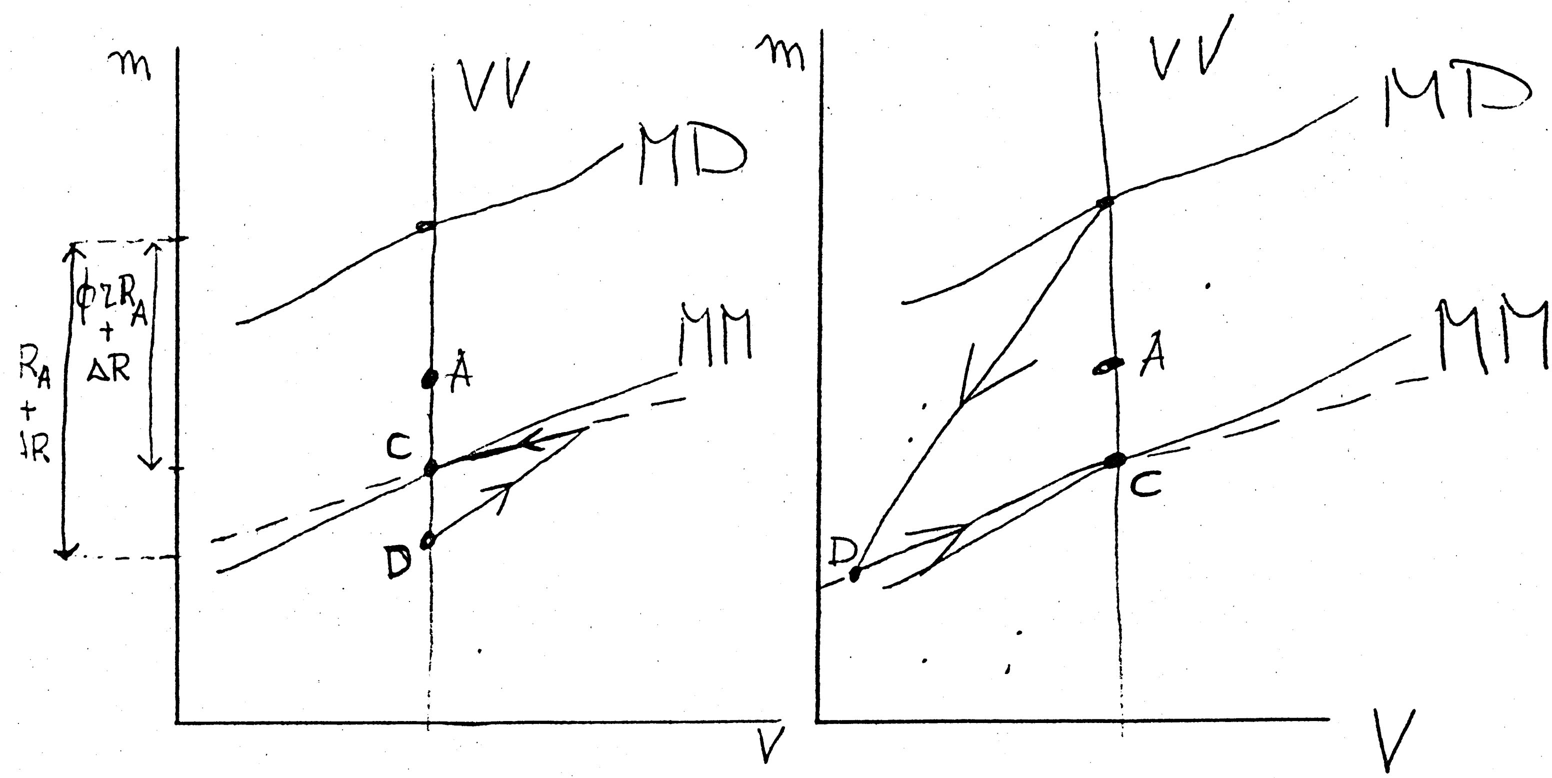
We already saw that an exchange rate freeze (or preannounced crawling peg at a rate below the pre-stabilization-program inflation rate π^{-}) will shift up the MD locus on which the economy will always be under fixed exchange rates, say from A to B in Figure 6a,b).

Now, the impact response of the economy to any shock is different under fixed and floating rates. Under floating rates, b could change only gradually, since it needs to be matched by the Current Account balance, a flow variable. Stock adjustment took place through discrete jumps in the exchange rate leading to discrete changes in m (since M too could only change gradually under that regime). Since $V = m + b$, discrete changes took place along a 45^{0} line through the starting point.

Under fixed rates, however, discrete changes take place through a different mechanism. e is fixed by assumption, so Central Bank reserves are not necessarily fixed anymore. Instead, discrete changes are effected through one for one swaps between m and b: The public will buy discrete quantities of foreign exchange from the Central Bank in order to purchase foreign assets with the CB losing an equivalent amount of foreign reserves; or, in the other direction, the public will deposit foreign currency obtained from the sale of units of b in the banking system to acquire domestic money, so increasing the CB's foreign assets and the monetary base m. Hence under fixed rates, jumps take place vertically maintaining V while m changes, and with reserves R going through a matching stock adjustment during the jump.

Call the level of CB reserves available at the moment of the announcement of the stabilization program $R_A(0)$. After the start of the program, a vertical jump to move to the MD curve will bring the economy from A to B

(Figure 6a,b): A discrete inflow of Central Bank reserves (the counterpart of which is a private sale of foreign assets b) expands the money supply from m_A to m_B, where it is in line with the new lower inflation rate π_B (π_B equals zero in the case of a literal "freeze").



TRANSITION TO A FIXED RATE REGIME FOLLOWED BY:

6a: An Instantaneous Speculative Attack

6b: A regime Switch after Gradual Reserve Losses have exhausted CB foreign reserves

To see whether a fixed rate regime at B is sustainable, we need to inspect the government budget constraint and see whether the implied rate of domestic credit issue is compatible with the increases in nominal money demand that arise when the economy stays at B (these will be zero if $\pi_B = 0$, an actual exchange rate freeze).

Consider therefore equations (20) and (21). We know that, since the economy was in equilibrium at A:

$$g_A - \tau_A + r(d_A - R_A) = \pi_A m_A \tag{23}$$

Also, between A and B, a reserve inflow of $\Delta R = m_B - m_A$ has taken place, so at B profit transfers by the CB into the government budget have increased by $r\Delta R$. On the other hand the private sector will absorb domestic credit at the rate $\pi_B m_B$; anything higher will cause unsustainable reserve losses.

The issue therefore is whether

$$g_A - \tau_A + r(d_A - R_A - \Delta R) \gtrless \pi_B m_B$$

Using (23) we get

$$\begin{aligned} & g_A - \tau_A + r(d_A - R_A - \Delta R) - \pi_B m_B \\ & = \pi_A m_A - r\Delta R - \pi_B m_B \\ & = \pi_A m_A - r(m_B - m_A) - \pi_B m_B \\ & = i_A m_A - i_B m_B \\ & > 0 \end{aligned} \tag{24}$$

since $\varepsilon_i^m < 1$ around A and more so around B (see the discussion of the slope of the saddle path in Appendix A3.

Hence the situation at B is not sustainable, the initial reserve inflow will be followed by a period of reserve losses:

$$\dot{R}(t) = i_B m_B - i_A m_A < 0 \tag{25}$$

for $t > 0$ until the regime is abandoned.

This is exactly the type of situation analyzed in Krugman (1979). Krugman shows that it leads to a speculative attack on the exchange rate regime, exhausting the Central Bank's foreign exchange reserves, thus forcing a return to floating exchange rates. We can use our diagrammatic framework to analyze the timing of the attack.

Before doing that, however, we draw attention to an important issue not covered in Krugman (1979) (or in any of the other speculative attack papers that followed): A speculative attack will exhaust the Central Bank's reserves and thus reduce its post-collapse profits from interest earnings on foreign assets to zero; as a consequence its positive contribution to the government budget comes to an end after the collapse and the government's basic budget balance deteriorates not only with respect to B, but even with respect to the pre-stabilization situation at A. Call the post-collapse situation C, then:

$$\begin{aligned} g_C - \tau_C + r(d_C - R_C) &= g_A - T_A + rd_A \\ &> g_A - \tau_A + r(d_A - R_A) \end{aligned} \tag{26}$$

The first equality obtains because a speculative attack exhausts the CB's reserves, hence $R_C = 0$.[6] Therefore, the post-collapse equilibrium will not be at A but lower, since the basic budget deficit has deteriorated by rR_A. Hence a shift down from A to C equal to

$$\Delta_{\dot{d}=0} = rR_A \times \frac{\partial m}{\partial(rR)}\bigg|_{\substack{MM \\ V=\overline{V}}} = rR_A \cdot \dot{m}_m^{-1} \tag{27}$$

$$= rR_A \; \varepsilon_\pi^m / (\pi_A(1 - \varepsilon_\pi^m))$$

$$= \phi r R_A$$

where ϕ is a positive constant defined for later use.

The post-collapse equilibrium will be at C, below the pre-stabilization equilibrium at A. This is important because at C, inflation will be higher than at A:

$$\begin{aligned} \pi_C &= \pi(m_C > V_C) & & \\ &= \pi(m_C, V_A) & \text{since } & V_A = V_C \\ &> (m_A, V_A) & \text{since } & m_A > m_C, \pi_M < 0. \end{aligned} \tag{28}$$

This establishes an important result: if the crawling peg or exchange rate freeze ends through a speculative attack a la Krugman (1979), <u>the post-collapse inflation rate will exceed the inflation rate that prevailed before the start of the stabilization program</u>.

Consider finally the timing of the speculative attack. Figures 6a and 6b look at two extremes. At the one end is the case where no attack takes place and the regime changes take place when CB reserves have been exhausted through the gradual outflow given in equation 25 (Figure 6b).

In that case $R = 0$ at the time of the regime change so that no outflow takes place and on impact no vertical jump takes place. However, in the post-collapse float, the economy will need to remain on the saddlepath passing through C. Hence immediately after R reaches zero and the CB abandons the fixed rate regime, a discrete devaluation takes place, taking the economy from B to D in Figure 6b. However, such a devaluation would inflict capital losses at an infinite rate on holders of domestic money. Rational speculators will therefore bring down the regime before that occurs (Krugman (1979)).

On the other extreme is a speculative attack at the very beginning of the freeze, immediately after the economy has jumped to B. That is the case depicted in Figure 6a. Such a speculative attack will exhaust Central Bank reserves and therefore instantaneously reduce the money stock by an equal amount. Since R_A is positive, the attack at that time will move the economy down below A. What we do not know is whether it will move below C. The downward shift equals $R_A + \Delta R$, while the distance B–C equals

$$\phi r R_A + \Delta R.$$

Therefore the attack will take the economy below C if $\phi < r^{-1}$ and vice versa. Both cases are possible. Consider the case where $\phi < r^{-1}$ (Figure 6a).

After the attack the economy moves below C since by assumption $\phi < r^{-1}$. Hence the economy will, after the float starts, be below the saddlepath on which it should be. Accordingly the exchange rate will immediately appreciate, moving the economy from D to E. It will then gradually depreciate back down to C. This scenario would, however, also be incompatible with rational speculative behavior: During the jump from D to E they would enjoy capital gains at an infinite rate.

As shown by Krugman (1979), the existence of competitive rational speculators will lead to a speculative attack timed to fall in between these two extremes, in such a way that no discrete depreciation will take place and therefore no infinite rate of capital gain will occur.

We can easily calculate the timing of the attack. The only way such a discrete change could be avoided is if the economy would be forced to jump to C in the process of exhausting the CB's foreign reserves. That suggests that the time of the attack is determined by the following equation (where $\{\dot{R}\}$ is the time path of reserve losses implied by equation (25)):

$$R(T) = R_A + \Delta R + \int_0^T \{\dot{R}(t)\} dt = \Delta R + \phi r R_A = m_A - m_C \qquad (29)$$

Equation (29) is an implicit equation in T, the time of the attack.

There is one possibility where equation (29) has no solution, and that is the case where

$$R_A + \Delta R < \phi r R_A + \Delta R \qquad (29)$$

or

$$\phi > r^{-1}$$

In that case an initial jump at $t = 0$ would fall short of C and also produce a depreciation, like in Figure 6b, although a smaller one (see Figure 6c below). In that case the freeze will be aborted straight at its beginning.

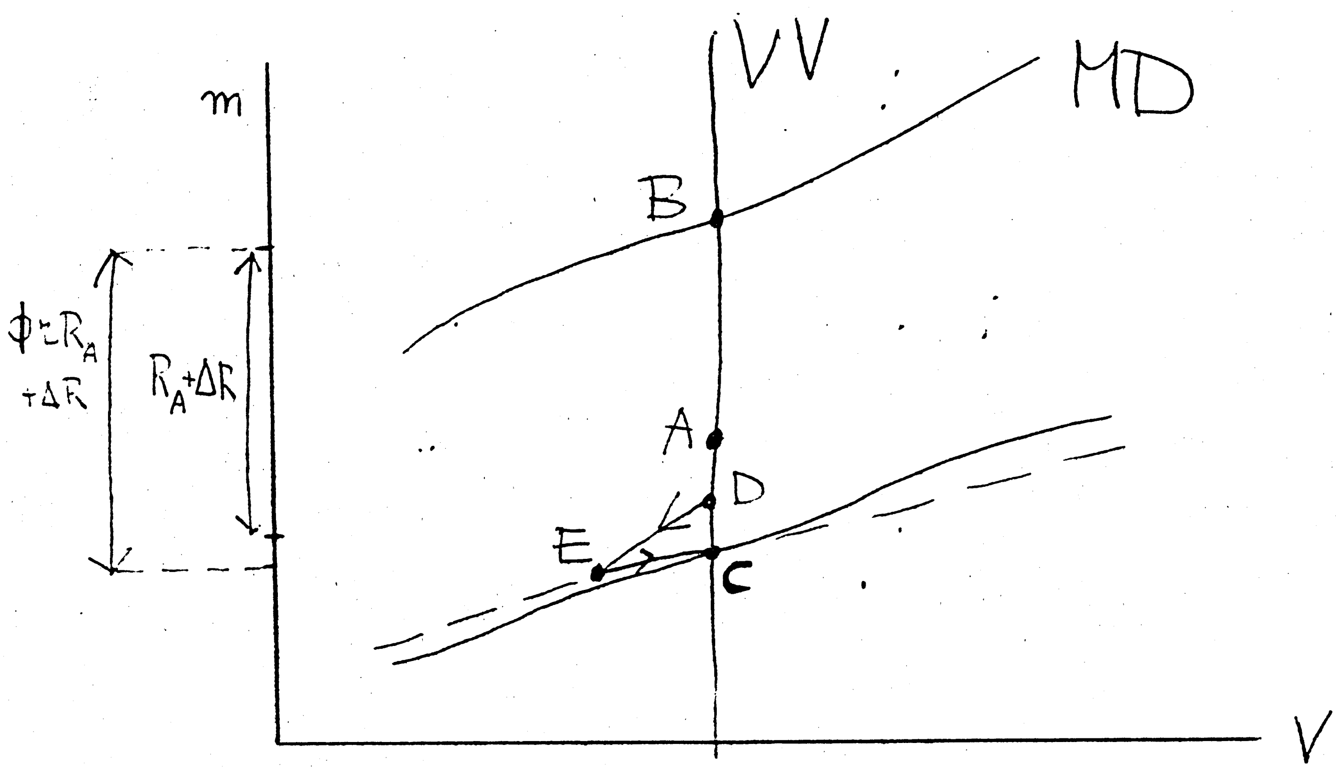


FIGURE 6c: $\phi > r^{-1}$; The Speculative Attack occurs Immediately after the initiation of the freeze

4.2. An Exchange Rate Freeze with $\dot{d}$ set to avoid gradual Reserve Losses while the freeze operates

Consider finally a freeze backed up by a domestic credit policy designed to avoid reserve losses, i.e. a time path of $\dot{C}$ that would keep $\dot{R} = 0$ in equation 25. This is very much the type of credit policy imposed during IHF administered adjustment programs.

From equation (24) we can immediately derive that such a policy implies

$$\dot{d} = i_A m_A - c_B m_B > 0$$

for as long as the freeze lasts. This, in turn, will, in the absence of a speculative attack, lead to a steady increase in external debt until the maximum level d^* is reached. Then the policy will need to be discontinued and, if there still is no speculative attack, the economy is back to the situation analyzed in section 4.1, and an attack will bring the regime down in the manner described in section 4.1.

There is, however, one important difference. In the process, public sector external debt has increased from d_A to d^*. Hence the downward shift of MM from A to C is larger and will now equal

$$
\begin{aligned}
\Delta_{\dot{d}>0} &= \phi r R_A + \phi r(d^* - d_A) \\
&= \Delta_{\dot{d}=0} + \phi r(d^* - d_A) \qquad (30) \\
&> \Delta_{\dot{d}=0}
\end{aligned}
$$

We will not take the reader through the mechanics of calculating the timing of the attack, but point out that equation (39) implies that the post-collapse equilibrium with a tighter domestic credit policy before and hence a higher public interest bearing debt afterwards, will be below C, say at F and will therefore be characterized by an even higher inflation rate:

$$
\begin{aligned}
\pi_F = \pi(m_F, V_F) &= \pi(m_F, V_B) \\
&> \pi(m_B, V_B) \qquad (31) \\
&>> \pi(m_A, V_A)
\end{aligned}
$$

We leave it to the reader to show that attack can take place before or after d^* will have been reached (the necessary formulas are given in footnote 7).[7] As a final observation, note that if it takes place before d^* is reached, the speculative attack will take place without any gradual loss of Central Bank foreign reserves. The conditions that will prevent an attack derived in Krugman (1979) and Flood and Garber (1984) are, therefore, necessary but not sufficient. In addition, conditions need to be satisfied on the growth rate of interest bearing public sector debt.

5. CONCLUSIONS

In the introduction we summarized a series of puzzles in the recent inflationary experience and stabilization failures in high inflation countries such as Israel, Brazil and Argentina. In this paper we present an analysis that explains these puzzles within the context of a model with rational, optimizing and forward looking consumers endowed with perfect foresight. The government budget constraint and the resolution of inconsistencies between the implications of different policy instruments for that constraint are at the core of our analysis.

In doing so this paper is in the spirit of the "public finance approach" to macroeconomics popularized by Phelps (1973). Several authors have recently used this approach to analyze current effects of future policy changes (Sargent and Wallace (1982), Liviatan (1984), Drazen and Helpman (1985a,b), Bentall and Eckstein (1985)). In a departure from those papers we endogenise the regime switch by linking it to rational speculative behavior. Furthermore we extend this approach to an open economy framework (all papers mentioned use closed economy models) which enables us to analyze exchange rate policy and changes in exchange rate regime.

After setting up a floating exchange rate version of our model, we show how external shocks such as increases in world interest rates lead to a deterioration of the government deficit in the presence of external public debt, and show how this will lead to a higher inflation rate through the residual role of the inflation tax in a floating exchange rate regime.

Such shocks to the basic budget position of the public sector (and one can think of many other shocks that would have similar effects) can therefore explain sudden increases in inflation rates that will then stay at these higher rates unless offsetting cuts in expenditure or increases in real taxes are instigated. This explains the first puzzle mentioned in the introduction, the "plateau-pattern" of inflation observed in countries such as Israel and Brazil.

We then introduce a fixed exchange rate version of the model and proceed to the main part of the paper, an analysis of the use of an exchange rate freeze (or preannounced crawling peg) as an attempt to reduce the rate of inflation, as was done in Israel in October 1982 and in Argentina from December 1978 onwards. We derive conditions that need to be satisfied for such an experiment to be sustainable. These conditions are derived from the government budget constraint. In particular we show that a domestic credit issuance policy designed to offset loss of international reserves while the fixed regime lasts, is necessary but not sufficient to prevent speculative attacks forcing a regime switch. This in contrast to the literature on speculative attacks in fixed exchange rate regimes (Krugman (1979), Flood and Garber (1984)). The difference arises because we explicitly incorporate the government budget constraint. We show that speculative attacks will also take place if such a domestic credit policy implies unsustainable increases in interest bearing (non-monetary) government debt.

We show that if a collapse occurs, the post-collapse inflation rate is higher than the inflation rate that prevailed prior to the stabilization experiment. This accords well with the Argentinian and Israeli experience.

The explanation is rather subtle and is related to the loss of interest earnings on the foreign assets of the Central Bank that are lost during the speculative attack.

We then endogenize such speculative attacks following Krugman (1979). We show that if a collapse occurs after a domestic credit policy during the exchange rate freeze designed to prevent reserve losses while the freeze lasts, will lead to a higher post-collapse inflation rate than will prevail when domestic credit issuance is higher during the freeze period, high enough to keep external public debt at the pre-freeze level. The explanation is the post-collapse deterioration in the basic government budget because of higher real interest payments on the extra external debt accumulated under the first policy. This ultimately inflationary effect of restrictive credit policies under an unsustainable fixed exchange rate regime is related to the Sargent-Wallace (1982) result of high inflation in response to temporary tight money in a closed economy.

Most of the results are, of course, conditional on the government not undertaking the reforms in expenditure or (non-inflation) taxes necessary to make the fixed regime feasible. However, it is important to realize that, even when the government intends to undertake such reforms in the future, private doubts on whether these reforms will in fact take place, will lead to similar results. This point is made in Drazen and Helpman (1985) in a discussion of monetary policy in a closed economy context. The policy conclusion is clear: fiscal reform is not only necessary for the success of an anti-inflation program, but should come up front.

FOOTNOTES

1. This structure is used to guarantee existence of a steady state without having to impose the arbitrary restriction of $r = \rho$ (r is the foreign real rate and ρ the domestic rate of time preference). See Buiter (1984) and Frenkel and Razin (1985) for an open economy application of the Blanchard (1985) framework.
2. Helpman and Razin (1985) discuss the transition from a floating to a fixed rate regime in a policy setting where taxes τ are varied to ensure sustainability of the fixed rate regime. This leads to a set of issues entirely different from the ones discussed in this paper.
3. Plus other variables and parameters that will not be varied in this paper and are therefore dropped from the argument list.
4. $\pi > \rho + p - r$ is sufficient but not necessary. On an annual basis, p is constrained to lie below one by definition. For the population as a whole, p is likely to be around .02 at most. In the economies we have in mind, π is well above one (=100Δ inflation) at the time the exchange rate policy was tried (125Δ in Israel in 1982, around 200Δ in Argentina in 1978). Of course, in practice p is not constant across ages but seems constant and well below .02 until 50 but to increase steeply thereafter (Blanchard (1985)). The highest empirical value of ρ that I am aware of (15 percent, Boskin and Kotlikoff (1985)) would then still imply that an inflation rate of 10-15 percent annually would be high enough. The necessary condition is weaker, however, as long as $u_{mm} < 0$ (see App.A.1).

5. Unless, of course, real government expenditure g is sufficiently cut or real taxes sufficiently raised <u>concurrently</u>.

6. In fact the Central Bank might abandon the fixed rate regime before R has reached zero, say at $R_C > 0$. Clearly $R_C < R_A$, since R_A was considered sufficiently high to actually start the fixed rate regime. We will assume $R_C = 0$, but all results carry through as long as $R_C < R_A$.

7. To give the answer away, the attack takes place before d^* has been reached if an attack at the moment d^* is reached would result in an immediate depreciation after the attack forced a transition to the floating rate regime. This will happen if

$$R_A + \Delta R < \phi r R_A + \phi r(d^* - d_A) + \Delta R$$

If this happens, i.e. if an attack ends the freeze before d^* is reached, the new equilibrium will be between C and F since then $d(T) < d^*$, although $d(T) > d_A$ (unless the attack takes place immediately after the announcement of the freeze, in which case the new equilibrium is at C again.

APPENDIX A

A1. Derivation of $\pi(m,V;r)$ and $C(m,V;r)$

Total differentiation of equation (7a,b) yields:

$$\begin{bmatrix} (r^*+\pi)A & -1 \\ 1 & m \end{bmatrix} \begin{bmatrix} dc \\ d\pi \end{bmatrix} = \begin{bmatrix} dr^* - u_{mm}/u_c dm \\ -(m + \frac{\rho+p}{(r+p)^2}(y-\tau))dr^* \\ -\ (r+\pi)dm + (\rho+p)dV \end{bmatrix} \qquad \text{(A1)}$$

with $A = -u_{cc}/u_c$, the coefficient of absolute risk aversion. Define the determinant of the LHS matrix as Δ:

$$\Delta = (r + \pi)Am + 1 > 0.$$

Hence:

$$\pi_m = -\Delta^{-1}(r+\pi)(A(r+\pi) - u_{mm}/u_m) < 0$$

$$\Pi_V = \Delta^{-1}(r+\pi)A(\rho+p) > 0$$

$$\pi_r = -\ \Delta^{-1}((r+\pi)Am + 1 + \frac{(\rho+p)}{(r+p)^2}(y-\tau)) < 0$$

$$C_m = -\Delta^{-1}(r+\pi)(1 + mu_{mm}/u_m \gtrless 0$$

$$C_V = \Delta^{-1}(\rho+p) > 0$$

$$C_r = -\Delta^{-1} \frac{(\rho+p)}{(r+p)^2}(y-\tau) < 0$$

with repeated use of $u^{-1} = (u_m/u_c)u_m^{-1} = (r+\pi)u_m^{-1}$.

The necessary condition referred to on p.13 and in ft.4 is:

$$\pi_m + \pi_V < 0$$

or

$$\pi > \rho + p - r + u_{mm}/u_m$$

A.2. Derivation of $\dot{m}(m,V;r)$ and $\dot{V}(m,V;r)$

Differentiation of (8) and (9) yields:

$$\dot{V}_m = 0$$

$$\dot{V}_V = (r - \rho - p) < 0$$

$$\dot{V}_r = (V + \frac{y-\tau}{(r+p)}) - \frac{(r-p)(y-\tau)}{(r+p)^2}$$

$$- \frac{y-\tau}{r+p}(\frac{p(\rho+p) + (r-p)^2}{(r+p)(r-\rho-p)}) > 0$$

The second expression for $\dot{V}_r$ uses that at $V = \overline{V}$ (steady state value), $(r-\rho)\frac{y-\tau}{r+p} + (r-\rho-p)V = 0$. It therefore holds exactly when evaluated at $\overline{V}$, but only approximately around $\overline{V}$.

$$\dot{m}_m = -(\pi + m\pi_m)$$

$$= -m\pi_m(1 - \varepsilon_\pi^m) \gtrless \Longleftrightarrow \varepsilon_\pi^m \lessgtr 1$$

$$\dot{m}_V = - m\pi_V < 0$$

$$\dot{m}_r = d - m\pi_r > 0.$$

A.3. Stability of (11), (12), and the slope of the saddlepath around E.

The characteristic equation of the matrix of partial derivatives of $\dot{m}$ and $\dot{V}$ (equations (12, (13)), with respect to m, V is:

$$(\lambda + m\pi_m(1 - \varepsilon_\pi^m))(\lambda - (r - \rho - p)) = 0 \tag{A2}$$

Around E, $\varepsilon_\pi^m < 1$, hence the negative root is $\lambda^- = r - \rho - p$. The other root, $\lambda^+ = -m\Pi_m(1 - \varepsilon_\pi^m) > 0$ around E, so the system is saddlepoint stable around E.

Straightforward calculation shows that the eigenvector corresponding to λ^- equals

$$(m,V) = (\frac{Z}{Z + Z_1}, 1)$$

where $Z = m(r+\pi)A(\rho+p) > 0$

and

$$Z_1 = -m\pi_m(1 - \varepsilon_\pi^m) - r$$

$$= \frac{\pi}{\varepsilon_\pi^m}(1 - \varepsilon_\pi^m) - r$$

Clearly, the slope of the saddlepath equals $Z/(Z+Z_1)$, so that the slope is smaller than one if $Z_1 > 0$. That, in turn, implies

$$\frac{\pi}{\varepsilon_\pi^m}(1 - \varepsilon_\pi^m) > r$$

or

$$\varepsilon_\pi^m < \frac{\pi}{r+\pi}$$

or

$$\varepsilon_i^m < 1$$

a slightly stronger condition than $\varepsilon_\pi^m < 1$, which we will assume to hold.

A.4. The other side of the Laffer Curve.

If $\varepsilon_\pi^m > 1$, as obtains for inflation rates in excess of the maximum revenue rate, the sign of the first root switches sign:

$$\lambda_1 = -m\pi_m(1 - \varepsilon_\pi^m) \gtrless 0 = \Leftrightarrow \varepsilon_\pi^m \lessgtr 1.$$

That implies that the initial conditions will not be uniquely tied down: Two negative roots and only one predetermined variable (b^*; m can jump). See Figure A1, equilibrium L.

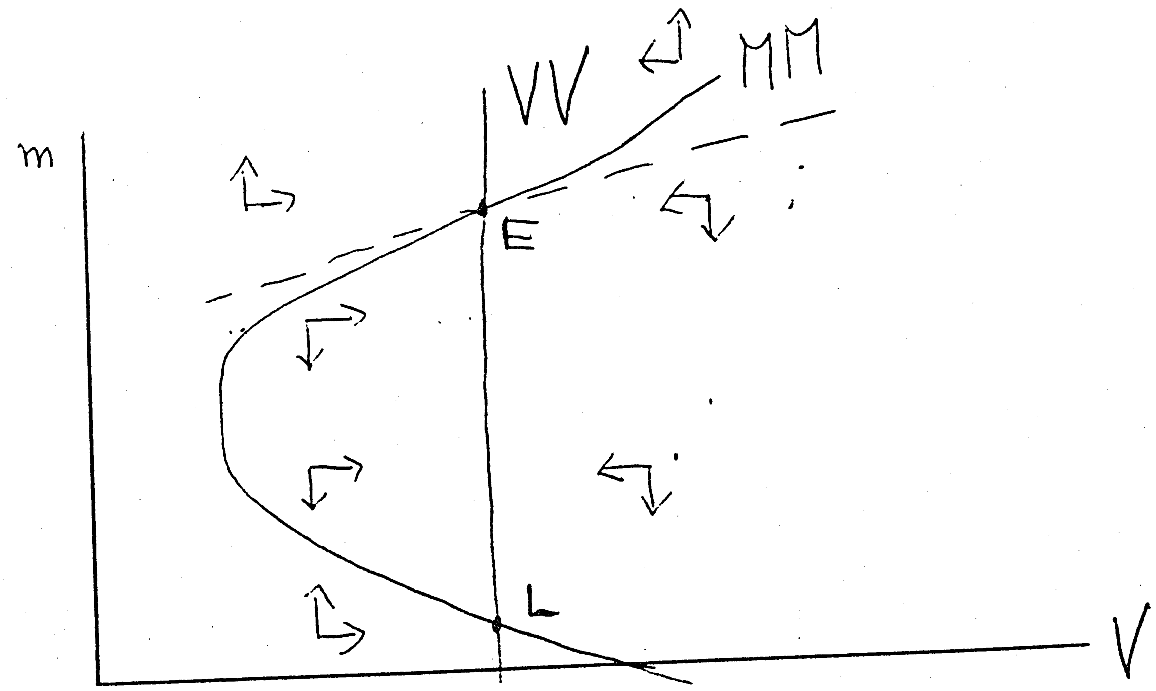


FIGURE A1: MULTIPLE EQUILIBRIA AND STABILITY

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