NBER WORKING PAPER SERIES

MONETARY STABILIZATION, INTERVENTION AND REAL APPRECIATION

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Working Paper No. 472

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
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April 1980

This paper is a chapter of my forthcoming book Open Economy Macroeconomics, Basic Books, July, 1980. The research reported here is part of the NBER's research program in International Economics. Any opinions expressed are those of the author and not those of the National Bureau of Economic Research.

NBER Working Paper 472
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Monetary Stabilization, Intervention and Real Appreciation

ABSTRACT

This paper investigates the adjustment process to a reduction in the rate of credit creation in an open, flexible exchange rate economy. The framework of analysis is one of rational expectations with respect to interest rates, inflation and depreciation. The special feature of the model is the role of exchange market intervention and the resulting endogeneity of the money stock.

The model is of empirical interest because of the growing experience in countries such as Israel, Spain or Argentina with the fact that monetary disinflation rapidly leads to real appreciation, unemployment and money creation induced by exchange market intervention. With capital flows and induced money creation threatening attempts at stabilization, there is a need to understand the relationship between intervention and inflation.

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MONETARY STABILIZATION, INTERVENTION AND REAL APPRECIATION

This chapter investigates the adjustment process to a reduction in the rate of credit creation in an open, flexible exchange rate economy. The framework of analysis is one of rational expectations with respect to interest rates, inflation and depreciation. The special feature of the model is the role of exchange market intervention and the resulting endogeneity of the growth rate of the money stock.

The model is of empirical interest because of the growing experience, for example in Israel, Spain and Latin America, with the fact that monetary disinflation rapidly leads to real appreciation, unemployment and money creation induced by exchange invervention. With capital flows and induced money creation threatening attempts at stabilization policy, there is a need to understand the interaction of stabilization and invervention.

Table 1 shows the facts to be explained. While these facts are becoming well-known, there appears to have been little formal modelling to date. Work by Liviatan (1979), however, has addressed these issues and the present model is directly stimulated by that contribution.

The chapter also adds to rational expectations models of flexible exchange rate systems. At present there are three main avenues of modelling. Following Black (1973) there are models of the "asset market approach" that emphasize the fast adjustment of financial relative to real markets as a basis of exchange rate dynamics. The

TABLE 1 SOME FACTS

	$\dot{e}$	$\dot{p}$	$\dot{R}/H$	$\dot{H}/H$
		SPAIN		
1977	18.5	24.5	17.5	21.6
1978	-13.4	19.7	26.7	24.9
79/I-78/I	-14.8	16.3	27.6	37.8
		ISRAEL		
1977	31.1	34.6	119.0	42.5
1978	67.0	50.6	179.9	27.8
79/I-78/I	21.8	58.1	259.3	17.5
		ARGENTINA		
1977	117.7	176.1	52.0	140.3
1978	67.9	175.5	60.5	109.7
79/I-78/I	60.4	169.0	81.8	131.1

NOTES: $\dot{e}$ = % change in the local currency price of the $ US;

$\dot{p}$ = % CPI inflation;

$\dot{R}/H$ = change in central bank foreign assets as % of "reserve money";

$\dot{H}/H$ = % change in "reserve money".

SOURCE: IMF International Financial Statistics, August 1979 Lines ae, 11, 14 and 64.

previous chapter explores that approach. A second line of theory emphasizes the current account as a basis of exchange rate dynamics and is dealt with in the last two chapters of this book. The third approach is concerned primarily with imperfect substitutability between domestic and foreign securities and takes portfolio composition effects as an important source of exchange rate movements and variability. Work along these lines has been done by Kourri (1975) and Dooley-Isard (1979), Branson (1976), Calvo and Rodriques (1977) and Henderson (1979).

This chapter is most nearly in the spirit of this third approach, especially in its emphasis on exchange market intervention. It does, however, differ in a critical respect. Rather than modelling imperfect capital mobility as the instantaneous, but imperfect substitutability of domestic and foreign securities we take the older approach that focuses on capital flows in response to interest differentials. The theory is less clear-cut than portfolio balance approaches, but it commands an empirical plausability.

Part I sets out the model, adapting the assets market approach developed in the previous chapter to a world of inflation, exchange market intervention that is "leaning against the wind" and finite capital mobility. The model is used to show the adjustment to a sustained reduction in the rate of domestic credit creation. We show that the adjustment process involves an initial overshooting in the rate of exchange depreciation relative to the trend rate of inflation, real appreciation and unemployment. The rate of monetary growth, fed by intervention, may acutally expand

for some time. The monetization of reserve gains constitutes part of the rise in real balances that takes place during the adjustment.

In Part II we study for comparison the adjustment process when there is no intervention. The exchange rate immediately appreciates and the unemployment level rises instantaneously. The difference between the two regimes is therefore seen to be one of timing. The concluding part and the appendices deal with a more general model.

I THE MODEL

Output is demand determined and depends on relative prices and the real rate of interest. Deviations of output from full employment and money creation are the sources of inflation. Nominal interest rates are determined in the standard LM curve manner, by real income and the real money stock.

1. The Structural Equations

The nominal interest rate, i, is determined by real income, y, and real balances, h-p:

$$i = ky - f(h-p) \tag{1}$$

where y, h, and p are all in logs. Aggregate demand is a function of relative prices and the real rate of interest, $i-\dot{p}$:

$$y = a'(e-p) - b'(i-\dot{p}) \tag{2}$$

or, substituting from (1) for the nominal interest rate:

(2)' $y = a(e-p) + b(h-p) + c\dot{p}; \quad a, b, c > 0$

Here e is the nominal exchange rate and e-p is the real exchange rate or the relative price of our goods. For the time being, we concentrate on a special case where aggregate demand is independent of the rate of interest, b = c = 0; only in Part IV below do we return to the general case. For our special case then the equilibrium level of output is solely determined by the real exchange rate;

(2)" $y = a(e-p)$

The full employment level of output, by choice of units, is set at the level $\bar{y} = 0$. Then y can be interpreted as the deviation of output from normal and similarly, e-p is the deviation of the real exchange rate from the level consistent with full employment.

Inflation is determined by the output gap, y, and by the rate of monetary growth, $\dot{h}$. Inclusion of money growth in the inflation equation is required for steady state full employment inflation, although the steady state growth rate of credit could serve the same purpose.

(3) $\dot{p} = \phi y + \dot{h}$

Equation (4) shows the intervention policy of "leaning against the wind." The rate of accumulation of reserves as a fraction of the money stock, $\dot{R}/H$, is negatively proportional to the excess of

the rate of depreciation, $\dot{e}$, over the rate of domestic credit creation, v[1]

$$(4) \qquad \dot{R}/H = -\theta(\dot{e}-v)$$

The intervention rule can be looked at in a slightly different way by defining total adjustment as the sum of reserve accumulation plus appreciation relative to trend: $\dot{R}/H - (\dot{e}-v)$.[2] With that definition of total adjustment, and using (4), we have the fraction of adjustment that is effected through reserve changes as:

$$(4)' \qquad \frac{\dot{R}/H}{\dot{R}/H - (\dot{e}-v)} = \theta/(1+\theta) \equiv \lambda$$

Active intervention or a value of λ close to unity thus implies that the exchange rate is maintained close to the long-run inflation trend, $\dot{e} \tilde{=} v$. A low value of λ by contrast allows the exchange rate to deviate substantially from trend inflation. We refer to λ as the "intervention coefficient."

The balance of payments is a function of the real exchange rate, real income and the nominal interest differential adjusted for exchange depreciation:

$$(5) \qquad \dot{R}/H = [g(e-p) - my + n(i-\dot{e}-i^*)]$$

Replacing the intervention, $\dot{R}/H$, by the rule given in (4) allows us to replace reserve changes with exchange depreciation to obtain:

$$(5)' \qquad \theta(\dot{e}-v) = -[g(e-p) - my + n(i-\dot{e})]$$

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[1] An alternative intervention rule is $\dot{R}/H = -\theta(\dot{e}-\dot{p})$. See Appendix II.

[2] Total adjustment corresponds to what Girton and Roper (1977) call "exchange market pressure."

where, for convenience, we have set the foreign interest rate equal to zero. In (5) and (5)', it is the excess of the nominal interest rate over the rate of depreciation that governs capital flow. Capital mobility is measured by the coefficient n.[1] A rise in the nominal interest rate leads to a capital inflow while increased depreciation leads to a capital outflow. Capital mobility is less than perfect in that, in the short run, interest differentials can persist.

Rational expectations are used here in two places. The actual real rate of interest, $i-\dot{p}$, determines aggregate spending and the actual interest differential, $i-\dot{e}-i^*$, governs capital flows. It is readily apparent that the assumption of rational expectations simplifies the analysis since it dispenses with the need of additional equations describing the formation of expectations about inflation and depreciation.

Finally, monetary growth is equal to the growth of domestic credit plus the monetary growth derived from exchange market intervention:

$$\dot{h} \equiv v + \dot{R}/H = v - \theta(\dot{e}-\tilde{v}) \tag{6}$$

The monetary growth equation shows that when exchange depreciation is high, the resulting intervention leads to a slowdown in monetary growth. Conversely, high depreciation leads to growth over and above the scheduled rate of credit creation.

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[1] The coefficient n is to be interpreted as the rate of capital inflow, as a fraction of the money stock, generated by a change in the interest differential. Even with high capital mobility, it is thus likely to be a fraction. The same normalization on the nominal money stock applied to the coefficients g and m.

Our model is simplified in three respects. First, we do not allow for a role of import prices, and hence the exchange rate, in the real balance deflator. Second, we exclude depreciation from the definition of the real interest rate in aggregate demand. Third, we do not allow for a direct effect of depreciation on domestic inflation. An alternative model is explored in Appendix II and shows some of these extensions.

2. Dynamics

We now have completed the description of our structural model and can turn to the equilibrium conditions and the dynamics. At any point in time the levels of the exchange rate, prices and nominal money are exogenously given. So are the growth rates of domestic credit and the intervention coefficient which are policy parameters.

For given levels of the stated variables we can solve the system for the current rates of inflation, depreciation and money growth and thus for the rate of change of the real exchange rate and the rate of change of real balances. Using (1), (2)", (3) and (5) we obtain:

$$\dot{h}-\dot{p} = \phi a(e-p) \tag{7}$$

$$\dot{e}-v = \mu(e-p) + \nu(x-\bar{x});\ \mu \equiv -\frac{g-a(m-nk)}{\theta-n} < 0;\ \nu \equiv nf/(\theta-n) > 0. \tag{8}$$

where $x = h - p$ and $\bar{x}$ denotes steady state real balances.[1] The rate of change of the real exchange rate is given by

$$\dot{e} - \dot{p} = \delta(e-p) + (1+\theta)\nu(x-\bar{x}); \qquad \delta \equiv (1+\theta)\mu - \phi a < 0 \tag{9}$$

For stability of this system we assume that $\delta < 0$ and that $\theta - n > 0$.

In Figure 1 we show the schedule $\dot{e} = \dot{p}$ along which the real exchange rate is constant. An increase in real balances lowers the nominal interst rate. The resulting interest differential leads to a capital outflow, a balance of payments deficit--an increased deficit or a reduced surplus--and therefore increased exchange depreciation. Since by assumption there is no effect on income and inflation, there is unambigously a depreciating <u>real</u> rate. To offset the effect of higher real balances, a higher level of the real exchange rate, and hence a higher level of income and an improvement in the external balance, are required. Thus the schedule is positively sloped.

Real balances are constant along the horizontal axis where relative prices are such that output is at the full employment level. The steady state equilibrium is shown at point A . At A the rate of depreciation equals the rate of credit creation; there is no intervention and real exchange rates and real balances are constant.

We also show in Figure 1 the schedule $\dot{h} = v = \dot{e}$ along which growth of money derives only from domestic credit. Intervention and the balance of payments are zero and depreciation equals the rate

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[1] Equation (8) is derived in terms of deviations from long-run equilibrium, recognizing that in the steady state $\dot{e} = \dot{p} = \dot{v}$.

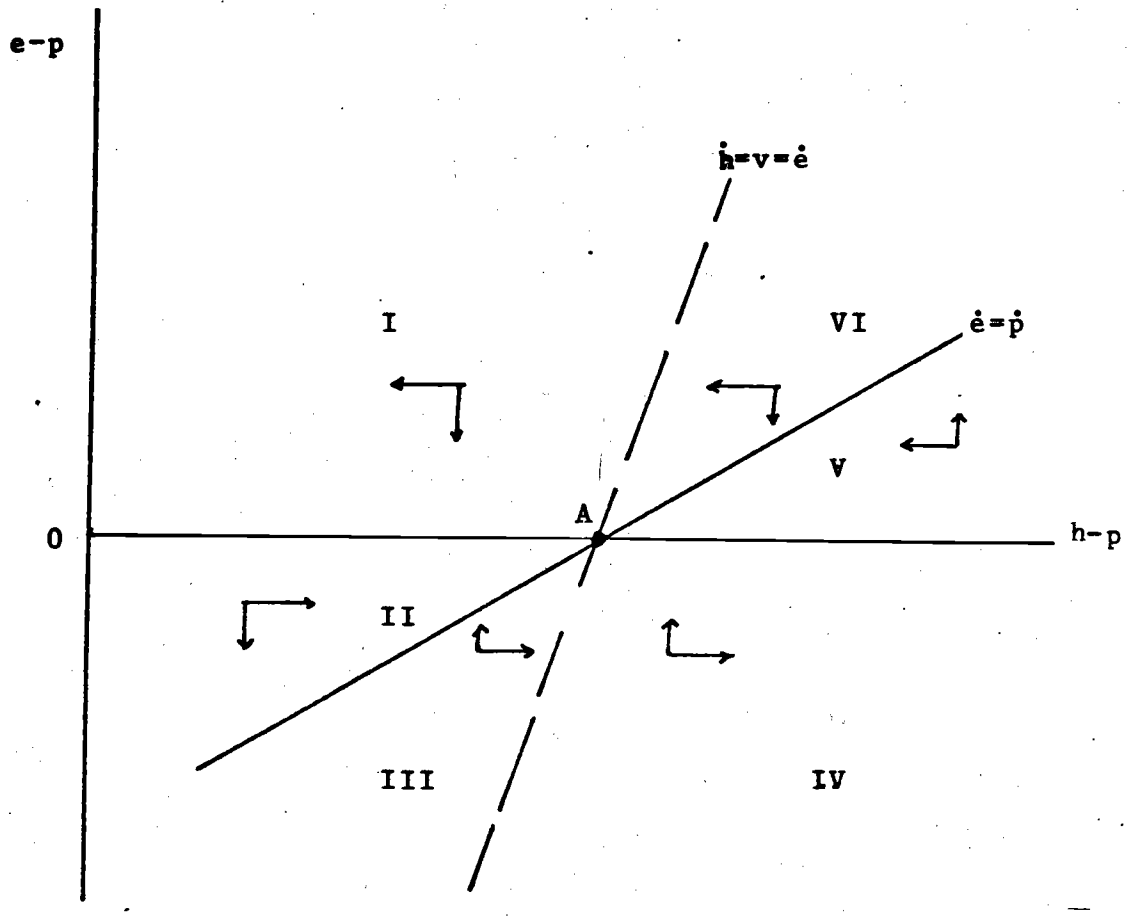

FIGURE 1

of credit creation. The schedule is steeper than the $\dot{e}=\dot{p}$ locus as can be noted from equations (8) and (9). Above the horizontal axis there is overemployment which causes by itself real appreciation. Along the $\dot{e}=\dot{p}$ schedule, the inflationary effect of the overemployment is precisely offset by the depreciation in excess of the rate of domestic credit creation. As the real exchange rate increases further the rate of depreciation declines and the first term in (9) becomes progressively smaller. Along the $\dot{h}=v$ schedule, the real exchange rate is therefore appreciating.

With these reference schedules we can now characterize the levels and relative rates of change of the endogeneous variables in the various regions. With symmetry we can limit ourselves to the first three:

TABLE 2

THE ROAD MAP

I	II	III
$\dot{p} > \dot{h} > v > \dot{e}$	$\dot{h} > \dot{p} > v > \dot{e}$	$\dot{h} > v > \dot{e} > p$
$y > 0$	$y < 0$	$y < 0$
Surplus	Surplus	Surplus

One point of Table 2 is worth emphasizing. That is, in all three regions the rate of credit creation, or the longrun rate of inflation, exceeds the rate of depreciation, $v > \dot{e}$. Accordingly there is exchange intervention leading to money creation

in excess of the rate of domestic credit expansion. There are thus balance of payments surplusses in all three regions.

3 The Adjustment Process To a Change in Credit Creation

We now consider the adjustment process to a reduction in the growth rate of domestic credit, v. We start with a full equilibrium at point A in Figure 2. The reduced rate of credit creation will, in long-run equilibrium, lead to no change in relative prices or output, but will change the equilibrium stock of real balances, $\bar{x}$, because from (2), $d\bar{x} = -dv/f > 0$. In addition, the new equilibrium inflation rate will be lower, as will be the nominal interest rate, di=dv. Point A' thus indicates the new long-run equilibrium.

Starting from the initial equilibrium we have, as yet, unchanged real balances and an unchanged real exchange rate; output and nominal interest rates are at their initial level. This is the essential point for an understanding of the exchange rate implications of the stabilizaton. The authorities, in line with the intervention rule, reduce the rate at which the exchange rate is allowed to depreciate. In so doing they create an interest differential in favor of the home country--an interest differential adjusted for depreciation, $i-\dot{e}$. Accordingly, there is a capital inflow or reduced outflow, creating pressure for a further reduction in the rate of depreciation and thus leading to intervention and money creation.

From (8) above the impact effect of reduced credit creation on the exchange rate, at the intial equilibrium, is

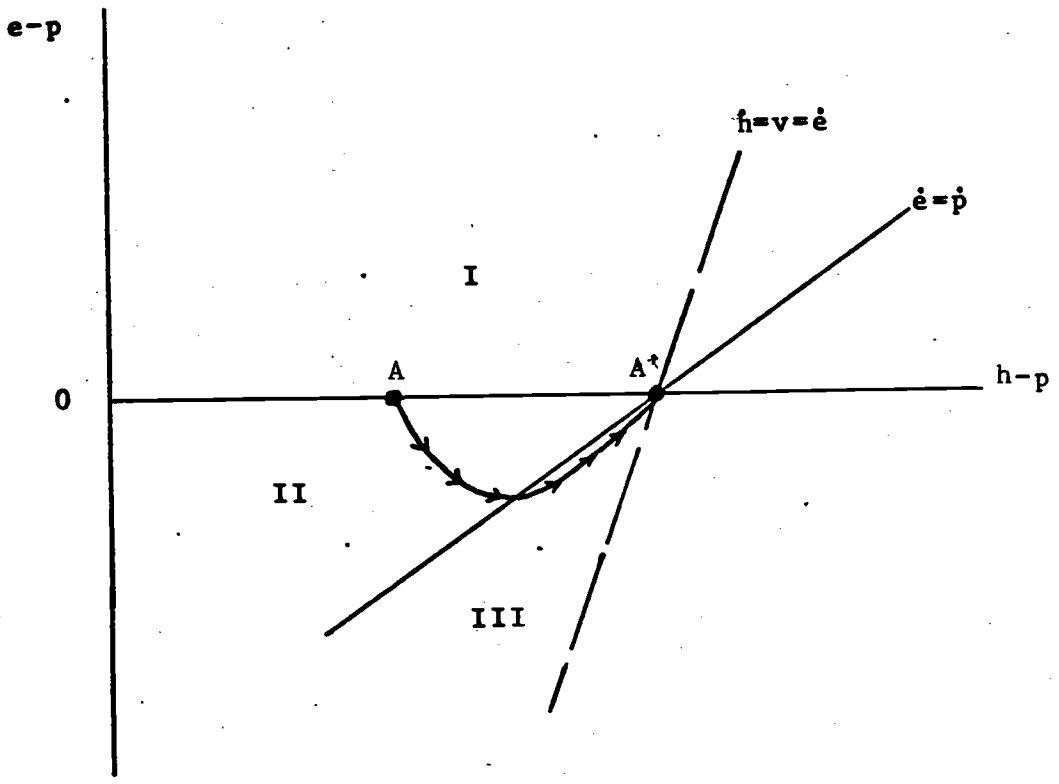

FIGURE 2

$$(10) \qquad \dot{de}/dv\Big|_{t=0} = 1-\nu d\bar{x}/dv = \theta/(\theta-n) > 1$$

There is, accordingly, an overshooting not in the level of the exchange rate, but in its rate of change. As shown in Figure 3 a reduced rate of credit creation thus leads to a reduction in the rate of depreciation below its new trend level.

The impact effect of reduced credit creation on monetary growth must take into account the monetary expansion due to intervention. From (6) and (10) we have:

$$(11) \qquad \dot{dh}/dv\Big|_{t=0} = 1 - n\theta/(\theta-n) = \frac{1+\theta}{\theta-n}\{\lambda - n\} \gtrless 0$$

A reduction in the rate of credit expansion need not reduce monetary growth unless $\lambda-n > 0$. With capital highly responsive to interest differentials, it is entirely possible that the intervention more than offsets the reduction in domestic credit creation.

Finally, the effect of reduced credit creation on inflation is, from (3), given by the change in monetary growth. Accordingly, with highly mobile capital and the intervention coefficient, λ, relatively small, it is possible that inflation in the first instance actually rises.

The impact effect of reduced credit creation thus involves real appreciation of the exchange rate, including the possiblity of rising inflation with nominal appreciation. The real appreciation at point A will lead to a fall in demand and output. Once output falls

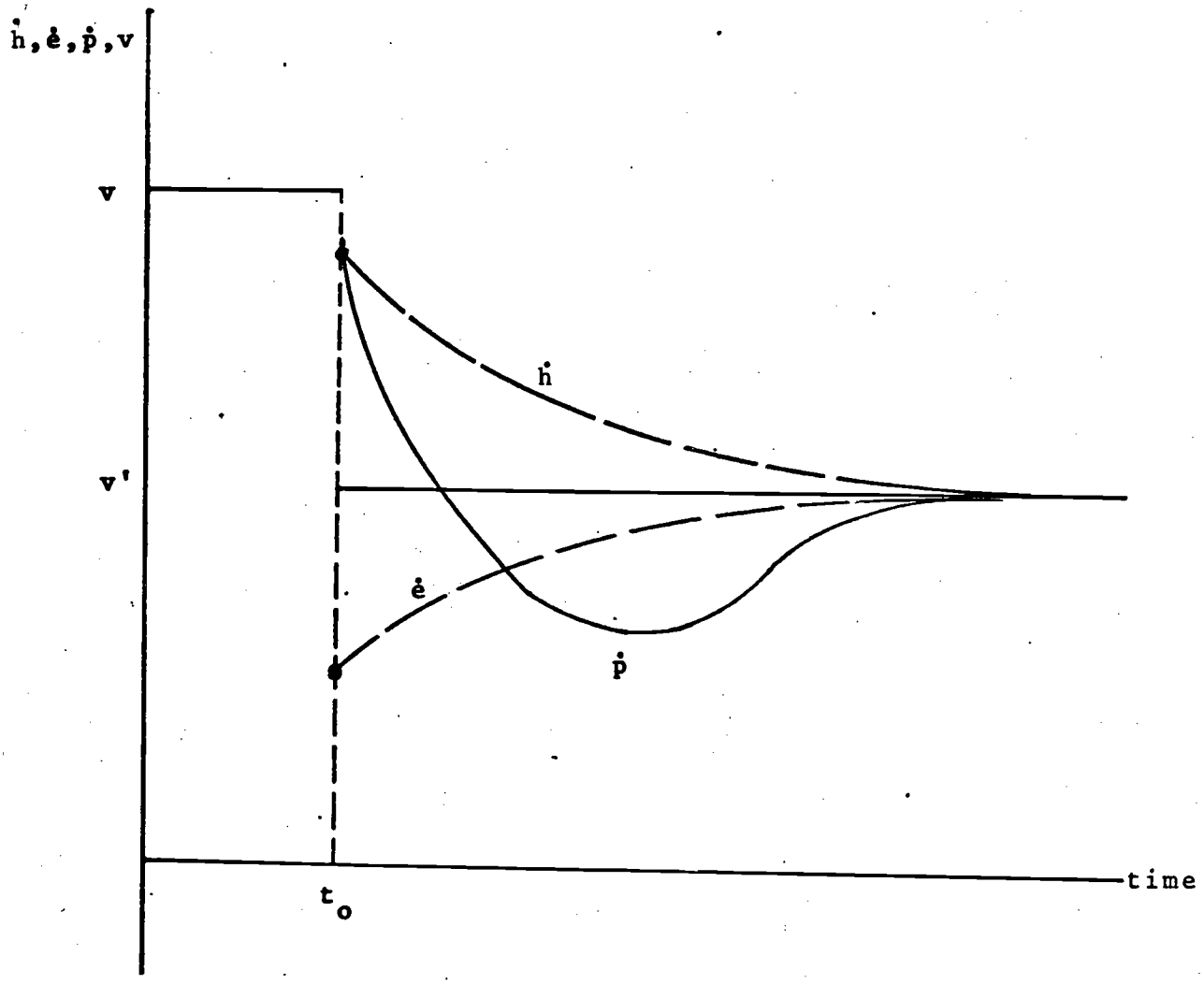

FIGURE 3

and thus exerts a dampening effect on inflation, real balances will be rising. This is the adjustment process shown in region II.

Real appreciation and rising real balances will continue until we reach the $\dot{e} = \dot{p}$ schedule. Both inflation and depreciation are below the trend, v, while monetary growth is above trend. Nominal interest rates have declined due to the fall in output and the rise in the real money stock. Depreciation and inflation now have converged. Depreciation has increased, as the trade balance has worsened in response to the real appreciation, and the capital account has deteriorated because of lower interest rates. Inflation, by contrast, has declined due to the increased output gap.

From here on there is real depreciation. Money growth is still in excess of the reduced rate of credit creation and there is still intervention to keep the depreciation more nearly in line with the rate of credit creation. Continued real depreciation and real balance growth restore output. The real depreciation in combination with rising real balances, brings the balance of payments more nearly into equilibrium.

By the time the economy reaches point A' relative prices are back to their initial level but the stock of real balances has risen in adjustment to the lower rate of interest, inflation and depreciation.

Thus in the long run, the reduction in credit creation is only reflected in a corresponding reduction in nominal interest rate, the trend rate of depreciation and, of course, in a higher

stock of real money balances. How is the gain in real balances achieved? Our model of inflation, allowing a full impact of money growth on prices, implies that the only way real balances can rise is through unemployment, or an output gap. It is true that intervention policy leads to nominal money growth, but that growth finds its way directly into inflation and thus does not help raise real balances. In Appendix II we explore an alternative model where depreciation direcly affects inflation. In that model it is true that the deceleration of depreciation immediately contributes to real balance growth, although that effect is subsequently undone when the real exchange rate depreciates.[1]

In summary, we have shown that a reduction in the rate of credit creation will, in the long run, reduce inflation and depreciation. In the transition, however, unemployment is created as the real exchange rate initially appreciates in response to an interest differential that is created by the disinflation policy. Can the transitory unemployment and real appreciation be avoided? Liviatan has proposed an equalizing tax on capital flows that would eliminate the incentive for capital imports in the transition. An alternative, for the believer in rational expectations models as shown here, is a once and for all increase in the stock of nominal money along with a reduced rate of growth. The combination of the two would move the economy to point A' instantaneously, although at a higher

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[1] In fact this result holds independently of whether intervention is geared to the change in the real exchange rate, $\dot{e}-\dot{p}$, or to trend inflation, $\dot{e}-v$. With the present intervention model and an inflation equation: $\dot{p}=\phi(y-y) + \alpha\dot{e} + (1-\alpha)\bar{h}$ the impact effect on real balances is: $d(\bar{h}-\dot{p})/dv = -\alpha(1+\theta)n/(\theta-n)$.

price level than is implied by the adjustment path in Figure 2. Of course, it is hard to persuade the public that the true path to monetary stabilization is a big money-bubble up front.

II FULLY FLEXIBLE RATES

In this part we compare the adjustment process derived so far, with one where there is no intervention at all; where exchange rates are fully flexible and can jump in response to new information. We maintain all other assumptions of the model, including in particular the perfect foresight assumption concerning exchange rate expectations.

1. The Model Without Intervention

In the absence of intervention money growth is equal to the growth rate of credit because the balance of payments is identically equal to zero. The balance of payments in (5) can be set equal to zero and solved for the rate of depreciation. Setting $\theta = 0$ in (8) yields the rate of depreciation:

$$\dot{e} - v = \bar{\mu}(e-p) - f(x-\bar{x}); \ \bar{\mu} \equiv [g-a(m-nk)]/n > 0 \tag{12}$$

The important point to note is that (12) differs from (8) not only in that the intervention coefficient θ is zero, but also in the effect of the real exchange rate on the rate of depreciation. Since a real depreciation improves the balance of payments by assumption, and since the overall balance must be zero, a real appreciation must be accompanied by a deterioration in the capital account through increased

anticipated depreciation. A rise in real balances lowers interest rates and worsens the capital account. It must be offset by a compensating reduction in anticipated depreciation that keeps the real interest, $i-\dot{e}$, and hence the capital account, constant.

With real depreciation determined by (9) it is readily seen that the equation for the evolution of the real exchange rate, $\dot{e}-\dot{p}$, now is given by

$$\dot{e}-\dot{p} = \bar{\delta}(e-p) - f(x-\bar{x}) \; ; \qquad \bar{\delta} = \bar{\mu} - \phi a > 0 \tag{13}$$

Figure 4 shows the schedule $\dot{e}=\dot{p}$ along which the real exchange rate is constant.[1] Above the schedule the real exchange rate is depreciating and below the schedule it is appreciating. Above the horizontal axis real balances are falling while below the axis the real money stock is rising. The arrows indicate the saddle-point instability characteristic of rational expectations models.

There is a unique trajectory FF along which the economy can converge to the steady state at point A. Any other trajectory does satisfy all equations, including the perfect foresight characteristic, but they do not converge. We assume henceforth that the economy will in fact be on FF, although there is no process in our model that will guarantee this.

2 A Reduction in Credit Growth

Consider again the reduction in credit growth already studied in the previous part. Real balances across steady states will again be higher and, in long-run equilibrium, will be at $\bar{x}'$, in Figure 5.

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[1] We assume that $\bar{\delta} > 0$ and deal only with that case here.

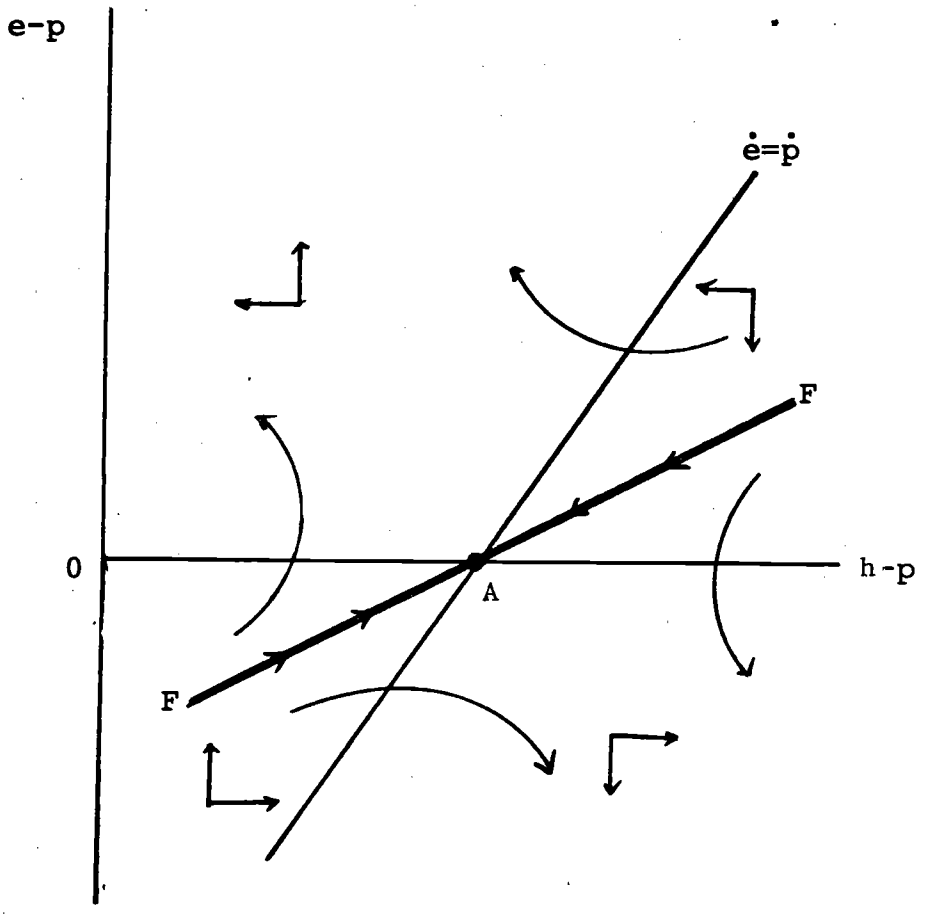

FIGURE 4

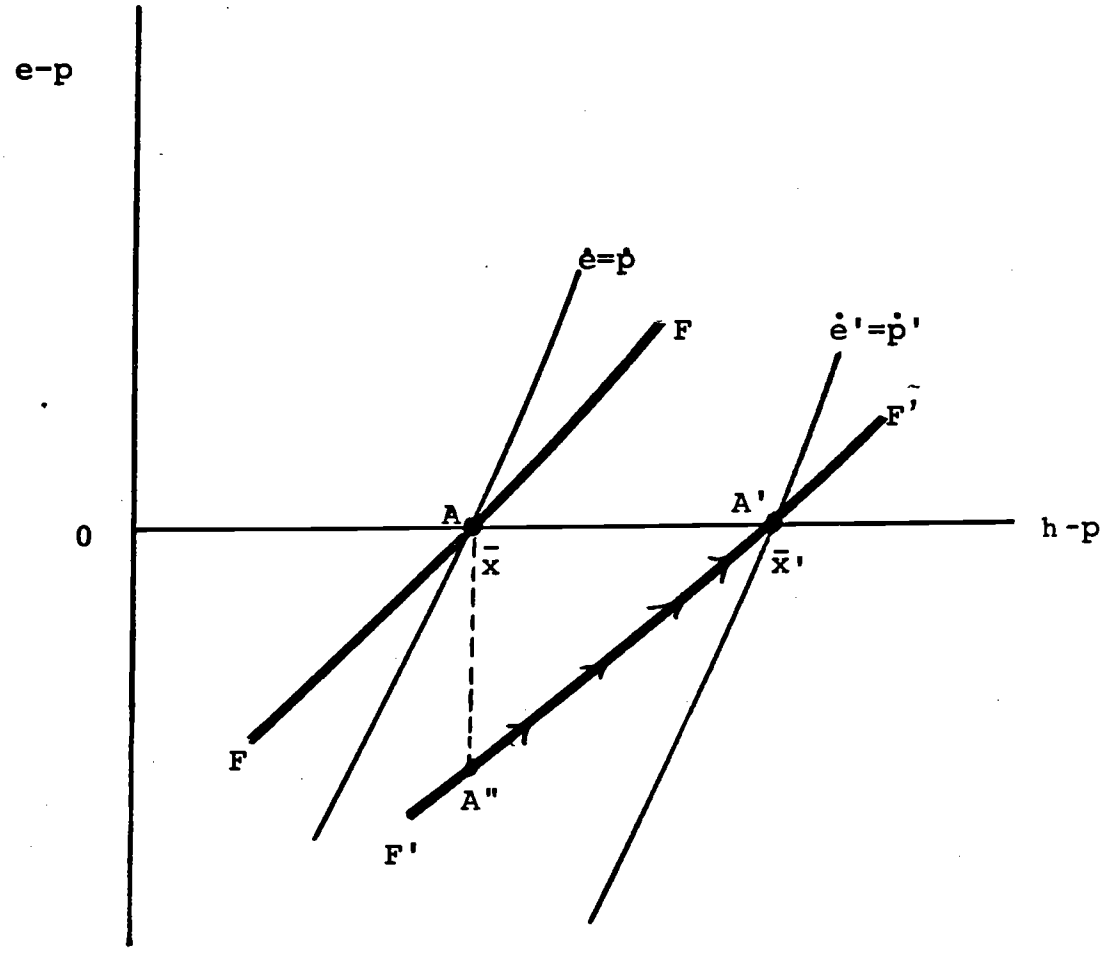

FIGURE 5

The adjustment process is the following. Announcement of the reduced credit growth shifts the perfect foresight path down to F'F'. The exchange rate immediately appreciates and the level of the real exchange rate moves directly to point A" on the new perfect foresight path.

The immediate real appreciation contrasts with the case of intervention. There, the real exchange rate starts appreciating while here, the level of the real rate directly rises. The freely flexible rate thus anticipates with a jump at the beginning the real appreciation process that builds up more steadily under intervention, as shown in Figure 2.

The impact effect of reduced credit growth at point A" is to lower real income because of the real appreciation. The fall in real income, in turn, implies a decline in nominal interest rates. What then maintains overall balance of payments equilibrium? It is readily shown from (12) that at A", the rate of depreciation of the nominal exchange rate is reduced. It is uncertain though whether the rate of depreciation declines below the new trend rate of inflation, v.

In the subsequent adjustment process, as the arrows indicate, the real exchange rate is depreciating. Accordingly nominal exchange depreciation exceeds inflation. Since across steady states real balances have to rise it is also apparent that inflation falls short of money growth during the adjustment process.

The unemployment effects of the monetary stabilization arise under flexible rates just as much as they do under the intervention

system. Here the unemployment shock is concentrated at the beginning with the subsequent real depreciation slowly eroding the economic slack. Cumulative deflation, to generate higher real balances, is just the same here as it is under the intervention system. Under both systems, deflation (or a once and for all rise in nominal money) is required to accommodate the reduction in velocity or the rise in real balances, associated with lower trend inflation. The real differences between the fully flexible rate and the intervention system thus lies in the time path of adjustment.

Part III THE EXTENDED MODEL

In concluding this chapter we look at the extended model where the real interest rate, as well as the real exchange rate, are determinants of aggregate demand. The formal model is laid out in the appendix and we only comment here on some points regarding the structure and results.

The essential complication of this model arises from the link between the balance of payments, money growth, depreciation and inflation. Appreciation, by raising money growth, raises inflationary expectations, reduces the real rate of interest and therefore expands aggregate demand. These channels are captured in the reduced form equation for output derived from (2)', (3) and (6). The equation is, once again, expressed in terms of deviations from long-run equilibrium[1]

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[1] The bar over a coefficient denotes that the coefficients in (2)' are multiplied by $(1-c\phi)^{-1} > 0$.

$$(14) \qquad y = \bar{a}(e-p) + \bar{b}(x-\bar{x}) - \theta\bar{c}(\dot{e}-v)$$

Equation (14) shows that real depreciation, or an expansion in the real money stock, raises output. A balance of payments deficit or a depreciating exchange rate (relative to trend), however, raises real interest rates through reduced money growth and inflationary expectations, and lowers output.

The second relationship we use is the balance of payments in (5)', having substituted for the nominal interest rate from (1)

$$(15) \qquad \dot{e}-v = \frac{-1}{\theta-n}\,(g(e-p) - (m-nk)y - nf(x-\bar{x}))$$

and where we assume here that the adverse expenditure effect of higher income on the current account outweighs the favorable capital account effect through higher nominal interest rates, $m - nk > 0$. Equations (14) and (15) are now used to show the impact effect of a change in credit growth on the depreciation rate and on output

Figure 6 shows, using the negatively sloped schedule, QQ, the output level of the economy as determined by demand and shown in (14). The positively sloped schedule BB shows the balance of payments relation in (15). Both schedules, of course, represent reduced forms that take into account monetary equilibrium and the intervention rule. They are drawn for given real balances x and $\bar{x}$ and a given real exchange rate, e-p.

A reduction in the growth rate of credit will raise steady state real balances and thus shifts both schedules in Figure 6.

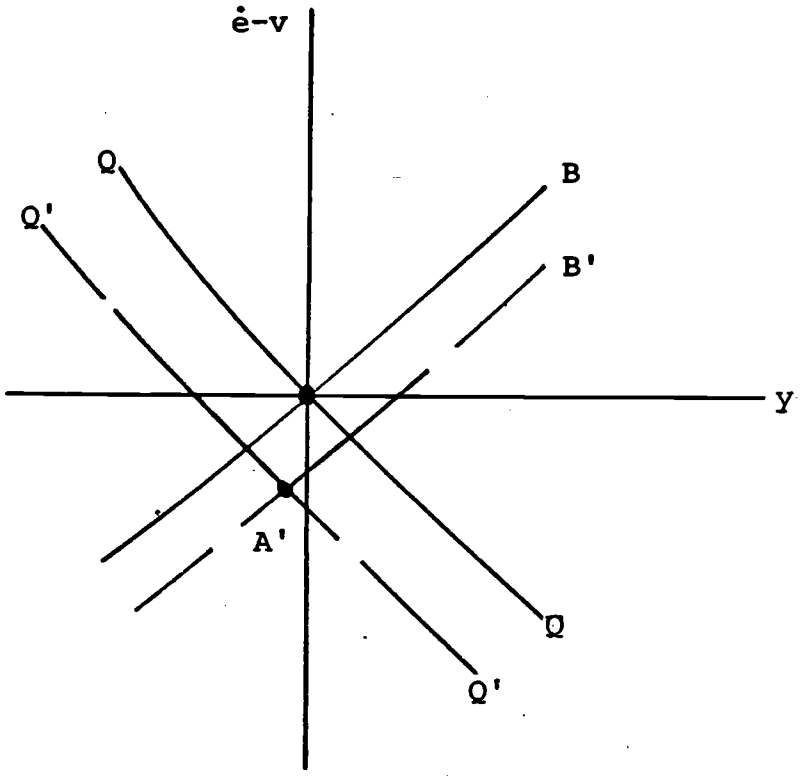

FIGURE 6

The output schedule shifts down and to the left because at each level of depreciation (relative to trend) there is now a reduction in inflationary expectations, higher real interest rates and thus lower demand. The balance of payments schedule shifts down and to the right. Here, intervention around the new and lower trend of credit growth implies a real interest differential in favor of the home country and a capital inflow that must be offset by a deterioration in the external balance through higher income.

The reduction in credit growth in Figure 6, leads, in the short run, to a new equilibrium at point A'. The rate of depreciation, once again has fallen below the new trend inflation rate so that we preserve here the overshooting property as well as the fact that there is, in the transition, a surplus and external money creation.

What determines the output effect of reduced credit creation? The higher expected real interest rate at home exerts an unambiguous deflationary effect shown by the downward shift of the output schedule. A high interest response of aggregate demand insures that this effect is large. The countervailing effect comes from the money supply side. The reduction in the rate of depreciation creates an international interest differential in favor of the home country, leading to capital inflows and external money creation which potentially offsets the effect of reduced credit growth.

It is readily shown that the output schedule shifts down

further than the balance of paymetns schedule provided $\lambda - n > 0$.[1] Thus output must fall initially if intervention is sufficiently vigorous relative to the degree of capital mobility. This condition, of course, is the same as that which ensures that a reduction in credit growth reduces the rate of growth in nominal money. It is through that channel that the expected real interest rate rises and the contraction in demand occurs. In any event it is apparent that for real balances to increase across steady states, there must on average be unemployment in the transition. For the stable system, an initial output expansion, if it should occur, implies a subsequent recession that more than offsets the initial output gain.

The extended model once more draws attention to the importance of the intervention coefficient. The interaction of intervention, money growth and inflationary expectations makes the intervention coefficient a key parameter. Vigorous intervention implies small interest differentials, small capital flows and therefore small external money creation. The other point that is to be emphasized, and this decidedly is a special feature of the model, is the direct link between money growth and inflation. The model is quite sensitive to the indicator of trend inflation expectations that we chose--$\dot{m}$, v, $\dot{e}$

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[1] The downward shift of the BB scheudle, from (15) is $d(\dot{e}-v)/dv = -n/(\theta-n)$. We have used here the fact that $d\bar{x}/dv = -1/f$, noting that increased trend inflation raises nominal interest rates. For the output schedule the downward shift is $d(\dot{e}-v)/dv = -\bar{b}/fc\theta$ which, from the definitions of $\bar{b}$ and $\bar{c}$, is readily shown to equal $-1/\theta$. For the output schedule to shift down further than the BB schedule we thus require $1/\theta > n/(\theta-n)$ or $\lambda - n > 0$.

or some combination of these. Any one formulation remains a special case but it is certainly an area for more modelling.[1]

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[1] To make the point, consider in place of (3) the inflation equation $\dot{p} = \phi y + \dot{e}$. What happens to relative price and output dynamics?

APPENDIX I

This appendix shows the reduced form equations of our complete model and develops the stability requirements. From equations (1) to (6) we derive the equations determining the level of output and the rate of depreciation at a point in time:

(A-1) $$y = \pi_1(e-p) + \pi_2(h-p) + \pi_3 v$$

$$\dot{e} = \sigma_1(e-p) + \sigma_2(h-p) + \sigma_3 v$$

where the following are the coefficients:

(A-2) $$\pi_1 = \{a(\theta-n)+c\theta g\}/\Delta\gamma \quad ; \quad \pi_2 = b(1+\theta)(\lambda-n)/\Delta\gamma$$

$$\pi_3 = \{c(1+\theta)(\lambda-n)\}/\Delta\gamma \quad ; \quad \sigma_1 = -\{g-a\beta\}/\Delta$$

$$\sigma_2 = \{nf+b\beta\}/\Delta \quad ; \quad \sigma_3 = (1+\theta)\{\lambda+c\beta\}/\Delta$$

$$\Delta = (\theta-n)+\beta c\theta \quad ; \quad \beta=(m-nk)/(1-c\phi);\gamma = (1-c\phi);\lambda=\theta/(1+\theta)$$

The dynamics are defined by the evolution of relative prices and real balances, omitting the constant terms and using equation (3)

(A-3) $$\dot{h}-\dot{p} = -\phi\pi_1(e-p) - \phi\pi_2(h-p)$$

(A-4) $$\dot{e}-\dot{p} = \{\sigma_1(1+\theta)-\phi\pi_1\}(e-p)+\{\sigma_2(1+\theta)-\phi\pi_2\}(h-p)$$

Stability of this system requires that all the coefficients of ξ in the characteristic equation be positive:

(A-5) $$\xi^2 + \xi\{\phi(\pi_1 + \pi_2)-(1+\theta)\sigma_1\} + (1+\theta)(\pi_1\sigma_2 - \sigma_1\pi_2)\xi^o = 0$$

A sufficient condition for stability is:

(A-6) $\sigma_1<0 \quad \sigma_2\pi_1, \pi_2 > 0.$

APPENDIX II

In this appendix we sketch an alternative model that allows (i) for a direct effect of depreciation on inflation, and (ii) uses an intervention rule geared to the rate of real depreciation. Equations A-1 and A-2 show the new specifications:

(A-1) $\dot{p} = \phi(y-\bar{y}) + \alpha\dot{e} + (1-\alpha)\dot{h}$

(A-2) $\dot{R}/H = -\theta(\dot{e}-\dot{p})$

As before, we assume here that output depends only on the real exchange rate and that money growth is determined by growth of domestic credit and by the balance of payments, $\dot{R}/H$:

(A-3) $\dot{h} = v - \theta(\dot{e}-\dot{p}) \quad ; \quad y = a(e-p)$

With these assumptions it is readily shown that a reduction in the growth rate of domestic credit will lead to a reduction in the rate of depreciation, with the possibility of overshooting:

(A-4) $d\dot{e}/dv = (1-\alpha)\theta/\Delta \quad ; \quad \Delta=\theta(1-\alpha)(1+n) - n>0$

where we assume that $\Delta>0$.

Next we note that the real exchange rate, on impact, will be appreciating as credit growth is reduced:

(A-5) $$d(\dot{e}-\dot{p})/dv = n(1-\alpha)/\Delta$$

Finally, real balances will, on impact, be growing due to the contribution of reduced depreciation in reducing domestic inflation:

(A-6) $$d(\dot{h}-\dot{p})/dv = -n/\Delta$$

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