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Some Illustrative Examples of the Consequences of Real Exchange Rate Rules for Inflation

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Summary

In the last few years, a number of countries have implemented rules that seek to adjust the nominal exchange rate in such a way as to prevent losses of competitiveness. Although the manner in which these rules have been implemented has varied across countries, exchange rate adjustments have typically been made on the basis of the difference between inflation at home and abroad, frequently with a lag reflecting delays in receiving price information.

This paper argues that these rules--real exchange rate rules--are likely to lead to a loss of control over the inflation process and, under certain conditions, to rapidly increasing inflation. The reason for this result is straightforward: following real exchange rate rules serves ultimately to index both the nominal exchange rate and, through the balance of payments, the money supply to the price level. Under these conditions, there may be no exogenous nominal anchor to tie prices down, and in situations in which inflation starts to rise, there may be no effective mechanism for controlling it. Any attempt to control inflation typically leads to a loss of control over some other economic variable, like foreign assets or the current account balance, and tends therefore to be infeasible over the longer term.

The result that a real exchange rate rule leads to a loss of control over the inflation process follows from the general principal that a sound monetary or exchange rate policy is needed to provide an anchor for prices in the long run; under a real exchange rule, ceilings for the growth in domestic credit or for the money supply are not in general adequate anchors. Since there is more disagreement about the determinants of prices in the short run than in the long run, however, the paper uses several

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different examples of the short-run behavior of economies to illustrate the loss of control over inflation implied by following real exchange rate rules.

I. Introduction

Recently, a number of countries have adopted exchange rate rules that consist of depreciating the nominal exchange rate in line with a measure of the difference between inflation at home and abroad. The aim of these policies is to keep the real exchange rate constant and avoid any slippages in the adjustment effort that would arise from losses of competitiveness. 1/

The adoption of these kinds of rules has certain advantages over discretionary exchange rate changes in that exchange rate adjustments are made more regularly and their determination is removed from the area of political debate. This paper argues, however, that these rules--real exchange rate rules, hereafter--are likely to lead to a set of monetary problems. Specifically, it is argued that countries risk losing control over the inflation process when following these rules and that rapidly increasing inflation may result under certain conditions. 2/

The reasons for the loss of control over inflation are straightforward: the adoption of real exchange rules serves to index both the nominal exchange rate and, through the balance of payments, the money supply to the price level. Under these conditions, a real exchange rate rule in combination with a target for domestic credit implies that there is no exogenous nominal anchor that can tie prices down. 3/ A real exchange rate rule represents therefore a policy of complete monetary accommodation; an increase in domestic inflation from any source is automatically accommodated by a faster rate of exchange rate depreciation and by a faster rate of monetary growth.

1/ The implementation of these rules is generally not made public, in order to limit speculative pressures. This paper, therefore, does not contain references to specific countries.

2/ As such, the paper deals with the monetary rather than real consequences of following real exchange rate rules; for a discussion of some of the real issues associated with these exchange rate rules, see Rodrick (1984).

3/ The possibility of sterilization of the monetary inflows that come through the balance of payments and, hence, of complementing real exchange rate rules with targets for money (instead of for domestic credit) is discussed below; it is noted that sustained sterilization is typically infeasible when following a real exchange rate rule.

The approach adopted in the paper is to consider five examples of economies with sticky prices or expectations and derive the behavior of inflation when real exchange rate rules are followed. 1/ By considering economies that differ either with respect to the number of commodities that are traded and/or the nominal variables that are sticky and which differ with respect to the way in which the real exchange rate rule is implemented, we are able to illustrate the general proposition that control over the inflation process and the price level by the authorities can be lost when real exchange rate rules are followed. While the models constructed are kept deliberately simple, they are sufficient to illustrate our general point; indeed, the kind of loss of control over the inflation process implied by following real exchange rate rules will hold in a wide class of models of the international adjustment process.

The paper begins with a nontechnical introductory section that discusses the concept of a nominal anchor to tie prices down, and identifies the nature of the nominal indeterminacy implied by following real exchange rate rules. 2/ The section also introduces the concepts of "indeterminacy," "instability," and "uncontrollability" as they relate to following real exchange rate rules and distinguishes between these concepts as they are applied in the remainder of the paper. It is argued that targets for domestic credit, in combination with real exchange rate rules, generally do not provide an exogenous nominal anchor that can tie prices down. Switching from a domestic credit target to a money supply target will not serve, in general, to provide an alternative exogenous anchor.

The following sections of the paper (Sections III through VII) are intended as more technical illustrations of how inflation may behave in the absence of an exogenous nominal anchor for prices. What all of the

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1/ If all prices were perfectly flexible and purchasing power parity held at all times, the real exchange rate rules we describe would be redundant or impossible to implement. With perfectly flexible prices, the real equilibrium of an economy is determined only by real variables, such as fiscal or commercial policy; an exchange rate rule that determines only a nominal variable would be unable to affect the real exchange rate in such an economy. Some stickiness in prices and/or expectations is necessary for a meaningful analysis of real exchange rate rules.

2/ In none of the examples considered do we make allowance for outside nominal assets other than money held by the private sector; under certain conditions (Patinkin (1965)) the existence of nominal public debt can serve to tie prices down, even when real exchange rate rules are followed. We disregard this possibility since most countries do not have targets for nominal public debt held by the private sector, and we believe that any anchoring of the price level through the existence of such assets is unlikely to be of importance in practice (see Appendix II).

stochastic examples have in common is that in the absence of an exogenous anchor, inflation tends to be whatever it was in the past modified by the shocks to prices during the current period. This characteristic we describe in terms of inflation having a "random-walk" property, which captures two aspects of the inflation process under real exchange rate rules: in the first place, that the inflation process tends to be unstable and fails to converge to any long-run equilibrium level; and, secondly, that shocks to inflation during any period have a tendency on average to change inflation in all future periods. 1/

In more detail, the examples of the paper cover the following issues:

The first example examines the effects of uncertainty on the inflation process when all goods are traded, nominal prices are sticky, and the nominal exchange rate is adjusted according to a measure of the difference between inflation at home and abroad in the previous period. Inflation is shown to have a random-walk property and to be uncontrollable by the authorities; its variability is determined by the nature of the uncertainty in the system. Shocks to the demands and supplies of goods are shown to have cumulative effects on inflation, the variance of which increases over time, in some instances without bounds. In this example, instability in the inflation process tends to lead to instability in real exchange rates.

The second example extends the first to include both traded and nontraded goods and studies the role of financial markets under real exchange rate rules. While inflation remains difficult to control and again has a random-walk property, its behavior is more complex; potentially explosive behavior can occur depending on the speed at which the prices of nontraded goods adjust. The example also demonstrates how the money supply is able to adjust passively through the balance of payments while following a real exchange rate rule and, hence, why there is no anchoring of the inflation process through a domestic credit target.

The third example focuses on the implications of stickiness in the formation of inflation expectations for the inflation process, and applies the natural rate hypothesis to exchange markets. The authorities are assumed to set the nominal exchange rate on the basis of the expected inflation rate of the private sector and with a view to offsetting shocks that change the real exchange rate. As in previous examples, the inflation process may have a random-walk property; in this example, rapidly increasing inflation may emerge when the targeted real exchange rate of the authorities is above the equilibrium real exchange rate.

1/ A variable x_t follows a random walk, if $x_t = x_{t-1} + v_t$, where v_t is "white noise". By a variable being described by a random walk, we mean either that it is described by a strict random walk or, if it has a trend, that it follows a random walk around that trend.

The fourth example considers some differences in the behavior of inflation in response to nominal shocks under flexible exchange rates and under real exchange rate rules, in an overshooting model due to Dornbusch (1976). Whereas, under flexible exchange rates nominal exchange rates can jump in response to nominal disturbances, no such jumping can occur under real exchange rate rules. Real exchange rate rules can then lead to instability of the inflation process.

Finally, the fifth example considers whether a sustained policy of sterilizing the monetary inflows associated with intervention in the foreign exchange market can allow the authorities to control inflation while following a real exchange rate rule. Sterilization is shown under general conditions to lead to instabilities in the system, leading one to question its feasibility. Concluding comments are contained in the last section of the paper.

II. Real Exchange Rate Rules and the Determination of the Price Level

The issues raised in this paper fall into the area of monetary theory and the determination of the level of prices rather than in the area of real theory, with its emphasis on the determination of the relative price of goods. This section addresses a number of issues that arise in monetary theory with regard to the determination of the price level and how it is that monetary policy can tie the price level down. As such, the section provides a background to the examples contained in the remainder of the paper and illustrates why the authorities will tend to lose control over the price level or the inflation process when following real exchange rate rules.

It is convenient to begin with a dichotomized economic system in which there is a "real" and a "monetary" part. 1/ In such a system, the real variables such as the relative prices of goods, real incomes, real expenditures, etc. are determined independently of the level of nominal variables according to equations such as given by:

$$(1) \quad q_i^d\left(\frac{P_1}{P_m}, \frac{P_2}{P_m}, \ldots, \frac{P_m}{P_m}, E\right) = q_i^s\left(\frac{P_1}{P_m}, \frac{P_2}{P_m}, \ldots, \frac{P_m}{P_m}, E\right) \quad i = 1,m$$

1/ The system is dichotomized in the sense that the real variables will be determined independently of nominal variables. Nominal variables, however, will be influenced by real variables (see Patinkin (1965)). Equation (1) represents a full equilibrium and hence real balance effects are not included in the equation.

Here, there are assumed to be m goods and equation (1) represents the equilibrium condition for the i^{th} good, in terms of equality between the demand for and supply of that good. Demands and supplies depend in general on all relative prices (P_i/P_m) and on real factor endowments (E). With m goods there are at most (m-1) independent equilibrium conditions of the form given by equation (1) and these can be regarded as giving rise to equilibrium relative prices, as functions of exogenous variables such as factor endowments according to:

$$(2) \quad \frac{P_i}{P_m} = \frac{P_i}{P_m}(E) \qquad i = 1, (m-1)$$

In this system, a scaling up or down of all nominal prices by the factor K (a reform in which a zero is added to, or taken off, all prices) has no impact on any real demand or supply.

Absolute prices are determined on the monetary side of the economy, as given by:

$$(3) \quad MV = PY$$

Here M is the stock of money (the unit of account for the nominal prices P_i-P_m), V is velocity, Y is the real volume of transactions, and P is a price index that is homogenous of degree one in the money prices of the m goods. With V and T given by the real side of the economy, equation (3) determines the price level (index) if the authorities set the money supply. 1/

In this system, a doubling of the money stock leads to a doubling of money prices while leaving all real variables unchanged. 2/ That is to say, money is neutral or is a veil as regards the determination of the real variables of the system. Setting the money supply is not of course the only kind of "monetary policy" that it is possible to consider in such a system; monetary policy could, for example, be aimed at stabilizing the price level with the money stock then being determined endogenously.

1/ If we allow for rational expectations, it has to be recognized that tying down the current money supply is not sufficient to anchor the price level; in general, it is necessary to tie down the path for the expected future money supply, as well, in order to tie down velocity and hence prices.

2/ Strictly, here we require a doubling of the current and all expected future money supplies so that expected inflation and, hence, velocity does not change. In what follows, we abstract from any super non-neutralities associated with changing inflation or monetary growth rates.

In a system such as the one outlined in equations (1) through (3), it is interesting to speculate about how the price level would be determined if the authorities did not set the money supply or try to stabilize prices. By inspecting equations (1) through (3), it is apparent that such a policy raises difficulties. By assumption, real behavior is independent of the absolute price level and depends only on relative prices and on endowments. The set of equations given by equation (1) cannot therefore give a solution for the price level (one level is as good as any other). Equation (3) no longer determines absolute prices either since the authorities are assumed not to set the money supply or price level.

The price level is clearly indeterminate in this case. If the model under consideration describes an economy in which the authorities are not concerned with nominal variables, it does not take one very far, however, to say that the price level is indeterminate in that economy. The price level will clearly, in practice, be at some level and in that sense has been determined. The important point is that at whatever level prices have been determined, the model cannot reveal what it will be and it is out of the control of the authorities.

In essence, our argument on the implications of real exchange rate rules for prices and for inflation in the long run is based on similar considerations. To be less abstract, assume a small economy with its own money and a real side that is described by equation (4) and a monetary side as given by equation (5).

$$(4) \quad d(SP^*/P, Y, E) = s$$

$$(5) \quad MV = PY$$

The economy is assumed to produce a single domestic good and there is a single foreign good; velocity and real income are assumed to be determined independently of nominal variables in such an economy when all nominal variables are flexible. 1/

There are three nominal variables in this model economy: P (the price of domestic output), S (the domestic currency price of foreign exchange), and M (the domestic money supply). If the authorities do not set M, P, or S but instead set the real exchange rate (the ratio of SP* to P), it is interesting to consider how the price level is determined. When the authorities intervene in the foreign exchange market so as to peg the real exchange rate, the money supply will change either through intervention in the foreign exchange market (ΔF) or through intervention in domestic financial markets (ΔC). At any point in time, the money stock thus can be written as:

1/ See footnote 2/ on page 6.

(6) $M = C + F$

It is straightforward to establish that a policy of pegging the real exchange rate and setting domestic credit (C) does not lead to the price level being tied down by the authorities, for the money supply can change through the balance of payments. 1/ A real exchange rate rule and a domestic credit target are not therefore sufficient for the authorities to tie the price level down.

Before considering the examples of the paper, it is useful to address a number of specific issues that are raised by the above discussion and which are covered in the examples that follow. In the first place, it is apparent that it is widely believed that in many economies nominal variables are only neutral in the "long run," tending to cast some doubt on the usefulness of an analysis built on "long-run" results. 2/ The examples of the paper, however, are all formulated in the "short run" with some kind of temporary stickiness in prices or in expectations that allow for nominal variables to be non-neutral. The tendency of economies to display longer-run neutrality, is sufficient as it turns out to rehabilitate the usefulness of "long-run" results and to give rise to issues of price level determination, when there is no exogenous nominal anchor to control prices.

Secondly, the indeterminacy of the price level that occurs under real exchange rate rules in the long run, comes about due to the insufficiency of domestic credit to control prices, when the money supply can vary endogenously through the balance of payments. It is interesting to consider whether the authorities will be able to control prices by switching from domestic credit to money targets, when following real exchange rate rules. This is the subject of examples 2 and 5 of the paper; in example 5 it is shown that the sterilization of monetary inflows through the balance of payments that is implied if one is to have a real exchange rate rule <u>and</u> a money supply target, typically leads to an instability in the system, making the policy infeasible over long periods.

1/ Consider an initial equilibrium with domestic credit given by C_0, and with the price of domestic output, domestic money supply, and exchange rate given by P_0, M_0, and S_0. Clearly, even with domestic credit fixed at C_0, there are an infinite number of possible equilibria in which M, P, and S are scaled up or down equiproportionately, leaving real variables unchanged.

2/ One is never too sure, of course, what is meant by the long run, and why it is that time lags exist. Informational difficulties may lie at the core of the "short-run" through "long-run" dichotomy (see Sargent (1979)).

Finally, at many points in the paper we use the terms "indeterminacy," "uncontrollability," and "instability." There are some differences between these terms which should be noted: by prices or inflation being indeterminate we mean that an economic model cannot reveal what their long-run values will be, and this is the case under real exchange rate rules with domestic credit targets; by a variable being "uncontrollable" we mean that the authorities will not be able to systematically influence its value; and by a system being unstable we mean that it will not converge (in an expected value sense) to a long-run equilibrium position. A general point that we should make is that in a number of examples we find that inflation may exhibit explosive behavior. This finding should not be interpreted as implying that inflation will in practice explode when following a real exchange rate rule. A finding of such explosive behavior should be generally interpreted as implying an inconsistency in a policy mix that will be resolved in one way or another. Volatile inflation behavior is one kind of resolution, a modification of policy settings is another.

III. Stochastic Shocks and the Inflation Process

A policy that adjusts the nominal exchange rate according to inflation differentials can have important implications for the stability of the price level and inflation. Assume that information on prices is reported with a one-period lag. If world inflation is zero, then the rule for adjusting the exchange rate is assumed to be given by:

$$(1.1) \quad \tilde{s}_t = \tilde{p}_{t-1} + u_t.$$

Here s is the log of the nominal exchange rate, expressed as the domestic currency price of one unit of foreign currency; $\tilde{s}_t$ is defined as $\tilde{s}_t \equiv s_t - s_{t-1}$ and p_t is the log of the general price level; accordingly

$\tilde{p}_{t-1}$ is inflation in period t-1. u_t represents a random term, assumed to have a mean of zero, which may be due to imperfect information about prices (in this case the "true" inflation rate would be $\tilde{p}_{t-1}$, whereas the authorities perceive $\tilde{p}_{t-1} + u_t$); u_t could also represent any one step devaluations the authorities undertake to try to affect the real exchange rate. 1/

1/ In this example, we assume that the authorities have a target for domestic credit. Monetary equilibrium is not explicitly considered until the next example where it is shown how the money supply adjusts endogenously through the balance of payments so as to finance any inflation rate that is forthcoming.

The domestic nominal price of a single traded good (the price level) is assumed to adjust slowly to divergences between the (log of the) actual real exchange rate, $s_t - p_t$, and its long-run equilibrium level $\bar{z}$. 1/ Inflation then follows:

$$(1.2) \qquad \tilde{p}_t \; = \; \phi[s_t - p_t - \bar{z}] + v_t + m \qquad \phi > 0.$$

Here ϕ is a positive constant, v_t is a disturbance that follows a random walk as given by $v_t - v_{t-1} = e_t$, and m could represent the equilibrium inflation rate or the target inflation rate of the authorities. 2/ Equation (1.2) implies that the change in the inflation rate is governed by:

$$(1.3) \qquad \tilde{p}_t - \tilde{p}_{t-1} \; = \; \phi[\tilde{s}_t - \tilde{p}_t] + e_t.$$

Using equation (1.1) to substitute for s_t in equation (1.3) yields the following expression for the current inflation rate, $\tilde{p}_t$:

$$(1.4) \qquad \tilde{p}_t \; = \; \tilde{p}_{t-1} + [e_t + \phi u_t]/(1+\phi).$$

The important implication of equation (1.4) is that the inflation rate in any period is equal to the inflation rate in the last period plus a composite disturbance term. This disturbance will be denoted by w_t (i.e., $w_t \equiv [e_t + \phi u_t]/(1+\phi)$. Whenever equation (1.2) accurately describes the price formation process, equation (1.4) implies that the authorities will not be able to control inflation when they are adjusting the nominal exchange rate according to the rule described by equation (1.1); inflation will follow a random walk and successive disturbances will have cumulative effects on inflation. Moreover, there will be no convergence of the actual inflation rate, $\tilde{p}_t$, towards its equilibrium or target rate, m. 3/

1/ $\bar{z}$ is assumed here to be constant but this is not essential for the conclusions, which only depend on the long-run equilibrium real exchange rate being determined independently of monetary variables.

2/ This kind of equation has been widely used in the literature; it could be derived from a "Phillips curve" adjustment process applied to the goods markets.

3/ As an alternative to the real exchange rate rule, equation (1.1), it is also possible to consider the implications of a policy that fixes the rate of depreciation of the nominal exchange rate without reference to domestic inflation. Such a policy of a prefixed crawl leads to a process for inflation that is stable and leads to an expected inflation rate equal to the target rate m, in the above model (see below).

It can be shown that if the exchange rate rule was introduced at time zero, current inflation can be written as:

$$(1.5) \qquad \tilde{p}_t = \tilde{p}_0 + \sum_{j=1}^{t} w_j$$

or, by using equation (1.2), as

$$(1.6) \qquad \tilde{p}_t = \phi[s_0 - p_0 - \bar{z}] + v_0 + m + \sum_{j=1}^{t} w_j.$$

Equations (1.5) and (1.6) together imply that the inflation rate that existed at the time the exchange rate rule was implemented will have a tendency to persist. A one-step devaluation in any period over and above ongoing domestic inflation will tend to raise the inflation rate in all future periods. This means that if during any period the authorities devalue by an additional 1 percent (i.e., in addition to the nominal depreciation needed to offset inflation differentials) inflation in all future periods will, on average, rise by $\phi/(1+\phi)$ percent. The random-walk property of the inflation process comes about in this example because there is no exogenous nominal anchor for the price level or inflation, the inflation rate will not therefore tend to settle down to any steady state level and shocks will have the cumulative effects outlined.

Equation (1.6) does not necessarily imply that there will be accelerating inflation; it does, suggest however that the authorities cannot control inflation under a real exchange rate rule and that the variance of inflation may increase over time. The variance of the inflation rate depends on the process governing the composite disturbance term w_t. If e_t and u_t are distributed independently over time, each with mean of zero and variance of Var(e) and Var(u) respectively, the variance of the inflation rate increases without bounds over time. 1/

1/ The variance (conditional upon current information) of the inflation rate at any time T in the future is given by:

$$\begin{aligned} Var(\tilde{p}_T) &= Var(v) + T[Var(w)] \\ &= Var(v) + T[Var(e) + \phi^2 Var(u)]/(1+\phi)^2. \end{aligned}$$

As time progresses, this variance clearly goes to infinity. This case might be called the worst case, however; if w_t follows a more "convenient" process, the variance of inflation will initially increase and then approach a steady state level. Assume that w_t follows

The purpose of real exchange rate rules is frequently to keep the real exchange rate constant. 1/ A real exchange rate rule like that given by equation (1.1), however, that is based on past inflation rates might not achieve a constant real exchange rate if inflation becomes highly variable. In the context of the present example, the real exchange (denoted by $q_t = s_t - p_t$) follows:

$$(1.7) \quad q_t = q_{t-1} + \frac{1}{1+\phi}(u_t - e_t)$$

This implies that if the real exchange rate rule is implemented by using past inflation rates as in equation (1.1), the real exchange rate follows a random walk and thus itself is unstable. 2/ There is no tendency then for the real exchange rate to converge to its long-run equilibrium, $\bar{z}$.

This illustrative case shows that, given our price formulation structure, rules that adjust the nominal exchange rate according to inflation differentials imply that the variability of the inflation rate is increased and that the inflation rate is not controllable by the authorities. It is interesting to contrast this situation with that of a conventional fixed or nominal crawling peg exchange rate policy. If the

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1/ (Cont'd from p. 11) $w_t = bw_{t-1} + x_t$, $1 > b > 0$, where x_t is distributed independently over time with variance $Var(x_t)$. In this case, the variance of the inflation rate at time t can be written as:

$$Var(\tilde{p}_t) = Var(v) + \sum_{j=0}^{t} b^j Var(x).$$

In this case, the variance initially increases; it will, however, reach a steady state level equal to:

$$Var(\tilde{p}_\infty) = Var(v) + [\frac{1}{1-b}]Var(x).$$

1/ The following argument applies if the target real exchange rate is not a constant, as long as the path of the target real exchange rate is prefixed.

2/ The other examples in this paper show that under different hypotheses about the implementation of the real exchange rate rule the resulting real exchange rate might be stable; the resulting inflationary process, however, is always unstable.

authorities aim for an inflation rate of m, they could set a rate of devaluation of m percent per period for the crawling peg (because world inflation is assumed to be zero). Formally, this policy can be written as:

$$(1.8) \quad \tilde{s}_t = m + u_t$$

The inflation rate is then governed by:

$$(1.9) \quad \tilde{p}_t = \tilde{p}_{t-1}/(1+\phi) + m\phi/(1+\phi) + (e_t+\phi u_t)(1+\phi).$$

Equation (1.9) implies that inflation is determined by a stable process under a crawling peg; indeed, the expected steady state inflation rate implied by equation (1.9) is equal to m. 1/ The central difference between this exchange rate regime and the real exchange rate regime described by equation (1.1) is that the crawling peg involves the authorities setting an exogenous nominal rate of devaluation. Under the real exchange rate rule the authorities have no target for the nominal exchange rate, which is indexed on last period's inflation rate.

IV. The Inflation Process With Nontraded Goods

This example concentrates on the implications of differences in the behavior of the prices of traded and nontraded goods for the nature of the inflation process under a real exchange rate rule. The exchange rate rule in this example is given by equation (2.1) where we allow for non-zero inflation in the rest of the world and abstract from random variations in the rate of devaluation.

$$(2.1) \quad \tilde{s}_t = \tilde{p}_{t-1} - \pi$$

Here π is a fixed rate of world inflation. In this example, the change in the general price level or consumer price index (CPI), $\tilde{p}_t$, is defined as a weighted average of the prices of traded and nontraded goods, with

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1/ With a prefixed rate of crawl the real exchange rate too is stable; under the policy of equation (1.8) it is governed by:

$$q_t = \frac{1}{1+\phi} q_{t-1} + \frac{\phi}{1+\phi} \bar{z} + (u_t'-v_t)/(1+\phi)$$

This is a stable process which implies a tendency for the real exchange rate to converge to its long-run equilibrium rate, $\bar{z}$.

weights of $(1-\alpha)$ and of α respectively. It is assumed that the domestic price of tradables is determined directly by the exchange rate and world market prices, which implies that the change in the price of traded goods is equal to the change in the exchange rate plus world inflation. CPI inflation is then given by:

$$(2.2) \qquad \tilde{p}_t = \alpha\tilde{p}_{n,t} + (1-\alpha)(\tilde{s}_t+\pi).$$

The change in the price of nontraded goods is assumed to be determined by the sum of two effects. The first of these represents adjustments to deviations of the real exchange rate from its long-run equilibrium level as in the first example; and the second, the inflationary forces that would change the price of nontradables even if the real exchange rate were at its long-run equilibrium level. It is assumed that these inflationary forces can be expressed in terms of past and current changes in the general price level; they then capture effects that might come from the indexation of wages and from expectations that are based on past price changes. Formally, the change in the price of nontraded goods is given by:

$$(2.3) \qquad \tilde{p}_{n,t} = \phi(p_{i,t-1} + s_{t-1} - p_{n,t-1} - \bar{z}) + \psi\tilde{p}_{t-1} + (1-\psi)\tilde{p}_t.$$

Here $p_{i,t}$ is the price of traded goods and $\bar{z}$ is the long-run equilibrium real exchange rate. ψ represents the relative weight of past inflation in expectations about nontradables goods inflation. A value of ψ equal to zero indicates no expected change in the real exchange rate; if the real exchange rate is at its equilibrium value, a value of $\psi = 1$ implies that expectations are only based on past inflation.

The link between inflation and financial markets is captured by a simple money demand function of the form:

$$(2.4) \qquad m_t^d = p_t - \varepsilon[r + \tilde{p}_t] = p_t - \varepsilon\tilde{p}_t$$

where the real interest rate (r) is assumed constant and in what follows is set equal to zero. Here m_t^d represents the logarithm of the demand for nominal money balances and ε is the semi-elasticity of the demand for money with respect to the nominal interest rate ($R=r+\tilde{p}_t$). 1/ The money market is assumed not to be continually in equilibrium; it is

1/ For simplicity, it is assumed here that expected inflation as of period t is equal to inflation during period t; this simple form is assumed for illustrative purposes.

assumed instead that money holdings adjust by a fraction of the discrepancy between money demand and the money balances that existed at the beginning of each period, according to:

$$(2.5) \quad m_t - m_{t-1} = \tilde{m}_t = \lambda(m_t^d - m_{t-1}).$$

The balance sheet of the central bank implies that changes in the money supply can originate either from domestic credit expansion, ΔDC, or from increases in reserves, ΔR:

$$(2.6) \quad \tilde{m}_t \cong \frac{\Delta M_t}{M_t} = \frac{\Delta DC_t}{M_t} + \frac{\Delta R_t}{M_t}.$$

where M_t represents the stock of nominal money (lower case letters refer to logarithms).

These equations imply that a rise in prices has to be associated with an increase in the stock of money which can come about from either domestic credit expansion or through the balance of payments. Because real exchange rate rules typically have been implemented in conjunction with a limit on domestic credit expansion, only the balance of payments channel is considered here. Moreover, since the most volatile item in the balance of payments is typically capital flows, capital flows are likely to be the balance of payments account that adjusts to satisfy shifts in money demand, at least in the short run.

A crucial issue that has arisen in some countries that have followed real exchange rate rules is whether capital flows have caused inflation or vice versa. In the context of real exchange rate rules and the example we have constructed, inflation is determined independently of capital flows and of all other financial variables; capital flows serve only to increase the available money balances necessary to satisfy a higher demand for money due to price level increases. 1/

1/ This conclusion would not be affected if excessive money growth had an independent inflationary impact on nontradables goods prices. To take this effect into account, equation (2.3) could be changed into:

$$\tilde{p}_{n,t} = \phi(RE_{t-1} - \bar{z}) + \psi\tilde{p}_{t-1} + (1-\psi)\tilde{p}_t + \gamma(m_t - m_t^d)$$

where RE_{t-1} is the real exchange rate; $RE_t \equiv p_{i,t} + s_t - p_{n,t}$. The term $\gamma(m_t - m_t^d)$ represents the independent impact of money on inflation in

The adjustment process that satisfies the increased demand for nominal balances that results from an increasing price level is not specified here. Such an adjustment process does not in general have to be based on perfect capital mobility. 1/ One possibility would be to use the balance sheet identity that the change in reserves, ΔR_t, is the sum of the current account and the balance of capital movements. The current account might then be a function of the real exchange rate and net capital movements could be a function of the interest rate differential, adjusted for expectations about exchange rate changes. Since the real exchange rate rule implies that prices and the exchange rate follow an autonomous process, the only variable that is free to adjust to induce the required flow of reserves (at a given rate of domestic credit expansion) is the interest rate. Sudden capital inflows might then happen because the inflationary process set in motion by the real exchange rate rule leads to a higher

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2/ (Cont'd from p. 15) nontradables goods. However, using equations (2.4) and (2.5) this can be rewritten as:

$$\tilde{p}_{n,t} = \phi(RE_{t-1}-\bar{z}) + \psi\tilde{p}_{t-1} + (1-\psi)\tilde{p}_t + \\ + \gamma[\lambda \sum_{i=0}^{t} (p_{t-i}-\varepsilon\tilde{p}_{t-1-i})(1-\lambda)^i - (p_t-\varepsilon\tilde{p}_{t-1})].$$

This last equation, like equation (2.3), contains only expressions in terms of the general price level, the price of nontradables, and the exchange rate; it can thus be solved for the current inflation rate as a function only of past inflation in a similar way as equation (2.3). The result, however, is more complicated since in this case inflation becomes an infinite order difference equation. Note that rising inflation in general has an ambiguous impact on money demand and hence the capital account; while higher prices raise the nominal demand for money, higher expected inflation reduces real money demand. In the text, the former effect is assumed to dominate.

Since this equation has an infinite order distributed lag it is not possible to determine the stability of the resulting process for inflation in general; but this equation implies that the authorities cannot control inflation.

1/ A small country may thus find that monetary policy cannot influence real interest rates in the short or long run, regardless of the degree of capital mobility. In general, its real interest can be determined by foreign real interest rates (as under perfect capital mobility); it could also be tied down by domestic real factors.

demand for nominal balances, which is not satisfied by domestic credit expansion. 1/

Formally, these points can be illustrated by noting that inflation is determined by the system of equations (2.1) through (2.3). These give rise to a homogeneous, 2/ second-order difference equation of the form:

$$(2.7)\quad [1 - \alpha(1-\psi)]\,\tilde{p}_{t+1} + [(\phi-2) + 2\alpha(1-\psi)]\tilde{p}_t - [\alpha(1-\psi) + (\phi-1)]\tilde{p}_{t-1} = 0$$

with roots, ρ_1 and ρ_2:

$$\rho_1 = 1, \qquad \rho_2 = 1 - \frac{\phi}{1-\alpha(1-\psi)}.$$

The unitary root is analagous to the random walk property found in the first example; any disturbance to the inflation rate has a tendency to show up in all future inflation rates. Inflation is thus unstable in the sense that there is no anchor in the form of a steady state inflation rate to which the system would eventually settle down. The second root indicates that inflation might be explosive and could exhibit fluctuations. Explosive fluctuations will occur if the second root is smaller than -1, i.e., if $\phi > 2[1 - \alpha(1-\psi)]$. 3/

1/ This does not imply that all countries that use real exchange rate rules experience sudden capital inflows. Many of the countries that use real exchange rate rules also experience high rates of domestic credit expansion because of slippings of fiscal targets. In these cases, monetization of the fiscal deficit might be enough to satisfy the additional demand for money that is induced by the inflation resulting from the real exchange rate rule.

2/ If world inflation changes over time the equation becomes nonhomogeneous with a particular solution that is a function of time.

3/ Restrictions on the value of the price adjustment parameter ϕ can be gained by looking at the behavior of prices under a crawling peg with a fixed rate of depreciation equal to m. Using $\tilde{s}_t = m$ instead of the purchasing power parity (PPP) rule (equation (2.1)) leads to this expression for inflation:

$$\tilde{p}_{t+n} + (\phi-1)\tilde{p}_t = (\pi+m)\phi,$$

which implies that there is a steady state inflation rate, equal to $\pi + m$ and that the system is stable as long as $\phi < 2$ (with damped oscillations if $1 < \phi < 2$).

The solution for the current inflation rate can be written as:

$$(2.8)\quad \tilde{p}_t = A_1 + A_2\rho_2^t$$

which shows that inflation and the price level depend on initial conditions, as given by A_1 and A_2 and on the second root, ρ_2. Because money demand is also a function of the price level and inflation, money demand can be expressed in terms of the same initial conditions and the behavior of the second root:

$$(2.9)\quad m_t^d = p_0 + \sum_{i=0} \ln(A_1+A_2\rho_2^i) - \varepsilon(A_1+A_2\rho_2^t).$$

The behavior of the real exchange rate implicit in this system is somewhat different than in the first example. Using the system of equation (2.1) through (2.3) the CPI-based real exchange rate, denoted by $q_t \equiv p_{i,t} + s_t - p_{n,t}$ follows:

$$(2.10)\quad q_t[\psi + \frac{1-\alpha}{\alpha}] = [\psi + \frac{1-\alpha}{\alpha} - \frac{\phi}{\alpha}]q_{t-1} + \frac{\phi}{\alpha}\ \bar{z}$$

This implies that there is a steady state real exchange rate which is equal to the equilibrium real exchange rate, $\bar{z}$; and the real exchange will tend to settle down to this equilibrium value as long as the second root in the system (equation (2.7)) above is larger than -1.

Given the partial adjustment process (equation (2.5)), money demand determines the evolution of the money supply. If domestic credit expansion is limited, this implies that the balance of payments adjusts to changes in money demand. Indeed, using equations (2.5) and (2.6) the balance of payments can be written in terms of past and current values of the demand for money:

$$(2.11)\quad \frac{\Delta R_t}{M_t} \cong -\frac{\Delta DC_t}{M_t} + \tilde{\lambda}\sum_{i=0}^{t} m_{t-1}^d(1-\lambda)^{i-1}.$$

Since money demand is determined by the evolution of prices as in equation (2.9), equation (2.10) shows that the balance of payments and, thus, changes in reserves (sterilized intervention is not considered here), 1/ are also influenced by prices when the authorities follow a real exchange rate rule. The large capital inflows experienced by some countries that have followed real exchange rate rules cannot necessarily be viewed as inflationary. Instead, as in the above example, these flows might be as the consequence of the high inflation rates that are caused by the real exchange rate rules. The increases in the price level brought about through these rules lead to a higher nominal demand for money which in turn is satisfied through the balance of payments, when domestic credit expansion is limited.

V. The Inflation Process with Flexible Prices and a Surprise Supply Function--An Application of the Natural Rate Hypothesis

The preceding two examples have been of economies in which some prices are sticky. In the following example, prices are assumed to be flexible, while expectations are assumed to adjust adaptively or sluggishly. The example represents an application of the Natural Rate Hypothesis to exchange markets and it is shown how maintaining the real exchange rate away from its full equilibrium (or natural rate) requires either continually rising or falling inflation.

An economy is considered that produces a single good that is an imperfect substitute for "foreign" output. The authorities are assumed to set the nominal exchange rate so as to maintain a constant real exchange rate which requires them to adjust the exchange rate not only for inflation differentials, but in response as well to shocks that affect the equilibrium real exchange rate. 2/

The supply and demand functions for domestic output are assumed to be of the form:

$$(3.1) \quad y_t^s = \alpha(p_t - E_{t-1}(p_t)) + \Sigma_t^s$$

$$(3.2) \quad y_t^d = \beta(s_t - p_t) + \Sigma_t^d,$$

where all variables are measured in logarithms. Foreign prices are constant and have been set equal to unity, and all parameters are defined

1/ Moreover, sterilized intervention would not make any difference in this framework. Since money demand has to be ratified somehow, sterilized intervention would only lead to a change in the composition of the assets of the central bank without any effect on the size of the total stock of money (see Section VII).

2/ In this example, we abstract therefore from any instability in the real exchange rate that could come about when following a real exchange rate rule (see Section III).

to be positive; Σ_t^s, Σ_t^d denote real shocks to supply and demand, respectively that are assumed to have a mean of zero. According to equation (3.1), supply depends on the gap between the actual and expected price level, and on shocks as given by Σ_t^s; according to equation (3.2), demand depends on the price of foreign relative to domestic output (the real exchange rate) and on Σ_t^d. The authorities are assumed to have a domestic credit target and we do not explicitly consider financial markets in this example. Money balances are assumed to adjust passively through the balance of payments as in examples one and two.

It is convenient to add and subtract P_{t-1} to/from the right hand side of equation (3.1). With the real exchange rate given by $r_t = s_t - p_t$, equations (3.1) and (3.2) can be rewritten as:

$$(3.1') \quad y_t^s = \alpha(\tilde{p}_t - \underset{t-1}{E}(\tilde{p}_t)) + \Sigma_t^s$$

$$(3.2') \quad y_t^d = \beta r_t + \Sigma_t^d$$

The rule for setting the nominal exchange rate is assumed to give rise to the real exchange rate remaining constant at its level ruling in period zero (r_0), which requires that the authorities adjust the nominal exchange rate according to their perception of the expected inflation rate of the private sector, and in response to shocks that alter the real exchange rate. 1/ Under these conditions, the evolution of inflation is described by:

1/ The nominal exchange rate is adjusted according to:

$$\tilde{s}_t = \underset{t-1}{E}(\tilde{p}_t) + \beta/\alpha \, r_0 + 1/\alpha(\Sigma_t^d - \Sigma_t^s).$$

To maintain the real exchange rate constant, the authorities need to know how private sector expectations are formed and the nature of the shocks to demand and supply. In the text, we investigate the implications of the authorities having this information, under conditions when $\underset{t-1}{E}(\tilde{p}_t)$ is related to past inflation. Accordingly, we show how real exchange rate rules that adjust nominal exchange rates according to past inflation can be rationalized not only by information lags, as in the first two examples, but by a particular expectation process as well. There is no suggestion that the assumption that the authorities have complete information is "realistic;" it is made for purposes of illustration and to demonstrate the implications of a policy that is able to hold the real exchange rate constant, but possibly at a "disequilibrium" level.

$$(3.3)\quad \tilde{p}_t = \underset{t-1}{E}(\tilde{p}_t) + \beta/\alpha\, r_0 + 1/\alpha(\Sigma_t^d - \Sigma_t^s).$$ 1/

The real exchange rate ruling in period zero is given by:

$$(3.4)\quad r_0 = (\alpha/\beta)(\tilde{p}_0 - \underset{t-1}{E}(\tilde{p}_0)) + 1/\beta(\Sigma_0^s - \Sigma_0^d).$$

According to equation (3.3), the evolution of inflation is related to the behavior of expectations and to the level of the real exchange rate in period zero; it also depends on the nature of the shocks to demand and supply.

The behavior of inflation is considered under the assumption that inflation expectations are "sticky" or "adaptive;" specifically, expectations are assumed to evolve according to equation (3.5), where Θ is a positive parameter lying between zero and unity. 2/

$$(3.5)\quad \underset{t-1}{E}(\tilde{p}_t) = \Theta\tilde{p}_{t-1} + (1-\Theta)\tilde{p}_{t-2}.$$

When $\Theta = 1$, the implication of equation (3.5) is that expectations are static and expected inflation is equal to the ongoing inflation rate; in general, expected inflation is a weighted average of inflation in periods t-1 and t-2.

Substituting equation (3.5) into equation (3.3)--and using equation (3.4) to eliminate r_0--gives rise to an inflation equation of the form:

$$(3.6)\quad \tilde{p}_t = \Theta\tilde{p}_{t-1} + (1-\Theta)\tilde{p}_{t-2} + [\tilde{p}_o - \underset{t-1}{E}(\tilde{p}_o))]$$
$$+ 1/\alpha(\Sigma_o^s - \Sigma_o^d) + 1/\alpha(\Sigma_t^d - \Sigma_t^s).$$

1/ For simplicity, inflation here is measured by changes in the price of domestic output rather than as a weighted average of changes in the prices of domestic and foreign goods.

2/ Equation (3.5) represents a kind of adaptive expectations mechanism; equations like it have been used to oroxy expected inflation in many Phillips curves.

According to equation (3.6), inflation follows a second-order difference equation. The general solution to equation (3.6) can be written in the form:

$$(3.7)\quad \tilde{p}_t = A_1(1)^t + A_2(\theta-1)^t + \frac{[\tilde{p}_0 - \theta\tilde{p}_{-1} - (1-\theta)\tilde{p}_{-2}]t}{(2-\theta)} + [\text{stochastic terms}].$$

Here, A_1 and A_2 are arbitrary constants and the roots of the difference equation are unity and $(\theta-1)$.

To consider the nature of the inflation process implied by equation (3.7), it is convenient to consider the case in which expectations are static, and hence $\theta = 1$. With reference to either equations (3.6) or (3.7), it can be seen that in this case inflation follows a random walk around a trend; the trend is determined by the nature of the shocks to demand and supply and by the difference between inflation in the initial and earlier period $(\tilde{p}_0-\tilde{p}_{-1})$.

$$(3.8)\quad \tilde{p}_t = \tilde{p}_{t-1} + [(\tilde{p}_0-\tilde{p}_{-1}) + 1/\alpha(\Sigma_0^s-\Sigma_0^d)] + 1/\alpha(\Sigma_t^d-\Sigma_t^s).$$

The solution to equation (3.8) can be written as:

$$(3.9)\quad \tilde{p}_t = \tilde{p}_0 + (\tilde{p}_0-\tilde{p}_{-1})t + \frac{1}{\alpha}\sum_{i=0}^{t}(\Sigma_i^d-\Sigma_i^s) \qquad t = 1, 2, 3, \ldots$$

Equation (3.9) illustrates that depending on whether the real exchange rate that is held constant is above or below its "full" equilibrium value, exploding or imploding inflation may result. 1/ The intuition behind this is straightforward: if the authorities are maintaining the real exchange rate above equilibrium it is necessary that actual inflation stay ahead of expected inflation. Since expected inflation, by assumption, "catches" up to actual inflation, inflation must be continually rising in order to hold the real exchange rate constant. More generally, with θ not equal to unity, the solution in equation (3.7) again has a random-walk property, in which one root is equal to unity; the other root, however, is negative and lies

1/ The full equilibrium real exchange rate is defined as the rate existing when actual and expected inflation are equal. Consequently, with reference to equation (3.9), the real exchange rate ruling at t = 0 is a full equilibrium rate if $(\tilde{p}_0-\tilde{p}_{-1} = 0)$.

between zero and one. Under these conditions, the inflation process has a more complex structure and oscillations may occur. The particular process that inflation follows will depend on the nature of the shocks to demand and supply (Σ_t^d, Σ_t^s).

The kind of accelerationist argument developed in this example may go part of the way toward explaining why inflation has often risen sharply when real exchange rate rules are followed. If initial devaluations are so large as to move the real exchange rate above its full equilibrium level (overdepreciate), inflation must then continually rise in order to hold the real exchange rate constant. The argument, of course, is an application of the Natural Rate Hypothesis that has often been applied to labor markets, to the implications of holding the real exchange rate away from its natural or full equilibrium rate. 1/

VI. The Inflation Process in an Overshooting Model

This example illustrates an important difference between the impact of nominal shocks under flexible exchange rates and under a real exchange rate rule. With a flexible exchange rate, it has been shown that the nominal exchange rate may "overshoot" in response to nominal disturbances when goods prices adjust slowly and capital is perfectly mobile (Dornbusch (1976)). Real exchange rate rules are shown to exclude such overshooting and in so doing may contribute to instability in the price level. The rationale for this result is that with flexible exchange rates the nominal exchange rate must typically jump in order to make the system stable. 2/ With a real exchange rate rule, the nominal exchange rate, however, can no longer jump; it cannot therefore lead the economy to a new equilibrium. Real exchange rate rules, as opposed to fixed predetermined nominal exchange rates, may also fix the real exchange rate; these rules therefore close other channels that might move the economy toward equilibrium.

The instability that may be caused by real exchange rate rules is illustrated here by two models. The first is kept as simple as possible to show the source of instability; the second model is somewhat more complex and takes into account a number of different effects; it arrives, however, at similar conclusions. Both models are in continuous time and abstract from the timing issues contained in the first two examples of the paper.

1/ As applied to labor markets, the argument is that if unemployment is held below its natural rate, continually rising inflation will occur.

2/ In more technical terms, the exchange rate jumps to the stable saddle path that leads to a new steady state with a finite price level.

The first model consists of two equations which describe respectively the demand for money and the balance of payments. Money demand is given by:

$$(4.1) \quad m = \alpha p + (1-\alpha) s - \varepsilon [\alpha D(p) + (1-\alpha) D(s)].$$

All variables are expressed as deviations from their respective trend values. The general price level is given by a weighted average of the prices of domestic goods, p, and the prices of foreign goods, s (the exchange rate) when the foreign currency prices of foreign goods are normalized to one. The notation D(-) designates the right-hand time derivative operator, i.e., D(p) = dp/d (time). The definition of the real exchange rate rule is assumed to imply that D(p) = D(s), but this does not imply that in this model goods markets are perfectly integrated; it is only the real exchange rate policy that makes this part of the economic system behave as if the law of one price held. The real exchange rate rule is assumed to fix the real exchange rate, i.e., $p - s = \bar{q}$ and this implies that money demand can be rewritten as:

$$(4.2) \quad m = \alpha q + s - \varepsilon (s),$$

where s is the rate of change in (the log of) the exchange rate.

The second building block of the model is the link between the balance of payments and the money supply:

$$(4.3) \quad D(m) = \beta [(\bar{r} - r^* - D(S))].$$

The right hand side of equation (4.3) is the capital account; it is assumed that the real exchange rate that is fixed by the authorities leads to a balanced current account. 1/ Capital inflows are an increasing function of the differential between a domestic interest rate, $\bar{r}$, which is assumed to be fixed, and an exogenous foreign interest rate, r*, adjusted for the expected change in the exchange rate. Capital flows are assumed to be negatively affected by the expected rate of depreciation of the nominal exchange rate and, hence, in this example, capital is assumed

1/ Allowing for a nonzero current account does not affect in any way the conclusions, since it would only add a constant to the right-hand side of equation (4.3).

to be less than perfectly mobile. Capital flows translate into changes in the money supply since it is assumed that the authorities keep domestic credit constant.

The real exchange rate rule does not allow the exchange rate to jump; equations (4.2) and (4.3) therefore represent a system of two differential equations with two predetermined variables: the money supply, m, and the exchange rate, s. The system is unstable in this case. 1/

The reason for the instability can be found by inspecting the money demand function (equation (4.2)). The only variable in this equation that can react to a change in the money supply due to an increase in domestic credit is the rate of depreciation: a decrease in money leads to a higher expected and actual rate of depreciation. 2/ This higher rate of depreciation then leads to capital outflows (or just lower capital inflows) which reduce the money supply further and thus require an even higher rate of depreciation. This instability occurs even if there is no capital mobility, i.e., even if $\beta = 0$. In such a case the money supply is constant but it remains the case that a negative money shock requires a faster rate of depreciation. The faster rate of depreciation has to be accompanied by a faster rate of inflation since the real exchange rate rule specifies that the rate of depreciation has to be equal to the rate of inflation. The faster rate of depreciation then leads to a higher price level in the future and thus to even lower real money stock, a lower real money stock then in turn leads to an even higher rate of depreciation in order to maintain equilibrium in the money market.

The model analyzed so far does not take into account a variety of channels that might move the economy towards a long-run equilibrium even under a real exchange rate rule. These channels include the effects of changes in income, which may influence money demand and prices, and the effects of changes in the interest rate which may influence money demand and capital flows. The model presented below takes these effects into

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1/ The system can be written in matrix form as:

$$\begin{bmatrix} D(s) \\ D(p) \end{bmatrix} = \begin{bmatrix} 1/\varepsilon \\ -\beta/\varepsilon \end{bmatrix} \begin{bmatrix} -1/\varepsilon \\ \beta/\varepsilon \end{bmatrix} \begin{bmatrix} s \\ p \end{bmatrix}$$

The determinant is equal to zero. This implies that the system is unstable; any small shock would drive both the money supply and the exchange away from equilibrium.

2/ This type of "perverse reaction" is well known in the literature (e.g., Dornbusch (1976)), however, it can usually be excluded because there is a variable such as the exchange rate that can jump and bring the economy to a stable path. Thus, under a freely floating exchange rate this "perverse reaction" could not happen.

account and shows that the instability problem remains, although it is no longer a necessary feature of the specification.

The extended model contains four equations. The first describes capital flows as a function of the difference between the (expected) rate of depreciation and the interest rate differential. The equation is modified, however, to account for the hypothesis that it is foreign capital that is attracted by the covered interest rate differential. This implies that the domestic currency value of the capital flows and, hence, the induced change in money have to be multiplied by the exchange rate. Capital flows are then determined by:

$$(4.4) \quad D(m) = \beta(r - r^{*} - D(s)) + s$$

The money demand function is modified to take into account income and interest rate effects.

$$(4.5) \quad m = \alpha\bar{y} + s - \varepsilon\, D(s) - \lambda r + \psi y^{d}$$

Here y^d represents aggregate demand or income and ψ is the income elasticity of money demand. Money demand is also influenced by the domestic nominal interest rate, r, which is no longer assumed to be fixed. Spending y^d is determined by the real exchange rate, potential output, y, and the real interest rate:

$$(4.6) \quad y^{d} = \phi(s - p + \bar{u}) + \gamma\bar{y} - \sigma[r - \alpha D(p) - (1-\alpha)\, D(s)]$$

Since the real exchange rate is fixed by the real exchange rate rule the first term on the right hand side of equation (4.6) is constant and can be set equal to zero. The real exchange rate rule also implies that D(s) = D(p); equation (4.6) can then be rewritten as:

$$(4.7) \quad y^{d} = \gamma\bar{y} - \sigma[r - D(s)].$$

Prices are assumed to follow a Phillips curve type relationship; their rate of change is a function of the divergence between actual and potential output:

$$(4.8) \quad D(p) = \pi\,(y^{d} - \bar{y}).$$

The extended model is thus given by equations (4.4), (4.5), (4.7), and (4.8); it determines the four endogenous variables: income, y^d, the interest rate, r, the change in the money supply, D(m), and the rate of inflation, D(p) (which has to equal the rate of depreciation, D(s) because of the real exchange rate rule). Details of the solution can be found in Appendix 1, where it is also shown that even this extended model, which takes into account the interaction between goods and financial markets is, in most cases, unstable. 1/ This is again a corollary of the principle mentioned in the introduction: with a real exchange rate rule, there is no anchor for the price level and thus inflation.

VII. An Economy with a Capital Market that is not Integrated with the Rest of the World; The Implications of Sterilization

In none of the examples considered does the possibility of sterilizing the monetary consequences of intervention in the foreign exchange market change the result that prices or inflation will be uncontrollable when following a real exchange rate rule. There is a widespread perception, however, that sterilization might give rise to the possibility of controlling prices in the short run, provided that the degree of capital mobility is not too high. In the following example the validity of this perception is considered in the context of a model in which there is zero capital mobility and hence the maximum scope for sterilization. It is demonstrated that a consistent policy of attempting to offset the monetary implications of intervention in the foreign exchange market for prices or for the money supply gives rise to an instability in the system reflected in either unstable current accounts or foreign assets, leading one to question the sustainability of such a policy. The results are obtained under private sector expectations that are assumed to be consistent with the attainment of policymakers' goals. As such, the results are derived under conditions that are particularly favorable to sterilization being successful. 2/ Due to the complexity of the model assumed, it is easier to work in continuous time and in a deterministic framework than to allow for stochastic elements. The results are general, however, and in qualitative terms can be compared with those of earlier examples.

The structure of the model is the same as in example one in the sense of there being a single domestic good. However, there is also a domestic bond which is not traded internationally and the return on which can move independently of international interest rates. A balance of payments (equals current account) equation is also added to the model;

1/ This conclusion does not depend on the degree of capital mobility or asset substitutability, see Appendix 1.

2/ The results accordingly suggest that it will not be feasible to complement real exchange rate rules with money supply targets.

there are assumed to be no private capital transactions. Using D for the right-hand time derivative operator and with all variables other than interest rates measured in logarithms the model consists of three equations describing the evolution of the endogenous variables (equations (5.1) through (5.3)), and a real exchange rate rule as given by equation (5.4). For ease, no time scripts are used.

$$(5.1)\quad Dp = \Pi[\alpha_0 + \alpha_1(s-p) - \alpha_2(R-Dp^E) + \alpha_3(M-p)) - \bar{y}] + Dp^E \quad \text{--Inflation}$$

$$(5.2)\quad DF = \beta_0 + \beta_1\ (s-p) + \beta_2(R-Dp^E) - \beta_3(M-p) + \rho F \quad \text{--Current Account}$$

$$(5.3)\quad M = \theta C + (1-\theta)F = \lambda_0 - \lambda_1 R + p \qquad \theta\varepsilon(0,1) \quad \text{--Money Supply = Money Demand}$$

$$(5.4)\quad s - p = \text{constant} = 0 \quad \text{--Real Exchange Rate Rule}$$

Equation (5.1) describes a Phillips curve, with deviations of actual from expected inflation depending on the deviation of output from its potential level, which in turn depend positively on the deviation of real exchange rate (s-p) from its equilibrium level, negatively on the deviation of the real interest rate ($R-Dp^E$) from its equilibrium level, and positively on real wealth (m-p) deviations (real money balances). 1/ For simplicity, endogenous output movements are abstracted from; their introduction complicates the model without changing its substantive conclusions. Equation (5.2) describes the current account and hence the evolution of foreign assets held by the monetary authorities, given intervention in the foreign exchange market. The trade account component improves both as competitiveness increases and real interest rates rise; it deteriorates as real wealth (real money balances) increases. The current account also depends on the interest payments on the outstanding net debtor position of the country, ρF. 2/ Finally, equation (5.3) describes equilibrium in the money market and hence in all financial markets, by Walras' law. The domestic money supply (M) is divided between domestic assets (C) and foreign assets (F) held by the monetary authorities. The nominal demand for money is assumed to vary directly with the price level and to fall as the interest rate (on bonds) rises. 3/

1/ It is assumed here that money is the only component of private financial wealth; public bonds are treated as an inside asset (see concluding comments).

2/ Changes in the net debtor position of the country are financed by the issuance of foreign bonds, which are assumed to be traded only between the (domestic) public authorities and foreigners.

3/ For simplicity, output effects in the money demand function are abstracted from.

In a pegged exchange rate regime, the monetary authorities set the nominal exchange rate (S) and domestic credit (C), and let the private sector determine the real exchange rate (S-P) and, through the balance of payments, the money stock. With $S=S_0$ and $C=C_0$ it is straightforward to verify that in the long-run, when $Dp=Dp^E=0=DF$, the real part of the system is independent of nominal variables. A doubling of the exchange rate at a constant stock of domestic credit leads to a doubling of the money supply and the price level, leaving the real exchange rate, the real interest rate, and the nominal interest rate unchanged.

Under a flexible exchange rate regime, the authorities set the money supply and let the nominal exchange rate and price level be determined endogenously, with no change in international reserves. Under this regime, it is straightforward to verify that a doubling of the money supply leads to a doubling of prices and the exchange rate in the long-run, while leaving all real variables unchanged. In fact, in the long-run the authorities can only set either the exchange rate or the money supply independently in this model. Given a level for either of these variables, there is one and only one value for the other, consistent with long-run equilibrium.

But what of the short run when a real exchange rate rule such as given by equation (5.4) is being followed? Is it possible for the monetary authorities to simultaneously peg the real exchange rate (s-p), which requires that they intervene in the exchange market to support whatever nominal exchange rate is forthcoming, while at the same time controlling either the money supply or prices? To consider this question, equation (5.4) specifies that the real exchange rate is held constant, at zero for simplicity. 1/

1. Holding inflation and prices constant while following a real exchange rate rule

To maximize the chances of success for this policy it is assumed that the private sector believes that the policy is feasible; it is assumed, therefore, that the expected inflation rate of the private sector is equal to the target inflation rate of the authorities, which is zero.

Under the conditions of following a real exchange rate rule and trying to hold inflation constant, the authorities have only one instrument: domestic credit. (The nominal exchange rate is linked to the price level to hold the real exchange rate constant.) Domestic credit can influence inflation because it can influence real interest rates and hence the deviation of output from its potential level. By assuming that there

1/ Note that if a real exchange rate rule is followed the level of prices is indeterminate in the long run. If P_0 is a solution for prices, so too is $p_0 + k$, $p_0 + 2k$, etc.

is zero capital mobility and that inflation expectations are constant, the authorities are assumed to have complete leverage over real interest rates.

To determine the implications of the assumed policy rule, set $s-p = Dp = Dp^E = 0$ in equations (5.1) through (5.3), and also set $p = 0$ leading to the following system:

$$(5.1') \quad \alpha_0 - \alpha_2 R + \alpha_3(\Theta C + (1-\Theta)F) = 0$$

$$(5.2') \quad DF = \beta_0 + \beta_2 R - \beta_3(\Theta C + (1-\Theta)F) + \rho F$$

$$(5.3') \quad \Theta C + (1-\Theta)F = \lambda_0 - \lambda_1 R$$

Starting out from a full equilibrium consider the implications of an autonomous fall in the demand for domestic goods at the expense of foreign goods ($d\alpha_0 < 0$, $d\beta_0 > 0$). 1/ Instantaneously, and before foreign assets have time to change through the trade account, the authorities must expand domestic credit to push down real interest rates sufficiently to eliminate deflationary pressure. While it appears that the monetary authorities have succeeded in controlling prices, there are further adjustments. An increased demand for foreign goods, lower real interest rates, and a higher money supply (due to a higher C) serve to deteriorate the trade account leading to a loss of foreign assets. As foreign assets fall, this tends to reduce the money supply and create incipient deflation pressure. In this model, the <u>only</u> way for the authorities to avoid this pressure is for them to sterilize monetary outflows 100 percent: every unit decrease in F is offset by an equal increase in C. By inspecting equations (5.1') through (5.3') the problem with this policy is apparent. 2/ While inflation is kept at zero and the interest rate remains constant, the trade account <u>never</u> moves back into balance. Under these conditions, the authorities are faced with sterilizing a given current account deficit indefinitely; in the process, they will have to buy increasing quantities of bonds. Such a situation is unstable either because the supply of bonds is limited or because foreign exchange reserves eventually go to zero. 3/ Another problem with such a policy

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1/ This disturbance changes the long-run real exchange rate; hence the real exchange rate the authorities are pegging is a disequilibrium one.

2/ See also Appendix 2.

3/ In the case of a shock of opposite sign, foreign exchange reserves might accumulate indefinitely, but in that case the central bank would have to sell increasing amounts of bonds to the public, which the public may be unwilling to acquire.

can be seen by solving equations (5.1') through (5.3') for the current account, i.e., DF. This yields:

$$(5.5)\quad DF = \beta_0 - \beta_3\lambda_0 + [\beta_2+\beta_3\lambda_1][\alpha_0+\alpha_3\lambda_0]\;[\alpha_2+\lambda_1\alpha_3]^{-1} + \rho F$$

This equation shows that the current account deteriorates at an increasing rate because of the effect of interest payments. This result also implies that the authorities do not control the current account if they try to keep the real exchange rate constant and, at the same time, try to control inflation. This is in sharp contrast to one of the purposes of real exchange rules, which is to control the current account. The loss of control over the current account arises in the present context because the current account is not determined exclusively by the real exchange rate and the authorities lose control over the other factors that determine the current account as they try to control simultaneously the price level and the real exchange rate.

2. Holding the money supply constant while following a real exchange rate rule

In the previous example, inflation and prices remain constant while the policy rule is in place. The money supply is initially contracted and it then remains constant. In a regime in which the money supply is always held constant, it is straightforward to verify that the system is again unstable. 1/

Consider a decrease in the demand for domestic goods similar to that assumed above. With reference to equations (5.1) through (5.4) it is apparent that, at the instant of the shock, prices are fixed so that financial equilibrium with a given money supply ties down the interest rate. Prices then start falling over time, tending to lower the nominal demand for money and reduce the trade account by increasing real wealth. With the nominal money stock held constant by means of sterilization, the domestic interest rate tends to fall. While this fall in the interest rate tends to lessen deflationary pressures, it leads to further deteriorations in the trade account and to additional sterilization.

There is no tendency again for the current account to settle down to zero. Price deflation will, however, tend toward zero and in this sense holding the money supply constant stabilizes inflation, apart from temporary deviations. Similar problems as under an inflation target clearly arise with respect to the sustainability of the policy.

1/ With reference to equations (5.1) through (5.3), set $(s-p) = 0$ but instead of setting $DP = 0$, set $m = M_0$. It is still assumed that $DP^E = 0$.

Formally, these points can be seen by solving equations (5.1) through (5.3) for DF and DP, which yields:

(5.6) $DP = \pi[\alpha_0 + \lambda_0[\alpha_3-(\alpha_2/\lambda_1)] + (M_0-p)(\alpha_3+\alpha_2/\lambda_1)]$

(5.7) $DF = \beta_0 + \beta_2\lambda_0/\lambda_1 - (M_0-p)(\beta_3+\beta_2/\lambda_1) + \rho F$

The first equation implies that the price level will eventually settle down to a steady state level. However, the current account is again unstable; as the price level goes toward its steady state level, the trade account deficit goes toward some constant, and interest payments on accumulated deficits then lead to an increasing current account deficit.

The system of equations (5.6) and (5.7) implies again that the authorities have lost control of the current account, although they keep the real exchange constant. By attempting to sterilize the monetary consequences of a real exchange rate rule, they lose control over the factors that influence the current account.

There are, of course, important senses in which the results obtained in these examples are "special" and one would not want therefore to take the specific characteristics of adjustment in each case too seriously. There is a general point already mentioned, however, that transcends the specifics of the model. It is that a policy of following a real exchange rate rule <u>and</u> trying to control money and/or prices is likely to be unsustainable; <u>it</u> will at some point break down. Thus, while it would be possible to question particular characteristics of the model, for example, that there are no wealth effects when there is 100 percent sterilization, 1/ it is easy to demonstrate that if wealth effects due to public bonds <u>do</u> exist that instability appears elsewhere in the system (see Appendix 2). In fact, the existence of wealth effects from sterilization in conjunction with a real exchange rate rule and sterilization often serve to lead to instability in the real interest rate and current account.

The example considered was intended to be the most favorable to following a real exchange rate rule and sterilizing. If one moves in the direction of allowing for some capital mobility and allows expected

1/ This result comes about because real wealth is equal to nominal money divided by prices; public sector interest bearing debt is not regarded as wealth. In the background of the example is a fiscal policy which holds wealth constant as the economy runs current account imbalances. We do not focus on this policy since our primary concern is with the monetary consequences of real exchange rate rules (see Appendix 2).

inflation to vary, both of these factors would tend to reduce the leverage of domestic credit on real interest rates. Both would tend, therefore, to increase the volume of bond sales necessary to influence real interest rates and hence would make the eventual collapse of the policy mix come forward in time. The policy mix is in general unsustainable and in this important sense demonstrates the infeasibility of following a real exchange rate rule and having a money supply or inflation target.

VIII. Concluding Remarks

This paper has examined the consequences of real exchange rate rules for the inflation process in the context of a variety of different models. These models were designed to capture and describe the different ways in which the functioning of economies is affected by stickiness in prices or expectations when real exchange rate rules are followed. All of these models imply that the monetary authorities may no longer be able to control inflation if they set the nominal exchange rate according to a real exchange rate rule; and if the authorities do try to control inflation that they will tend to lose control of another economic variable. This loss of control might not be a cause for serious concern if inflation could be expected to remain moderate or converge to a constant level. But the examples show that real exchange rules also imply that inflation may become highly unstable and that under certain conditions, exploding inflation may result.

The source of this potential instability can best be understood by using the fundamental insight of the monetary approach to the balance of payments; namely, that monetary or exchange rate policies are two equivalent, but mutually exclusive, ways to determine inflation in the long run (Frenkel (1976)). Given the fundamental equivalence between monetary and exchange rate policy, a real exchange rate rule is essentially a policy of full monetary accommodation: any shock to the price level is "validated" 100 percent through the exchange rate and via the balance of payments, through the money supply.

It might be objected that this accommodation is not immediate because the feedback from the exchange rate to the money supply is given by the balance of payments which might react only slowly to exchange rate movements. But, the speed of the feedback from the exchange rate to money, via the balance of payments, is an empirical question which was not addressed in this paper. Recent developments in some of the countries that follow real exchange rate rules suggest, however, that very high inflation rates might appear even within relatively short periods of time.

Apart from the question of how fast the potential instability manifests itself in actual inflation rates, it has also been argued that the authorities might neutralize all feedback through the balance of payments by a policy of sterilized intervention. Since it is generally recognized that sterilized intervention is not a viable long-run policy, such a policy is possible only for the short run; but it has been suggested that this short run might be long enough for practical purposes. However, the second example presented suggests that sterilized intervention may have no effect on inflation even in the short run. In the context of this example, sterilized intervention would produce only a temporary monetary disequilibrium without having any effect on inflation in the short or long run. The fifth example suggested that successful sterilization might lead to instability in variables other than prices.

The conclusion of the paper can therefore be restated as follows: widely accepted principles about the general long-run properties of economies imply that under a real exchange rate rule the authorities no longer control the price level and inflation might become unstable. Recent events in some countries that have adopted real exchange rate rules suggest that the potential instability in inflation might manifest itself rapidly; indeed the concerns raised by these developments are the main impetus for this initial appraisal of the consequences of real exchange rate rules.

The building blocks of the extended model of the fourth section are reproduced below:

(A1) $D(m) = \beta(r-r^*-D(p)) + p$

(A2) $m = \alpha\bar{q} - \epsilon D(p) - \lambda r + \psi y^d$

(A3) $y^d = \gamma\bar{y} - \sigma(r-D(p))$

(A4) $D(p) = \pi(y^d-\bar{y})$

In this system, D(s) does not appear because the exchange rate policy implies D(s) = D(p). To analyze the stability of the inflationary process under these conditions, it is necessary to reduce this system of equations to two differential equations in *m and p*. This will be done first. Equations (A3) and (A4) can be used to solve for the interest rate, r, which yields:

(A5) $r = \frac{\gamma-1}{\sigma}\ \bar{y} + D(p)\ [(\sigma\pi-1)/\pi\sigma]$

This equation can be used to eliminate r from equation (A1); this yields:

(A6) $D(m) + \beta[(\pi\sigma-1)/\pi\sigma]\ D(p) - p = \beta(\bar{y}(\gamma-1)/\sigma - r^*)$

This is the first differential equation of the system; to obtain the second equation (A5) and (A3) can be used in equation (A2):

(A7) $m - [\psi/\pi - \varepsilon - \lambda((\pi\sigma-1)/\pi\sigma)] - p = \bar{q} + \bar{y}\ [\psi - \lambda(\gamma-1)/\sigma]$

Denoting the constant terms in equations (A6) and (A7) by C6 and C7, respectively, this system can be written more compactly as:

(A8) $$\begin{pmatrix} D \\ 1 \end{pmatrix} \begin{pmatrix} D\ \ \beta\left(\frac{\pi\sigma-1}{\pi\sigma}\right)\ -1 & m \\ \left[\frac{\psi}{\pi}\ \ \varepsilon - \lambda\ \left(\frac{\pi\sigma-1}{\pi\sigma}\right)\right]\ -1 & p \end{pmatrix} = \begin{pmatrix} C6 \\ C7 \end{pmatrix}$$

The roots of the system are determined by:

$$\text{(A9)} \quad D^2 \left[\frac{\psi}{\pi} - \varepsilon - \lambda\left(\frac{\pi\sigma-1}{\sigma}\right)\right] + D\left[1 + \beta\left(\frac{\pi\sigma-1}{\pi\sigma}\right)\right] - 1 = 0.$$

Since this system involves two predetermined variables, p and m, it is unstable even if only one root is positive. It follows that if $y[\psi/\pi - \varepsilon - \lambda(\pi\sigma-1)/\pi\sigma] > 0$ the system is unstable because the negative constant term in equation (A9) implies that there have to be two distinct real roots, one negative and one positive. However, if $[\psi/\pi - \varepsilon - \lambda(\pi\sigma-1)/\pi\sigma] < 0$, the system would still be unstable if $[1 + p(\pi\sigma-1)\pi\sigma] > 0$. This implies that as long as $\psi/\pi - \varepsilon \geq 0$, the system is always unstable. (A sufficient condition for this would be that $\varepsilon = 0$, i.e., that money demand depends only on the interest rate and not on inflation.) Note that the stability of the system does not depend on the degree of capital mobility.

The model of example five consists of three equations that can in general be written as:

$$DP = \underset{+}{f}\,(\underset{+}{r},\ \underset{+}{m},\ \underset{-}{R},\ \underset{+}{\alpha})$$

$$DF = g\,(\underset{+}{r},\ \underset{-}{m},\ \underset{+}{R},\ \underset{-}{\beta})$$

$$R = h\,(\underset{-}{m})$$

Expected inflation has been set equal to zero; m is equal to real money balances $(\frac{C + F}{P})$; r is the real exchange rate (S/P), and α and β are shift parameters. The real variables of this system (M, r, R) are independent of nominal variables in the full equilibrium when DP = DF = 0. For simplicity, we abstract in this appendix from the interest payments component of the current account.

The full equilibrium can be written as:

$$(1)\quad r = r\,(\alpha,\ \beta)$$

$$m = m\,(\alpha,\ \beta)$$

$$R = R\,(\alpha,\ \beta)$$

This equilibrium is assumed to exist and to be unique. Nominal variables in the full equilibrium are determined by noting that since real variables depend only on real variables, changes in nominal variables from one full equilibrium to the next satisfy

$$(2)\quad \theta\,\tilde{C} + (1-\theta)\tilde{F} = \tilde{M} = \tilde{P} = \tilde{S}$$

Under a pegged nominal exchange rate regime, the authorities determine $\tilde{S}$ and $\tilde{C}$. From equation (2), this is clearly sufficient to determine $\tilde{P}$, $\tilde{M}$, and $\tilde{F}$. Under a flexible exchange rate regime, the authorities set $\tilde{M}$ (with $\tilde{F}$=0). From equation (2), this is sufficient to determine $\tilde{P}$ and $\tilde{S}$.

Under a real exchange rate rule, the authorities typically set only the nominal variable $\tilde{C}$. From equation (2) this is not sufficient to determine $\tilde{M}$, $\tilde{F}$, $\tilde{S}$, and $\tilde{P}$.

Note that this indeterminacy arises in the long run, independently of the degree of capital mobility. In the present model, there is zero capital mobility. Two problems potentially arise with the real exchange rate rule: (i) it does not tie down prices and the nominal money supply in the long run; and (ii) the real rate that is pegged (r_0) may differ from the full equilibrium rate as given by equation (1), implying that no long-run equilibrium exists.

The examples in the text consider whether the authorities can follow a sustained policy of pegging the real exchange rate and sterilizing. Here, in turn, we demonstrate three propositions referred to in the text.

1. In the absence of a real exchange rate rule, the model is stable and nominal variables are controlled either by the authorities setting M or S (but not both).

Without a real exchange rate rule, the dynamics of the system are found by substituting r, m, and R into the first equation to give, in deviations from equilibrium

$$Dp = Dp\,(\underset{(-)}{(p - \bar{p})},\ \underset{(+)}{(F - \bar{F})})$$

$$DF = DF\,(\underset{(?)}{(p - \bar{p})},\ \underset{(-)}{(F - \bar{F})})$$

The only ambiguity here concerns the impact of prices on the trade account; higher prices reduce competitiveness, worsening the trade account but at the same time they tend to improve the trade account by reducing real wealth.

If the competitiveness effect dominates, the system is unambiguously stable. The determinant of the above system is positive and its trace is negative. A real equilibrium such as that described by equation (1) is reached and through the arguments stated earlier, nominal variables are determined if either M or S is tied down.

2. With a real exchange rate rule, long-run equilibrium does not exist unless the real exchange rate that is set by the authorities equals its equilibrium value. Regardless of whether the real rate is in equilibrium, the price level is indeterminate under a real exchange rate rule and a domestic credit target.

The first part of this proposition comes from equation (1)--given α and β, there are by assumption unique values of M and r associated with them.

Nominal indeterminancy arises, as noted above, because fixing domestic credit and having a real exchange rate target does not determine prices.

Consider the stability of the system under a real exchange rate rule. In linear form, the equations can be written:

$$Dp = a\,([F - \overline{F}] - [P - \overline{P}])$$

$$DF = b\,([F - \overline{F}] - [P - \overline{P}])$$

where a and b are composite coefficients. The determinant of this system is negative; in (p, F) space, the Dp = Df = 0 lines have a 45 degree slope. Neither prices nor foreign assets are determined.

3. If the authorities hold the money supply constant by sterilizing foreign assets (dC + dF = 0), the system continues to be unstable under a real exchange rate rule. With the money supply constant, the equations of the system can be written:

$$DP = -\alpha\,(P - \overline{P})$$

$$DF = \beta\,(P - \overline{P})$$

Since the DF equation no longer includes F as an argument, the instability problems alluded to in the text arise; the current account does not settle down to balance. Note that we abstract here from the interest payments components of the current account; when this is included, as in the text, the current account may change at an increasing rate.

4. As referenced in the text, when public bonds are assumed to be a component of private sector wealth, the instabilities associated with following a real exchange rate rule and holding prices constant in general may be reflected in instability in some variable other than the current account. To illustrate this possibility, consider briefly the following model, where prices are assumed to be held constant by open market operations, while the real exchange rate is held constant by intervening in the foreign exchange market.

$$DF = a_1R - a_2(C+F+B) + a_o$$

$$DP = 0 = -b_1R + b_2(C+F+B) + b_o$$

$$R = -h_1(C+F) + h_2B + h_o$$

For simplicity, prices have been set to zero and B denotes private sector holdings of public bonds. The stability of this system can be considered under conditions when open market operations ($dC+dB=0$) ensure that prices remain constant while intervention in the foreign exchange market gives rise to $DF \neq 0$. Expressing the above equations in deviation from equilibrium form, we obtain one expression for the current account and another for domestic credit (ignoring constants):

$$DF = \left\{ \frac{a_1b_2}{b_1} - a_2 \right\} F'$$

$$dC' = - \frac{\left(1 + \frac{h_1b_1}{b_2}\right)}{(h_1+h_2)} \cdot \frac{b_2}{b_1} dF'$$

where a prime indicates a deviation from equilibrium. From the first equation, it is apparent that the trade account is not necessarily stable under the assumed policy mix. The reason for this is clear: the need to hold prices constant calls for the authorities to lower interest rates whenever the trade account is in deficit so as to prevent lower wealth leading to deflation; lower interest rates can lead to the trade account deficit never disappearing. Note from the second equation that if the trade account is unstable this will lead to instability in domestic credit and, from the monetary equilibrium condition, to instability in the interest rate. This example does not imply that it is impossible to hold the real exchange rate constant and have a price level or inflation target; only that one will not in general be assured of being able to achieve these objectives simultaneously.

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