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THE EXCHANGE RATE AND THE BALANCE OF PAYMENTS IN THE SHORT RUN AND IN THE LONG RUN: A MONETARY APPROACH

by

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I. Introduction

This paper develops a simple dynamic model of the determination of the exchange rate in the short run and in the long run. The model is an extension, to the regime of flexible exchange rates, of the monetary approach to balance of payments and devaluation.[1] It goes beyond the recent contributions of Dornbusch (1976), Genberg and Kierzkowksi (1975) and others by analyzing explicitly the dynamic interaction between the exchange rate, exchange rate expectations, and the balance of payments under the regime of a freely floating exchange rate, and under alternative assumptions about the formation of expectations using an approach similar to Black's (1973).

The essence of the monetary, or asset market, approach to exchange rates adopted in this paper is that the exchange rate, as a relative price of monies, is viewed as one of the prices that equilibrates the international markets for various financial assets. Therefore, to explain the behavior of exchange rates, one has to examine the behavior of the supplies of various monies and other financial assets, as well as the behavior of the demands for these assets. This is in contrast to the traditional approach to flexible exchange rates which focuses on the behavior of imports and exports and of capital flows between countries. The distinction is similar to that between the liquidity preference theory of interest on the one hand, and the flow of loanable funds theory on the other.

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1) Some of the most relevant references are Johnson (1958, 1973, 1975), Mundell (1968, 1971), Dornbusch (1973, 1974), Frenkel (1971), Frenkel and Rodriguez (1975), Kemp (1968), Krueger (1974), Negishi (1968), Mussa (1974), Pearce (1961), Polak (1958), Prais (1960), and Samuelson (1971). Some of these references are collected in Frenkel and Johnson (1976). This paper also draws on the portfolio balance models of McKinnon and Oates (1966), and McKinnon (1969). More recent contributions in this strand of literature include Branson (1974), Brunner and Meltzer (1974), and Myhrman (1975).

It should be emphasized that the choice between the stock approach and the flow approach is partly an empirical matter. In the stock approach it is assumed that financial markets equilibrate very fast. Transactions costs are so small that one may assume that financial assets are always held in desired proportions. For example, if a market participant has too many sterling assets in his portfolio, he can in a very short time exchange these assets for dollar assets. For a large segment of the international short-term money market, this is probably a reasonable simplifying assumption. Revisions of existing portfolios are much larger in size than marginal additions to asset demand from new savings.

In contrast, in the flow approach it is assumed that transaction costs prohibit instantaneous adjustments of portfolios. Financial markets are equilibrated only 'in the margin'. Thus the exchange rate is determined to equilibrate the flow supply of (demand for) foreign exchange from a current account surplus (deficit) with the net desired additions (subtractions) of foreign assets by holders of financial assets. The choice between the two approaches is to this extent an empirical question.

However, it is often assumed in the literature that portfolio equilibrium obtains instantaneously and yet the exchange rate is viewed as a price that equilibrates the balance-of-payments flows. This is shown to involve two logical problems. First, in general, the balance-of-payments flow account is no more than an *ex-post identity* which in no sense can be interpreted as an *ex-ante equilibrium condition*. This is because with the assumption of continuous portfolio equilibrium one cannot define market demand equations in terms of changes in desired asset holdings. It is shown that the expected, or planned, change in the stock of foreign assets equals the realized *ex-post* change only if expectations are correct. In the case of perfect foresight, the balance-of-payments flow account is shown to define a second-order differential equation in the exchange rate, which must be satisfied along a perfect foresight adjustment path. However, there is an infinite number (in

fact, a continuum) of such exchange rate paths, so that the balance-of-payments flow account is not sufficient to determine the behavior of the exchange rate.

In order to sharpen the analysis of these issues, a number of simplifying assumptions are made in the paper. First, it is assumed that the economy is small and produces only internationally traded goods. Secondly, prices and wages are assumed to be flexible, so that the labor force is always fully employed. Thirdly, the structure of financial markets is very rudimentary. The only two assets are domestic paper currency and foreign money. There is no accumulation of real capital, nor any equity claims on real capital. Simple as the model is, it still enables one to analyze a number of interesting problems.

One of these is a reformulation of the problem of the stability of the exchange rate. Since the exchange rate is viewed as a relative price of two financial assets, the critical determinants of stability are connected with asset substitution effects and the nature of expectations formation, rather than relative price elasticities of exports and imports.

In this connection the assumption of perfect foresight or rational expectations, which is often made in the analysis of foreign exchange markets, is shown to imply a basic indeterminacy of the exchange rate familiar from similar problems in other areas of economics. From any initial exchange rate there is a path along which markets are in equilibrium and expectations are continously fullfilled. Only one of these paths is such that the rate of change in the exchange rate will approach a constant (if the rate of monetary expansion is constant). In order for this path to be chosen, it must be assumed that speculators have *long-run foresight* and rule out the possibilities of both hyperinflation and hyperdeflation.

Another problem investigated in this paper is the nature of the adjustment path, and the link between the short-run momentary equilibrium and the long-run stationary state. There presently exists a gap in the literature between the portfolio balance, stationary-state models, and the short-run models

which take the asset supplies and expectations as given. In general, the short-run impact of policies can be quite different from the long-run impact depending on the nature of the expectations. It is shown that this dilemma can be resolved by assuming long-run foresight. In that case, the long-run impact on the *exchange rate and asset supplies* correctly predicts the short-run impact on the *exchange rate and the balance of payments*.

The plan of this paper is as follows. Section II develops the concept of a momentary equilibrium and analyzes the short-run effects of various shifts on the current account and the exchange rate with given exchange rate expectations. This section also compares the stock model of the exchange rate with the flow model. Section III analyzes the long-run effects of the same shifts on the stationary state in which the current account is in balance, asset supplies constant, and exchange rate expectations correct. Section IV analyzes the problem of the dynamic stability of the exchange rate and the balance of payments under alternative assumptions about the formation of expectations. Dynamic stability is defined as the convergence of the sequence of momentary equilibria to the stationary state. Section V analyzes the dynamic response of the exchange rate and the balance of payments to various shocks, thereby connecting the short-run analysis of Section II with the stationary-state analysis of Section III. The concluding part discusses the limitations and needed extensions of the simple model developed in this paper, as well as the implications of the new approach that go beyond this or any other particular model.

II. Momentary Equilibrium

In this section we develop the concept of a momentary equilibrium and analyze the short run effects of various shocks on the exchange rate and on the balance of payments. To simplify the analysis, we assume that the economy produces only traded goods the relative price of which is fixed in the world market. We also assume that the world price level is constant and equal to one so

that the domestic price level and the rate of exchange are the same thing. Labor is the only factor of production and it is fully employed. Domestic output (Y) is therefore constant. Domestic absorption is equal to the sum of private consumption (C) and government expenditure (G). Private consumption is a function of real disposable labor income (Y-T) and the stock of real financial wealth (A) in accordance with Modigliani's life cycle model of consumption.[2] The excess of domestic output over domestic absorption equals the trade account surplus:[3]

$$B = Y - C\,(Y - T,\ A) - G \tag{1}$$

The stock of financial wealth consists of domestic money (M) and foreign assets (F):

$$A = \frac{M}{P} + F \tag{2}$$

The demand for real balances is a function of the expected rate of inflation (exchange rate depreciation), π, the level of real income and the stock of wealth. Since we assume that foreigners do not hold domestic paper currency, in equilibrium the domestic demand for money equals the supply of money:

$$\frac{M^d}{P} = L(\pi,\ Y,\ A) = \frac{M}{P} \tag{3}$$

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2) Dornbusch (1973) uses an alternative formulation. In his model, money is the only store of value. He assumes that the flow of *saving* is a function of the discrepancy between the long-run demand for real balances and the current stock of real balances. This approach is identical to ours with a fixed exchange rate but has different implications if the price level is changing: it implies that investors stabilize saving and let capital gains and losses be reflected on consumption. This is both implausible and at variance with empirical evidence.

3) The equality of the excess of domestic absorption over domestic output and the current account deficit is the essence of the absorption approach to the balance of payments. See Alexander (1952) and Johnson (1958) for a discussion of this approach. Dornbusch (1973) and Mussa (1974) emphasize the similarity between the monetary approach and the absorption approach in the process of adjustment. The link between the two approaches disappears, however, once there are other assets. The excess of income over absorption represents a change in wealth, and not necessarily a change in the holdings of money balances.

The other equilibrium condition is that the demand for foreign assets equals the stock of foreign assets:

$$F^d = F(\pi, Y, A) = F \tag{4}$$

Because of the wealth constraint only one of equations (3) and (4) is independent. Substituting the definition of real wealth in equation (3) we obtain the equilibrium condition for the asset markets:

$$L(\pi, Y, \frac{M}{P} + F) = \frac{M}{P} \tag{5}$$

Given the expected rate of depreciation (π), the stock of foreign assets (F) and the nominal supply of money (M), *this condition of equilibrium in the asset markets determines the exchange rate.* Equally well we could say that the exchange rate is determined to *equilibrate the demand for foreign assets with the existing stock of foreign assets.*[4]

We may solve equations (5) and (3) for the reduced form real balance and wealth equations:

$$\overline{M} = \frac{M}{P} = \underset{(-)\,(+)\,(+)}{H(\pi, Y, F)} \tag{6.1}$$

$$A = \underset{(-)\,(+)\,(+)}{A(\pi, Y, F)} \tag{6.2}$$

An increase in the expected rate of depreciation reduces the stock of real balances and hence the real value of financial wealth by causing the exchange rate to depreciate.

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4) This strong separation obtains only because we assume a small open economy producing only traded goods. In a two country model or in a model with non-traded goods, the asset market equilibrium and the commodity market equilibrium are determined simultaneously so that it would be incorrect to say that the exchange rate is determined only in the asset markets, since it depends on the relative prices of commodities which are determined simultaneously with the exchange rate.
But even in the more general case, it is incorrect to say that the exchange rate is determined to equilibrate the balance of payments flows.

In order to complete the model we need to introduce the government budget equation and the behaviour of the money supply. For convenience, we assume that the Central Bank acquires all government debt, and does not intervene continuously in the foreign exchange market. Therefore, the nominal budget deficit is equal to the change in the supply of money. The government can independently determine only two of the variables under its control: real tax revenue (T), real expenditure (G), and the change in the money stock ($\dot{\frac{M}{P}}$). We assume that it fixes the rate of change in the nominal money stock (m) and the real tax revenue, and adjusts real expenditure accordingly. This gives us the government expenditure function:

$$G = \bar{T} + m\frac{M}{P} \tag{7}$$

An increase in the price level reduces the real value of new debt issue and hence government expenditure. Substituting equation (7) into equation (1) together with the definition of real wealth we obtain *the capital flow or current account equation:*

$$\dot{F} = B = Y - C(Y - T, \frac{M}{P} + F) - T - m\frac{M}{P} = \underset{(+)\ (-)\ (-)\ (+)\ (-)}{B(Y,\ T,\ F,\ \pi,\ M)} \tag{8}$$

We assume that the rate of interest on foreign assets is equal to zero.

The last expression is the reduced form current account (capital flow) equation, obtained by substituting the reduced form real balance equation in place of $\frac{M}{P}$. An increase in real income increases the current account surplus as long as the marginal propensity to consume out of income -- after allowing for the effect of income on the real value of financial wealth -- is less than one. We assume this to be the case. A tax financed increase in government expenditure reduces the current account surplus, as long as

the private propensity to consume is less than one. An increase in the stock of foreign assets increases consumption and hence reduces the current account surplus. An increase in the expected rate of depreciation reduces the real value of financial wealth and hence improves the current account. An increase in the rate of growth of the money stock increases government expenditure and hence reduces the current account surplus.

Equations (5) and (8) constitute the temporary equilibrium model. Equations (6.1 and 6.2) and the right hand side of equation (8) define the endogeneous variables as functions of the current stocks of assets and expectations regarding the future.

a. The Flow Model of the Foreign Exchange Market

The literature on the foreign exchange market typically starts from the *ex-post* balance-of-payments identity:[5]

$$\text{current account} + \text{capital account} = B - \dot{F} = 0 \qquad (9)$$

The problem with this approach is that in general this accounting identity has no meaning as an *ex-ante* equilibrium condition. The reason is that with the assumption of a continuous portfolio equilibrium one cannot define 'flow demand equations' for individual assets. At each instant, investors choose the composition of their wealth and the rate of consumption. The change in the real value of wealth is then equal to the sum of new savings ($S = Y - T - C = \frac{\dot{M}}{P} + \dot{F}$ in the model) and the change in the valuation of existing assets ($-\frac{M}{P}\frac{\dot{P}}{P}$ in the model). The latter is not known to the investors in advance unless they have perfect foresight. Therefore, they cannot determine *ex ante* the change in the real value

5) A classic reference on the traditional theory of foreign exchange market is Robinson (1949). For representative modern discussions, see Kindleberger (1973, Chapter 17), Sohmen (1969, especially Chapter 1), and Stern (1973, Chapter 2).

of wealth, or of the various components of wealth.

One could define the *planned* change in the stock of foreign assets (*ex-ante* capital flow equation) as:

$$\dot{F}^d = F_\pi \dot{\pi} + F_A \dot{A}^e = F_\pi \dot{\pi} + F_A S - F_A \frac{M}{P} \pi \qquad (10)$$

The first term ($F_\pi \dot{\pi}$) represents the *'stock shift'* induced by the change in the expected return on domestic assets. The second term ($F_A \dot{A}^e$)) is the *flow component* of capital movements representing the proportion of expected new savings allocated to foreign assets.[6] Intuitively, equation (4) tells how much the investors expect their foreign asset position to change *ex-ante* in the next instant. The realized change in the stock of foreign assets is:

$$\dot{F} = F_\pi \dot{\pi} + F_A \dot{A} = F_\pi \dot{\pi} + F_A S - F_A \frac{M}{P} \frac{\dot{P}}{P} \qquad (11)$$

The difference between the planned (*ex-ante*) change in the stock of foreign assets on the one hand and the realized (*ex-post*) change on the other is then:

$$\dot{F}^d - \dot{F} = F_A \frac{M}{P} \left(\frac{\dot{P}}{P} - \pi\right) \qquad (12)$$

It is only if expectations are always correct that the two are equal.[7]

Even if there is perfect foresight so that $\dot{F}$ and $\dot{F}^d$ are equal, there is no way in which the balance-of-payments identity can be interpreted as an equilibrium condition which determines, *ceteris paribus*, the exchange rate. To see

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6) In discussing the extension of the portfolio model of an open economy to the regimes of flexible exchange rates, Branson (1974) in essence substitutes $\dot{F}^d$ in the balance-of-payments identity and allows "...the foreign exchange market to determine the exchange rate so that the balance of payments ... is equal to zero" (Branson, *op.cit.*, p. 47). He recognizes the problems with this approach but leaves them unresolved. Mundell's famous article on flexible exchange rates (1968, Ch. 18) avoids the stock-flow problem by assuming 'perfect capital mobility' in which case any surplus of deficit in the current account is always financed by capital inflow or outflow at a fixed interest rate.

7) For an excellent discussion of the distinction between stock and flow models in monetary analysis, see Foley (1975). He shows in a more general model that the assumption of stock equilibrium and the assumption of perfect foresight imply flow equilibrium, and that the assumption of simultaneous stock and flow equilibrium implies perfect foresight.

this, observe that the current account can be written as:

$$B = Y - C - G = S - m\frac{M}{P}\,, \tag{13}$$

where the government's budget constraint has been used. Substituting this and $\dot{F}^d$ from equation (10) into the balance-of-payments equations (9), and using the fact that F_π equals $-L_\pi$, and F_A equals $1 - L_A$ because of the balance sheet constraint, we can rewrite the balance-or-payments equation as:[8]

$$L_\pi\,\dot{\pi} + L_A\,\dot{A} = (M - \frac{\dot{P}}{P})\,\frac{M}{P} = (\frac{\dot{M}}{P}) \tag{14}$$

But this is nothing more than the stock equilibrium condition (5) differentiated with respect to time. With perfect foresight $\dot{\pi}$ is equal to $\frac{\ddot{P}}{P}$ so that equation (14) defines a second-order differential equation that any equilibrium path of the exchange rate must satisfy. The problem is that there are an infinite number (in fact, a continuum) of such paths so that the balance-of-payments 'equilibrium condition' is not sufficient to determine the behavior of the exchange rate (see section IV (b) below).

It is possible to reformulate the flow model of the foreign exchange market in a logically correct way by dropping the assumption of instantaneous portfolio equilibrium and instead specifying functions for the desired changes in the stocks of foreign assets and real money balances. A rigorous formulation of such a model involves a number of difficult problems which are, however, beyond the scope of this paper.[9]

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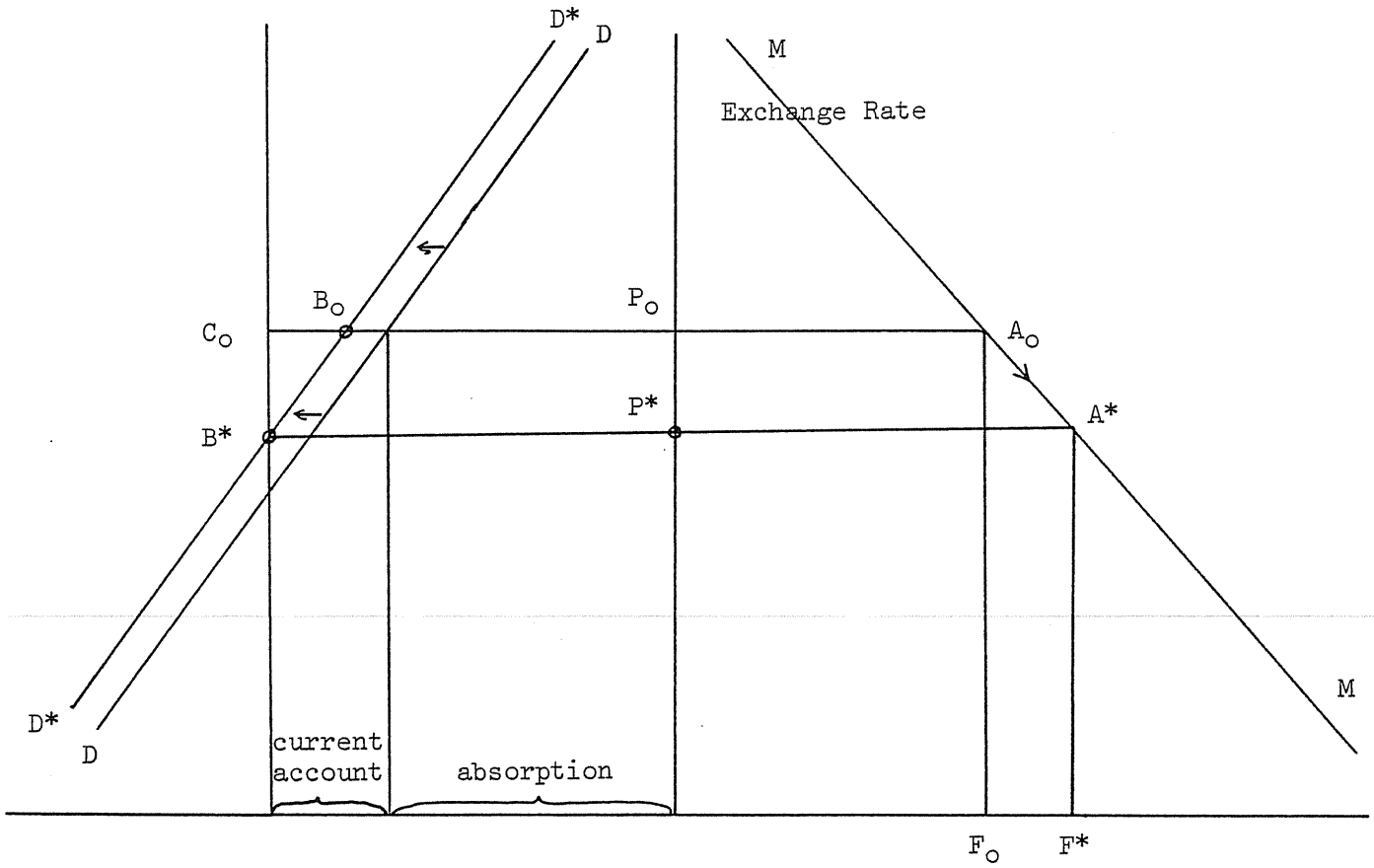
8) From equation (10), $\dot{F}^d = F_\pi\,\dot{\pi} + F_A\,S - F_A\frac{M}{P}\,\pi = F_\pi\,\dot{\pi} + F_A\,S - F_A\frac{M}{P}\frac{\dot{P}}{P}$, because of the assumption of perfect foresight. Setting $\dot{F}^d$ equal to B, we obtain equation (14).

9) For a good discussion of these problems, see Foley (1975).

Diagram I

The Short-Run Determination of the

Exchange Rate and the Current Account



b. The Determination of the Exchange Rate and the Balance of Payments in the Short Run

The short run determination of the exchange rate and the current account is illustrated by diagram I. The MM curve implies equilibrium in the asset markets. The DD curve (defined by equation (10)) gives domestic absorption as a function of the exchange rate. If the initial stock of foreign assets held by the private sector is F_o, the momentary equilibrium value of the exchange rate is P_o. At that exchange rate, domestic absorption equals P_oB_o which is less than domestic output so that the current account is in surplus. Therefore, the economy will not stay in this momentary equilibrium position: with static expectations the economy moves to the right along the MM schedule. In consequence, the exchange rate appreciates, which, together with the increasing stock of foreign assets, increases domestic absorption until *stationary state equilibrium* is reached with zero current account balance and a constant stock of wealth. A stationary state obtains in the diagram when the stock of foreign assets equals F*, the exchange rate is P* and the D*D* schedule intersects the supply curve at that exchange rate. (We assume here for expositional convenience that the nominal money stock is constant).

Diagram II

The Short Run Effects of Stock and Flow Shifts

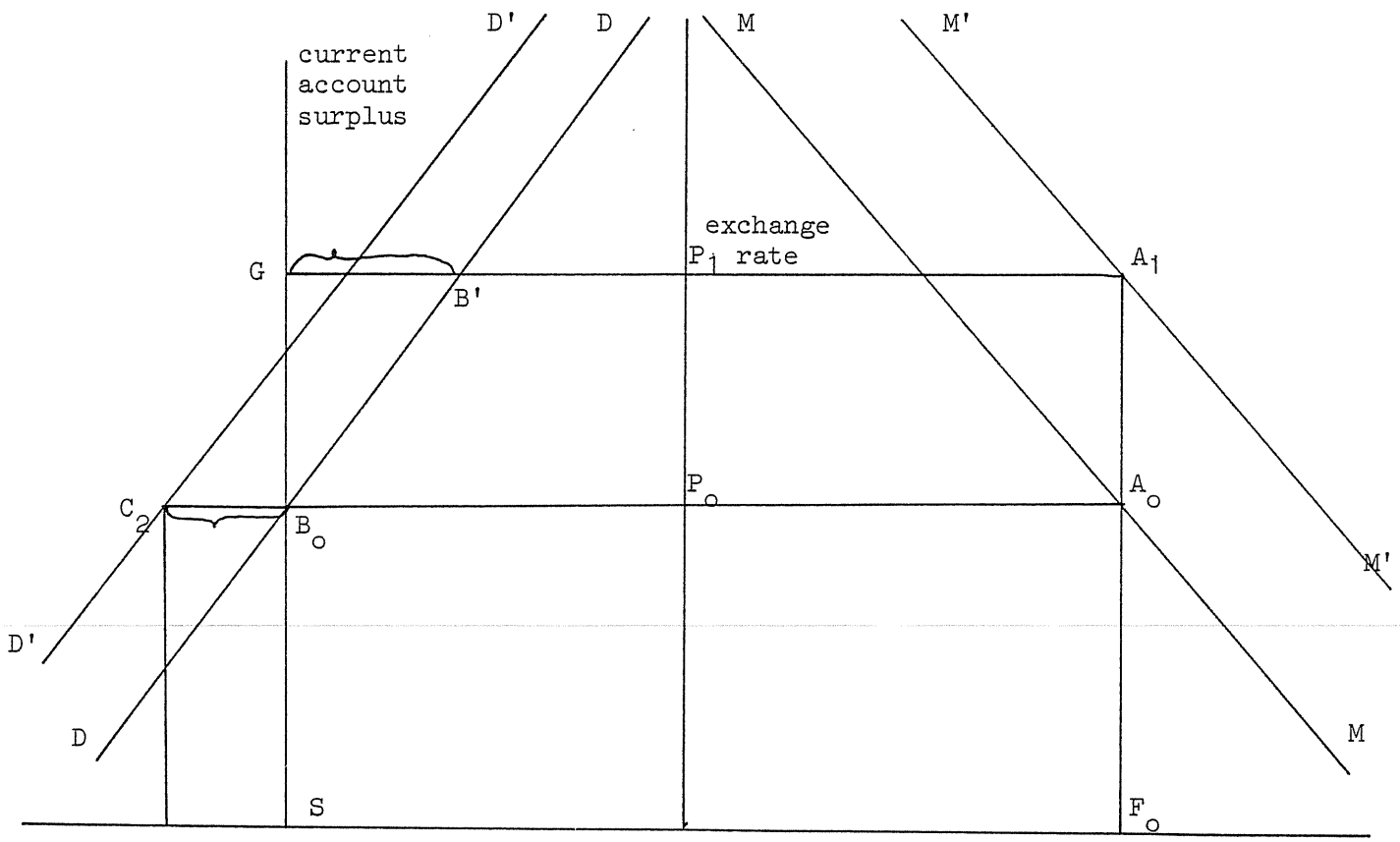


Diagram II illustrates the response of the momentary equilibrium exchange rate and the current account to two types of shifts: (i) an increase in the expected rate of depreciation (a stock shift). This causes an increase in the 'desire to lend abroad' (cf. J. Robinson (1949), Section II), without directly affecting domestic absorption. The MM curve shifts to the right causing the exchange rate to depreciate. The depreciation causes the current account to move to a surplus (C_1B_1 in the diagram). This surplus gradually increases the stock of foreign assets which tends to appreciate the exchange rate and cause the current account surplus to diminish. The complete dynamic analysis of this adjustment process with explicit treatment of expectations will be taken up in Section V below and analysis of the ultimate stationary state effects in Section III. (ii) A tax financed increase in government expenditure (*a flow shift*, cf. J. Robinson (1949), Section III) shifts the DD schedule to the left but, *ceteris paribus*, leaves the MM schedule unchanged. Therefore, the exchange rate remains unchanged and the current account moves to a deficit. The current account deficit reduces the stock of foreign assets, which causes the exchange rate to depreciate. Both of these effects reduce private absorption and gradually bring the economy to stationary equilibrium with a zero current account.

Thus with stationary expectations a *shift in absorption that does not affect asset demands has no effect on the exchange rate in the short run*. We shall see later that if expectations are rational, the anticipated future effects induced by the current account deficits will be reflected on the current exchange rate (see Section V below).

Diagram III illustrates the short-run effects of Central Bank intervention in the foreign exchange market. The economy starts from a position of full equilibrium at A_o with stock of foreign assets F_o and exchange rate P_o. The Central Bank suddenly purchases $F_o'F_o$ of foreign exchange from the private sector with domestic money. The private sector's initial foreign asset position reduces to F_o' and the MM curve shifts upwards to M'M'. The exchange rate jumps to P_o'. The sharp reduction in real financial wealth causes the current account to go to a surplus ($B_o'C_o'$ in the diagram). The surplus begins to move the economy back to a new stationary state equilibrium position. It is shown in the next section that in the new long run equilibrium position the private sector's stock of foreign assets is the same as it was initially. All that happens is that the exchange rate depreciates by exactly the same proportion that the money supply is initially increased. Note that *the exchange rate initially depreciates more than in proportion to the increase in the supply of money.* Subsequently, the rate appreciates down to its long run equilibrium level. One may view the impact effect of foreign exchange market intervention as a capital levy on money balances -- much in the same way as devaluation.[10]

III. The Stationary State

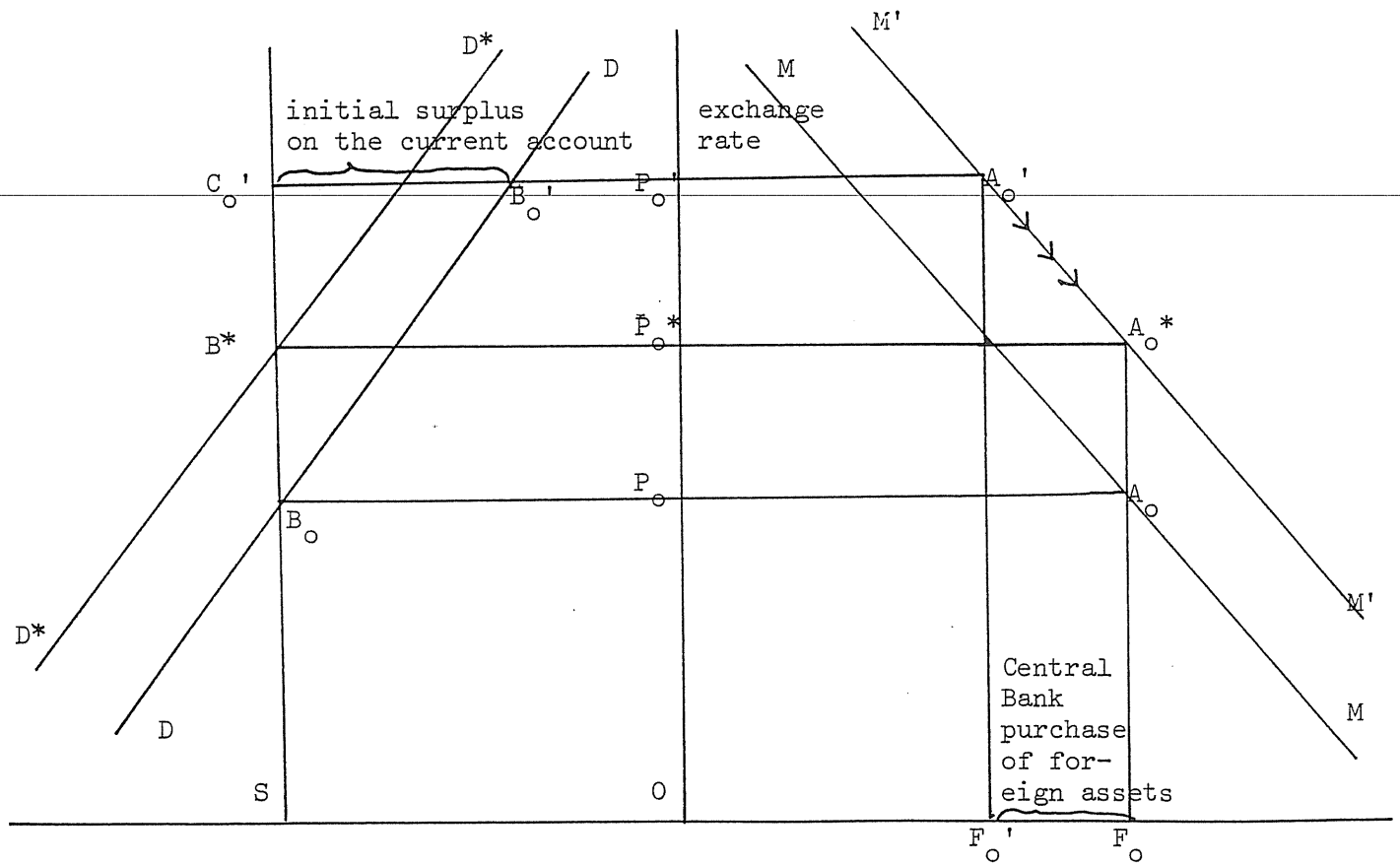
In this section we investigate the long run effects of various shifts. The dynamic adjustment path from the short-run momentary equilibrium to the long-run stationary state is analyzed in Section

10) Cf. Dornbusch (1973).

Diagram III

Short Run Effects of Central Bank Intervention

in the Foreign Exchange Market



V. In the stationary state, the stock of real wealth and its composition is constant, all nominal variables grow at the same rate and the expected rate of inflation equals the actual rate of inflation and hence the rate of change in the money stock.[11]

The constancy of real wealth requires that the current account is equal to zero:

$$C(Y - T, \bar{M} + F) + T + \pi \bar{M} = Y \text{ (cf. equation 8)} \quad (15)$$

Equation (15) defines the locus of $\bar{M}$ and F that implies balance of payments equilibrium. It is illustrated by the BB schedule in diagram IV. The schedule is downward sloping -- for the trade account to remain in zero balance when the stock of foreign assets increases, the stock of real balances must fall to prevent an increase in absorption.

The second stationary state equilibrium condition requires that the stock of wealth is held in desired proportions:

$$L(\pi, Y, \bar{M} + F) = \bar{M} \text{ (cf. equation 5).} \quad (16)$$

The description of the stationary state is complete once we observe that the expected rate of inflation (π) equals the actual rate of inflation ($\frac{\dot{P}}{P}$), which in turn equals the rate of growth in the money stock (m):

$$\pi = \frac{\dot{P}}{P} = m \quad (17)$$

The locus of the stocks of foreign assets and real balances that are consistent with portfolio equilibrium is illustrated by the MM schedule in diagram IV (cf. diagram I). It is upward sloping because an increase in the stock of foreign assets increases the

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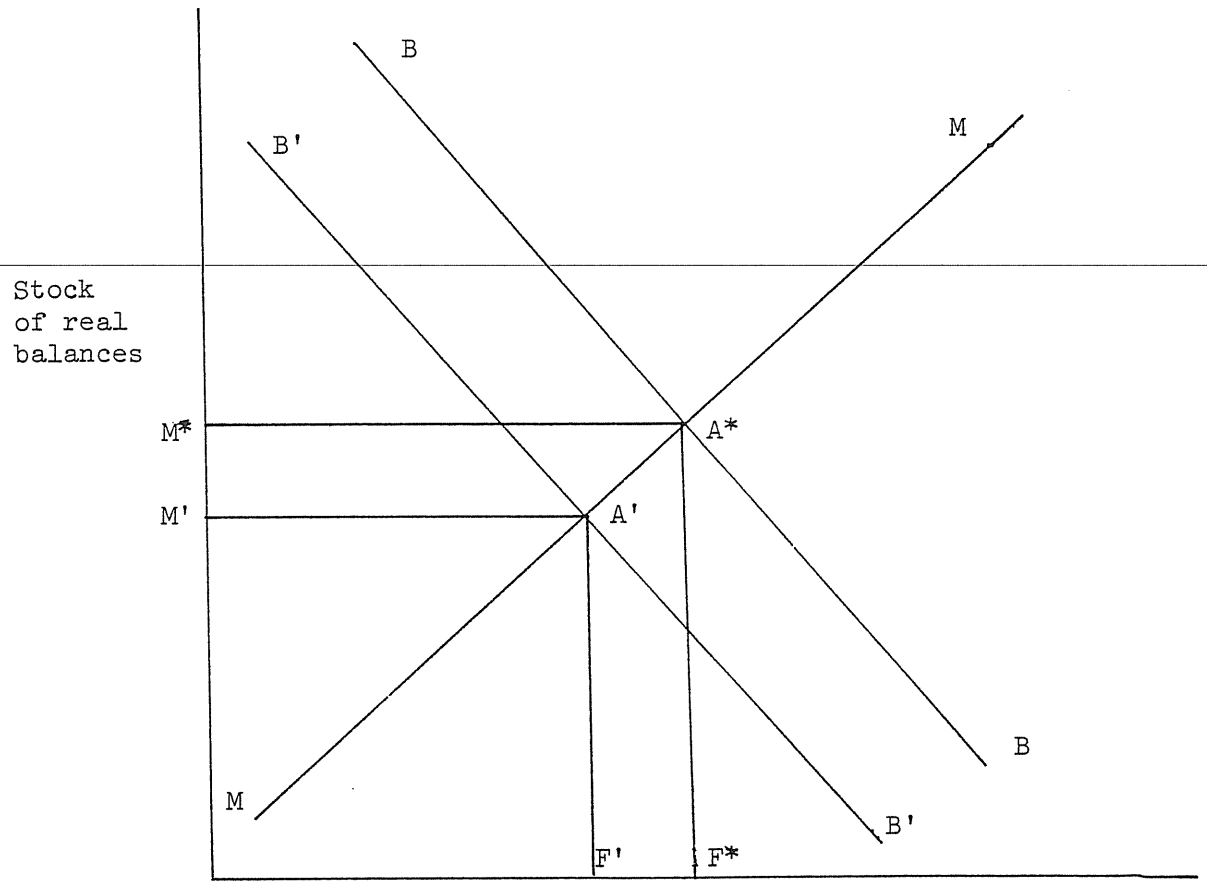
11) The stationary state model is similar to that of McKinnon and Oates (1966), except that we assume fixed output and variable price level (exchange rate) whereas they assume a fixed price level and variable output even in the long run.

Diagram IV

The Stationary State



Stock of foreign assets

demand for real balances. The intersection of the BB and MM schedules at point A* determines the long run stationary state stock of foreign assets (F*) and real balances ($\bar{M}$*). We shall assume throughout this paper that there exists a unique stationary state for all rates of inflation greater than some negative $\tilde{\pi}$. The long run exchange rate *path* (we obviously cannot talk about a long run exchange rate if that rate is steadily depreciating) is defined by:

$$\ln P(t) = \ln M_o + mt - \ln \bar{M}^* \qquad (18)$$

There is thus a one-to-one correspondence between the long run exchange rate path and the stock of real balances. The lower the stock of real balances, the 'higher' the exchange rate path. Subsequently, when we refer to a long run depreciation of the exchange rate, we mean an upward shift in the exchange rate path.

It follows immediately from equations (16) and (17) that a once-and-for-all intervention in the foreign exchange market has no long run real effects -- all that happens is that the exchange rate increases in proportion. This implies that a purchase of X units of foreign exchange by the Central Bank will be followed by a period of current account surpluses which add up to exactly X units of foreign exchange.

Fiscal policy can affect the long run equilibrium position in two ways: by changing the tax revenue and by changing the rate of growth of public debt, and hence the rate of inflation. These two methods are two alternative forms of taxation. The first is a lump sum tax on income, the second a capital levy on cash balances. They have quite different long run effects because the inflation tax changes the desired portfolio composition.

The long-run effect of an increase in government expenditure financed by higher taxes can be established without ambiguity with reference to diagram IV. The BB schedule shifts down to B'B': at a given stock of foreign assets there is an increase in absorption. In order that the balance of payments remains in equilibrium, the stock of real balances must fall and reduce private absorption. Therefore, *a tax financed increase in government expenditure will reduce the long-run stock of foreign assets held by the private sector, and depreciate the long run exchange rate.* This means that between the short run momentary equilibrium and the long-run stationary state the current account must be in deficit.

The effect of an increase in the rate of inflation on the stationary state depends on the magnitude of the rate of inflation. From equations (16) and (18) we obtain:

$$\hat{M} = \frac{C_A L_\pi - L_A \bar{M}}{\Delta} \hat{\pi} \tag{19}$$

$$\hat{F} = \frac{L_A \bar{M} - (C_A + \pi) L_\pi - \pi \bar{M}}{\Delta} \hat{\pi} \tag{20}$$

$$\hat{A} = \frac{-\pi L_\pi - \bar{M}}{\Delta} \hat{\pi} \tag{21}$$

where $\Delta = C_A + \pi L_A$. The effect of a higher rate of inflation on the stationary state stock of real balances is unambiguously negative. Therefore, we may write the stationary state demand for money function in the form $\frac{M}{P} = L^*(\pi, Y)$ with L_π negative.[12] The effect on the stock of foreign assets and the stock of real wealth is ambiguous. If L_π is well behaved, the stock of wealth at first reduces with the rate of inflation reaching the minimum when the

12) This is the Archibald-Lipsey long run demand for money function. See Archibald and Lipsey (1958). See also McKinnon (1969) for a discussion why the stock of wealth does not appear in the long run asset demand equations.

rate of inflation equals the inverse of the inflation elasticity of money demand, and thereafter increasing with the rate of inflation. The stock of real private financial wealth is minimized when the government revenue from the inflation tax is maximized.[13] As the rate of inflation approaches infinity, the stationary state stock of wealth approaches what it would be if the rate of inflation were zero. The reason is that in both cases the average real rate of interest is the same, namely zero.[14] An increase in the rate of inflation at first reduces the stock of foreign assets but after a while the substitution effect begins to dominate and the stock of privately held foreign assets begins to increase. It is clear from equation (17) that this occurs before the revenue maximizing rate of inflation is reached (see diagram V).

An increase in the rate of inflation may thus be accompanied either with a period of current account deficits (when the rate of inflation is small) or a period of current account surpluses (when the rate of inflation is high). The dynamic response pattern depends critically on how expectations are formed (see Section V).

IV. The Dynamic Stability of the Adjustment Process

In this section we investigate the dynamic stability of the balance of payments adjustment process under flexible exchange rates. By dynamic stability, we mean the convergence of the

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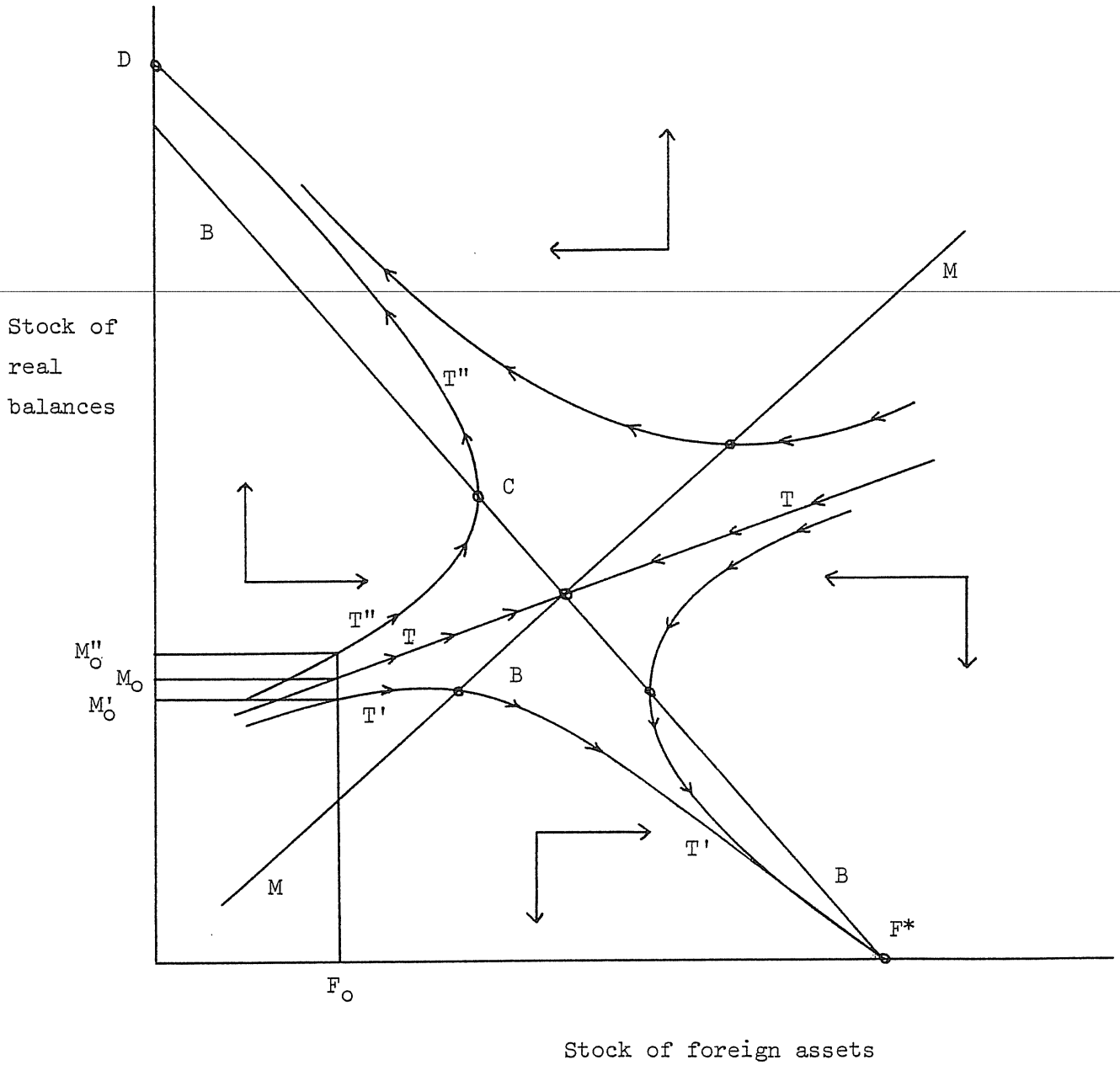
13) On the optimal inflation tax see the recent treatment of the problem by Phelps (1973).

14) With zero rate of inflation equation (12) is of the form $C(Y - T, A) + T = Y$. With an infinite rate of inflation $\pi\bar{M}$ becomes zero (under appropriate conditions on the inflation elasticity of money demand) so that equation (12) is of the same form: $C(Y - T, A) + T = Y$.

Diagram V

The Adjustment Process with Perfect Foresight



sequence of momentary equilibria to the stationary state. We shall examine three mechanisms of expectations formation:

a) *static expectations:* $\pi = m$

b) *myopic perfect foresight:* $\pi = \frac{\dot{P}}{P} = m - \dot{X}$

c) *adaptive expectations:* $\dot{\pi} = \beta(\frac{\dot{P}}{P} - \pi) = \beta(m - \dot{X} - \pi)$

where X is equal to the logarithm of the stock of real balances ($\ln\bar{M}$). The adjustment process is defined by one of the above expectations equations and the following two equations:

$$\dot{F} = k(\pi, F) \quad \text{(cf. equation 8)} \tag{22}$$

$$X = h(\pi, F) \quad \text{(cf. equation 6.1)} \tag{23}$$

a. Static Expectations

With static expectations, π is constant and equation (22) becomes an ordinary differential equation in F. Because k_F is negative and we assume a unique stationary state, the adjustment process is globally stable. In diagram IV, the economy moves along the asset market equilibrium line (MM). Along the static expectations path the exchange rate is continuously changing in a way that implies profit opportunities for speculators so that it hardly is an adequate representation of the adjustment process.

b. Myopic Perfect Foresight

The strong stability result that obtains in the case of static expectations suggests that the question of dynamic stability hinges on the nature of expectations formation. We show in this section that perfect foresight renders the exchange rate *indeterminate:* from any initial exchange rate there is an exchange rate and foreign asset path such that expectations are continuously

fulfilled and all markets are in equilibrium. This problem of indeterminacy has been raised in a different context by Black (1974), and is well known in the models of money and growth as well as in growth models with many capital goods.[15] There is only one path along which the economy converges to the stationary state -- provided that it gets on that path in the first place.

The fact that the stationary state is a saddlepoint can be established by considering the dynamic system consisting of equations (22) and (23) with $\dot{X}$ substituted in place of π. It is straightforward to show that the characteristic roots of the resulting dynamic system, linearized around the stationary state, are real and of opposite sign, which is a sufficient condition for the stationary state to be a saddlepoint locally.[16]

The dynamic behaviour of the stock of real balances and the stock of foreign assets with perfect foresight is illustrated in diagram V. The AA curve implies that the stock of real balances is constant (whence the rate of depreciation of the exchange rate equals the rate of growth of the nominal money stock). The BB schedule implies that the current account is zero and hence the stock of foreign assets is constant. The assumption of a unique stationary state implies that the BB curve cannot be

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15) For a discussion of this problem in models of money and growth see Hahn (1969) and references contained therein. See also the recent paper of Brock (1975). Brock resolves the problem of indeterminacy by assuming an economy of identically infinitely lived intertemporal optimizers. The transversality condition enables him to eliminate the deviant paths. It is not clear, however, what market forces enforce the transversality condition. A useful reference is also Burmeister-Dobell (1970), Chapter 6, and Stein (1970), especially Chapter I, Section E.

16) The details of the mathematical derivations are left out since they are straightforward.

steeper than the MM curve although it can be locally upward sloping.[17] The assumption of the existence of a stationary state for positive rates of inflation also implies that the stock of foreign assets never exceeds the stationary state level of wealth with zero rate of inflation(cf. footnote 14, p.17). That is why the BB curve cuts the X-axis at a finite stock of foreign assets F*.

The arrows in diagram V indicate the direction of movement. Suppose that the initial stock of foreign assets is F_o. The initial exchange rate should be set in such a way that the initial stock of real balances is equal to M_o in order that the economy converges to the stationary state along the TT trajectory. If the exchange rate is initially undervalued, the stock of real balances is too low - M_o' in the diagram - the exchange rate appreciates initially as people build up their domestic money balances faster than they accumulate foreign assets in order to restore portfolio equilibruim. After a wnile, the stock of real balances reaches a point where it stops increasing (point B in the diagram). At that point, the exchange rate begins to depreciate. The speculators catch on immediately and start the flight out of domestic money. Hyperinflation ensues and foreign money drives domestic money valueless. The opposite outcome follows if the currency is initially overvalued so that the initial stock of real balances is too high. Both the stock of real balances and the stock of foreign assets will increase at first but after a while (point C in the diagram) the substitution effect begins to dominate and the domestic residents start reducing their foreign assets because of the high yield on domestic assets. It is implausible that the boom

17) See Samuelson and Liviatan (1969) for a detailed analysis of the properties of saddlepoints in optimal growth models. The problems of local instability and multiple equilibria can also arise in our model but we assume them away.

in the foreign exchange market could continue much beyond point D in the diagram when domestic residents no longer have any foreign assets. At that point the appreciation suddenly stops, the market collapses and speculators incur a large capital loss. If speculators have *long-run perfect foresight* they will anticipate this outcome and will prevent the hyperdeflation from ever getting started.

It is less clear how one might rule out hyperinflation since there appears no good reason why domestic currency could not be substituted by foreign money even in domestic transactions. Of course, the society as a group loses from this since they have to give up real resources (cut down consumption) in order to accumulate foreign money. There is no self-evident competitive market mechanism which rules out the society making itself worse off by destroying the value of its money through speculation. In addition to just ruling out such possibility because it seems unreasonable (Sargent and Wallace, 1974), or because it has never happened without excessive monetary expansion, one could argue that a minimum stock of real balances is always needed to carry out some transactions -- for instance, payments of taxes. If that is the case, *long-run perfect foresight* rules out hyperinflation as well. There remains the troublesome question of how the speculators are able to compute the initial exchange rate which will take the economy to the stationary state. We shall not attempt to tackle this question, but shall use the assumption of long run perfect foresight (rational expectations) as a convenient tool of dynamic analysis.

Diagram V shows the important property of the rational

expectations adjustment path: *the stock of foreign assets and the stock of real balances always move monotonically and in the same direction.* This result will prove very helpful in the next section.

c. Adaptive Expectations

With adaptive expectations the dynamic evolution of the economy is defined by equations (22) and (23) and the adaptive expectations equation (c). It is straightforward to show that a sufficient condition for the local stability of this system is that the product of the absolute value of the inflation elasticity of the demand for real balances (h_π) and the speed of revision of expectations (β) is less than one:

$$h_\pi \beta < 1 \qquad (24)$$

If the system is stable the convergence to equilibrium is nonoscillating. This stability condition is the same as the condition of stability in Cagan's model of hyperinflation except that h_π is a reduced form elasticity unlike in his model. Our model of the inflationary process differs from Cagan's analysis amongst other things because equilibrium can be restored not only through price changes but also through changes in the stock of the money substitute.

V. Dynamic Response of the Exchange Rate and the Balance of Payments to Various Shocks

In this section we analyze the dynamic response of the exchange rate and the balance of payments to the various shocks considered

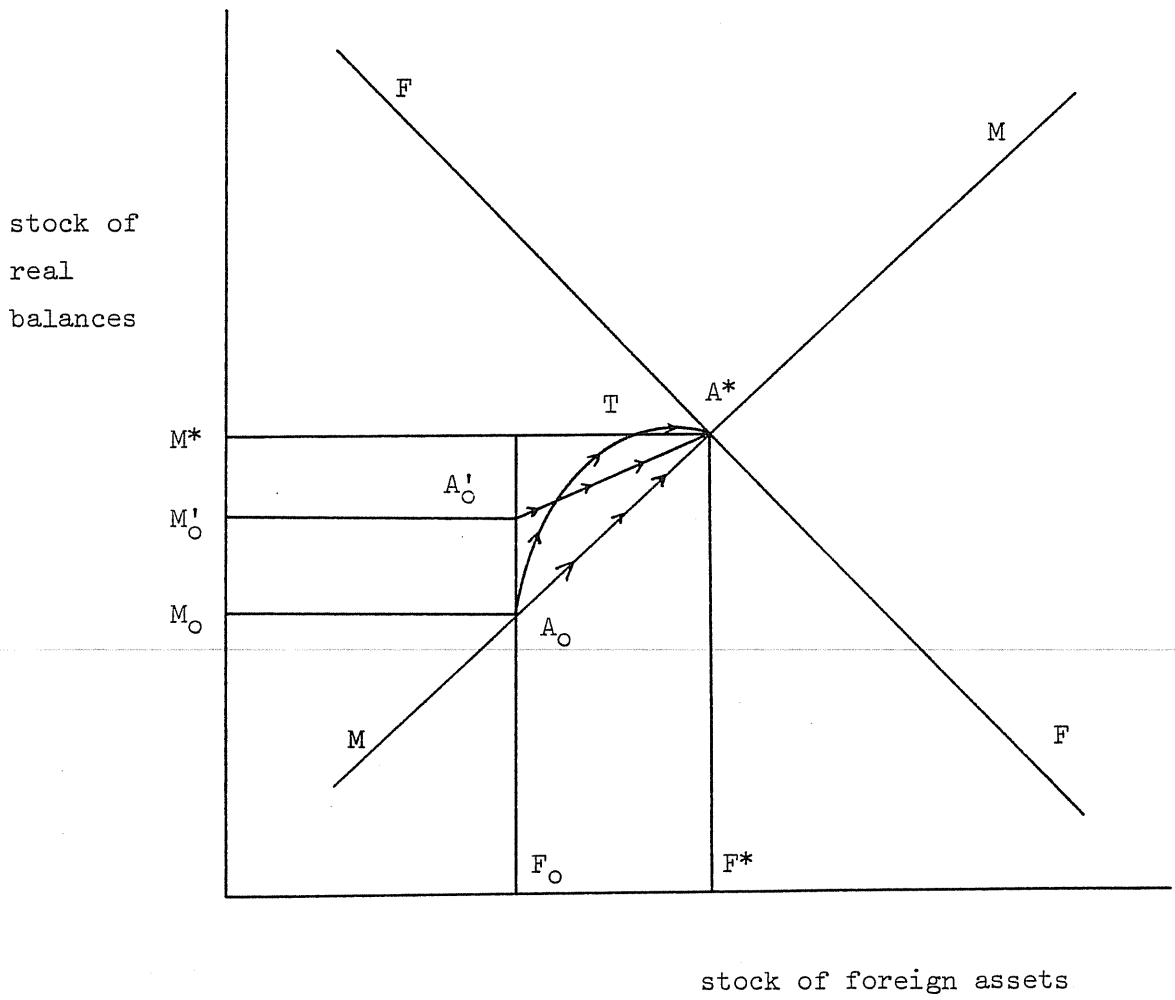
in Sections II and III from the short run and long run perspective. Our strategy is to use the phase-diagram introduced in the previous section and infer from that what the response of the exchange rate and the current account must be. The response of the exchange rate can be established easily from the response of the stock of real balances and the response of the current account from the direction of change in the stock of foreign assets. We shall examine separately each of the three shocks considered above and in each case compare the response pattern under the three different hypotheses about expectations formation.

a. The Dynamic Effects of An Once-And-For-All Intervention in the Foreign Exchange Market

In diagram VI the economy is initially in a stationary state with stock F* of foreign assets and M* of real money balances. The MM and the FF curves have the same interpretation as before. The Central Bank purchases F_oF^* of foreign assets. This leaves both the MM and the FF schedule unchanged. With static expectations, the economy stays on the MM schedule so that the stock of real balances declines to M_o. Thereafter, the economy moves back to the same stationary state with the exchange rate *appreciating* and the current account *in surplus*. The static expectations path implies an appreciating exchange rate which the speculators persistently ignore. With foresight, this is not possible whence the initial decline in the stock of real balances is less (implying that the initial devaluation is also less). Thereafter, the behaviour of the economy is similar to that under static expecta-

Diagram VI

The Dynamic Effects of A Once-and-For-All Intervention in the Foreign Exchange Market



tions. This case illustrates that speculators with long run foresight cushion the exchange rate against discrete and *non-repeated* changes in the money stock. A possible response pattern of the economy under adaptive expectations is illustrated by the A_oTA trajectory. The initial point is the same as with static expectations. As the exchange rate subsequently appreciates the speculators revise their expectations upwards. Hence, the stock of real balances must always be above what it is under static expectations (hence the exchange rate is below what it is along the static expectations path). Speculators may cause the stock of real balances to go above the stationary state value which means that the exchange rate will, after a period of appreciation, start to depreciate. The current account cannot, however, move into a deficit (this is implied by the stability condition).

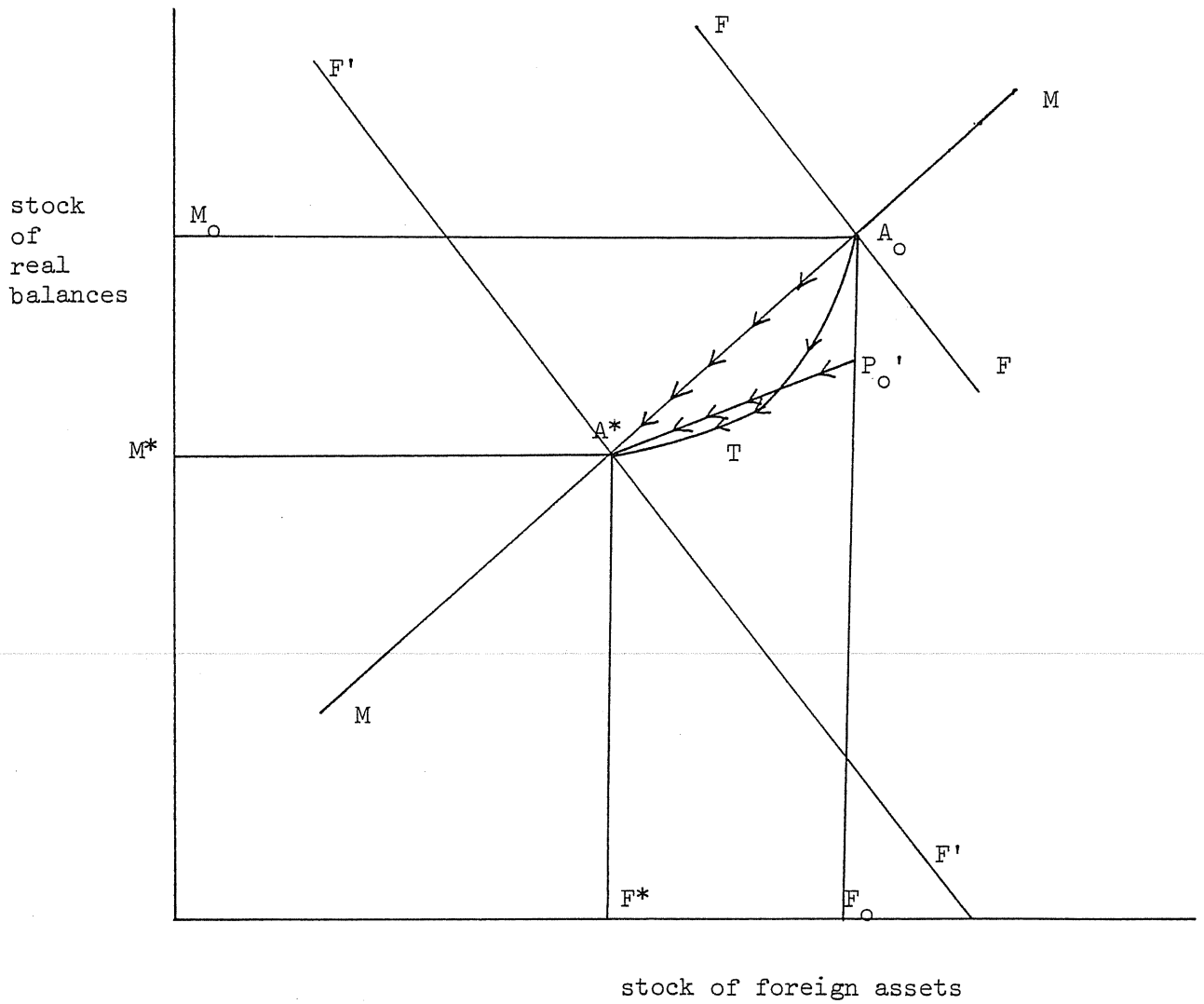
To summarize, in all cases the exchange rate initially depreciates more than in proportion to the change in the money stock. Thereafter, the exchange rate appreciates and the current account is in surplus until the economy has reached a new equilibrium position with a higher exchange rate but the same values for the real variables.

b. The Dynamic Effects of a Tax Financed Increase in Government Expenditure

An increase in government expenditure financed by taxes will shift the FF schedule down and leave the MM schedule unchanged (see diagram VII). Before the shift, the economy is at point A with stock F_o of foreign assets and M_o of real balances. In the

Diagram VII

The Dynamic Effects of an Increase in Tax Financed Government Expenditure



new equilibrium position both are less, F* and M*, respectively. With static and adaptive expectations, the stock of real balances and hence the exchange rate remain initially unchanged. The only impact effect of the shift is that the current account moves to a deficit (cf. Section II.b.). Over time this causes the exchange rate to depreciate. Rational speculators foresee this possibility and cause the exchange rate to depreciate *immediately*, thereby bringing about a larger current account surplus than with static and adaptive expectations. Thereafter, the rational expectations path is similar to the static expectations path. Both of them differ from the adaptive expectations path which may cause the exchange rate to overshoot, as is illustrated by the ATA* trajectory.

Three points that emerge from this analysis merit re-emphasis:

(i) In all cases the long run effect on the stock of foreign assets correctly predicts the short run effects on the current account.

(ii) If long run foresight is assumed, the long run effect on the exchange rate correctly predicts the short run effect on the exchange rate.

(iii) The ensuing current account deficit is temporary and in no case reverses itself.

It is also of interest to note that the short run change in the current account has informative value for speculators about the future course of the exchange rate.

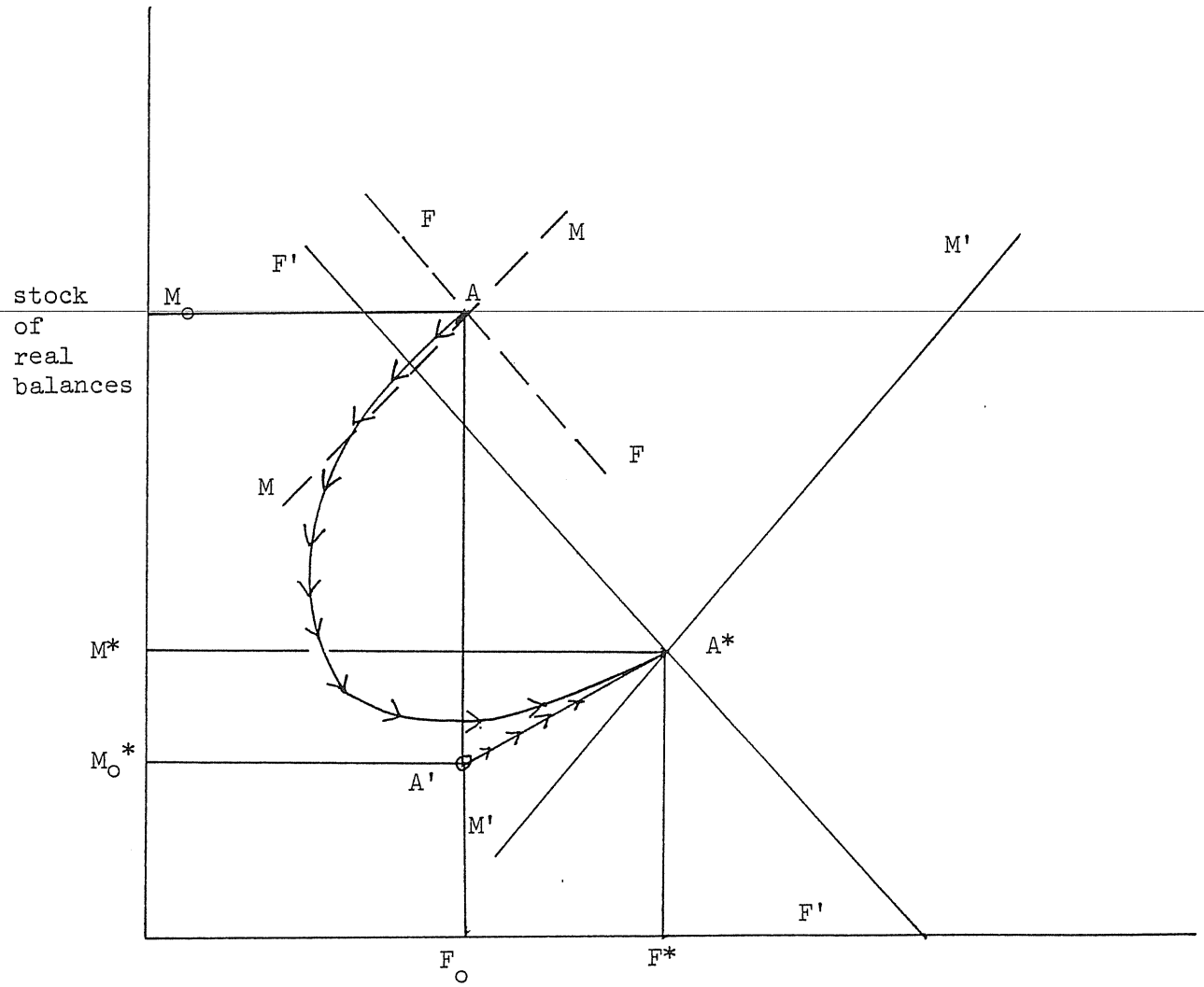
c. The Effects of an Increase in the Rate of Monetary Expansion

With an increase in the rate of monetary expansion, two long-run outcomes are possible: the stock of real balances will unambiguously decline, but the stock of foreign assets may either increase or decrease depending on the strength of the substitution effect (which itself depends on the magnitude of the rate of inflation). Diagram VIII illustrates the first case. The economy is initially at point A. The new equilibrium position is A*, with stock F* of foreign assets and M* of real balances. The response to this change is radically different under adaptive and rational expectations. It is meaningless to assume static expectations in this case. With rational expectations, *there is an immediate, discrete devaluation of the exchange rate, whereafter the exchange rate appreciates relative to its new trend. The sharp depreciation causes the current account to move to a surplus* despite the increase in government expenditure. After the initial adjustment, the stock of real balances and the stock of foreign assets increase *pari passu* to the new equilibrium position. Note that *the short run impact is correctly predicted by the long run stationary state impact.*

With adaptive expectations there is no change in the initial exchange rate whence the increased government absorption causes the current account to move to a deficit. For a while, the stock of real balances and the stock of foreign assets decrease *pari passu*, but once speculators catch on, the substitution effect bebins to dominate, capital begins to flow out and the current

Diagram VIII

The Dynamic Response to An Increase in the Rate of Monetary Expansion



account moves to a surplus. The surpluses add up to the sum of the previous deficits and the long run increase in the stock of foreign assets because of the lower rate of return on domestic assets.

The case when both the stock of real balances and of foreign assets decline in the long run can be analyzed with reference to the previous diagram VII since in both cases the new equilibrium position is to the southwest of the initial point. With rational expectations, there is an instant depreciation of the exchange rate attendant upon the (known) increase in the rate of monetary expansion. The depreciation is not, however, sufficient to cause the current account to move to a surplus. The *exchange rate will continue to depreciate faster than the new growth rate of the money stock* and the stock of real balances and of foreign assets decline *pari passu*. Note that in the previous case the rate of depreciation was less than the rate of monetary expansion.

With adaptive expectations the path may look like trajectory A_oTA^* in diagram VII. Initially, there is no change in the exchange rate. The current account deficits cause the rate to depreciate. Speculators catch on and may cause the rate to overshoot its long run equilibrium path.

VI. Concluding Remarks

This section summarizes the main principles of the monetary approach to flexible exchange rates developed in this paper and discusses the various implications of this approach that go beyond the particular model examined above:

(i) In the long run there is a symmetry between the régime of fixed and flexible exchange rates. Under fixed exchange rates, the exchange rate is exogeneous and the supply of money endogeneous. Under flexible exchange rates, the supply of money is exogeneous and the exchange rate endogeneous. A devaluation under fixed exchange rates increases the supply of money in proportion in the long run; under flexible exchange rates, an increase in the money stock increases the exchange rate in proportion in the long run. An important long-run difference between the two regimes is that under flexible rates the *rate of inflation* can be varied independently of the rest of the world. Changes in the rate of inflation can be interpreted as changes in the tax on domestic money and they will have systematic effects on the long-run stock of wealth as well as its composition. Other instruments of fiscal policy can be used in both regimes to alter the stationary state. Because fiscal policy and other real variables have an effect on the long run demand for money, it is not correct to say that the exchange rate can be explained by monetary factors alone, even in the long run.

(ii) The adjustment process is quite different under the two regimes. In both systems, the *stock of wealth* adjusts to its long-run desired level through deficits and surpluses *in the current account*. Under fixed exchange rates portfolio equilibrium between domestic money and foreign assets *at a given level of wealth* is obtained through *instantaneous* capital inflows and outflows because the Central Bank supplies foreign assets at a fixed price. Under flexible exchange rates instantaneous portfolio

equilibrium is obtained through changes in the *valuation* of assets -- that is, through changes in the exchange rate. Whereas a desire to hold a larger proportion of foreign assets results in an *immediate* adjustment of private portfolios and has no long-run consequences under fixed exchange rates, such a shift under flexible exchange rates will give rise to a gradual adjustment process and will have long-run consequences. The exchange rate will depreciate initially and the current account will move to a surplus. This surplus increases the *actual stock* of foreign assets. In general, the exchange rate in the new equilibrium position will not be the same as before the portfolio shift because the long-run stock of wealth will be different.

(iii) The dynamic behaviour of the exchange rate and of the balance of payments depends critically on the nature of expectations formation. The traditional theory has missed the relevant problem of instability under flexible exchange rates, namely, the problem of instability of *relative asset prices*, by focusing on balance of payments flows. The crude purchasing power parity theory of exchange rates has also missed the problem of possible instability by ignoring the fact that different monies, and assets denominated in different currencies, are substitutes. The requirement of no expected profits does not rule out dynamic instability.[18] In fact, in the case of perfect foresight the *exchange rate is indeterminate* -- for any initial exchange rate, there is a path along which all markets clear and

18) If, however, speculators have long-run foresight and rule out explosive price paths, speculation will cushion the exchange rate against reversible shocks as has been correctly argued by Friedman (1953). However, *permanent* changes in the long run determinants of the exchange rate will, even with -- and in the case of 'flow shifts' (see the text), in particular with -- rational expectations, have an accentuated effect on the spot exchange rate.

expectations are continuously fulfilled. Only one of these paths converges to the stationary state. Since hyperdeflation, or inflation, has seldom, if ever, developed by the force of speculative behaviour alone, there must be reasons why the deviant paths cannot be sustained. Some reasons are given in the paper.

(iv) This paper does not give any role to relative price effects in the adjustment process, emphasized by the traditional analysis of foreign exchange market stability. A necessary condition of stability in our model is that an increase in the stock of foreign assets reduces the current account surplus. With non-traded goods and low price elasticities, this may not happen, in which case the foreign exchange market would be dynamically unstable.

(v) If long-run perfect foresight is assumed, the short-run effects and the dynamic path of various disturbances can be inferred from the long-run effects of these disturbances. This result greatly enhances the usefulness of the portfolio balance models of open economies.

(vi) The view of the exchange rate as a relative asset price suggests that in a world in which the underlying determinants -- monetary and real -- of the exchange rate change continuously and in a stochastic fashion, there is no reason to expect the exchange rate to be stable. In fact, the behaviour of the exchange rate is likely to resemble the behaviour of asset prices in other speculative markets, such as the stock market.

(vii) The analysis of this paper suggests a framework for analyzing the effects of monetary policy under flexible rates which departs significantly from the traditional analysis. The immediate

effect of a change in monetary policy is to change the relative price of assets -- such as the exchange rate -- and the rates of interest. These changes have effects on aggregate demand, prices and output through various channels: (a) by changing the real value of wealth and its distribution across countries, (b) by changing the rates of interest and thereby affecting the rate of investment, and (c) by changing relative commodity prices and real wages. The link between monetary policy and the inflow or outflow of capital goes through the effect of monetary policy on aggregate demand and output and thereby on the current account, which determines the capital account. The direct and immediate link between monetary policy and the capital account in the traditional analysis has resulted in the false presumption that monetary policy acts fast under flexible rates because it has an *immediate* effect on the current account and hence on aggregate demand. The correct reasoning is, of course, that monetary policy has an immediate effect on the current account *if* it has an immediate effect on aggregate demand.

(viii) Finally, the model developed in this paper can be extended in a straightforward manner to allow for rigid wages and unemployment, for changes in relative prices, and for accumulation of real capital. The extension of the model to two or more countries would bring out the point that what in the end connects the exchange rate and the current account is the transfer of wealth implied by current account deficits and surpluses and the fact that asset preferences are likely to be different in different countries.

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