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THE DYNAMIC INTERACTION OF EXCHANGE RATES AND TRADE FLOWS

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ABSTRACT

During the fifteen years since 1970, the theory of exchange-rate determination has been completely transformed. In the late 1960s, the standard model of the foreign exchange market had supply and demand as stable functions of exports and imports, with the expection that a floating rate would move gradually with relative price changes. However, the period of floating rates that began in the early 1970s has revealed that exchange rates exhibit the volatility of financial market prices. This experience, coupled with development of theory, led first to the "monetary" approach to exchange rate determination and then to the "asset market" approach.

The monetary approach to exchange rate determination had essentially one-way causation from money to exchange rates, sometimes via purchasing power parity. The broader asset market approach assumes two-way causation. The exchange rate, in the asset-market view, is proximately determined by financial-market equilibrium conditions. It, in turn, influences the trade balance and the current account. The latter, in its turn, is the rate of accumulation of national claims on foreigners, and this feeds back into financial market equilibrium. Thus the asset market approach contains a dynamic feedback mechanism in foreign assets and exchange rates. This approach is called here a "fundamentals" model of exchange rate dynamics. Recent work on rational expectations adds a layer of expectations to the model. It is assumed that following an unexpected disturbance the market can anticipate where the fundamentals will move the system, and move the exchange rate in anticipation of that fundamentals path.

This paper integrates the traditional elasticities and absorption approaches into the general equilibrium fundamentals model, and then add the expectations layer. The model is used to interpret recent shifts in U.S. fiscal policy and portfolio preferences for the dollar.

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The Dynamic Interaction of Exchange Rates and Trade Flows.

I. Introduction.

During the fifteen years since 1970, the theory of exchange-rate determination has been completely transformed. In the late 1960s, the standard model of the foreign exchange market had supply and demand as stable functions of exports and imports, with the expectation that a floating rate would move gradually with relative price changes. However, the period of floating rates that began in the early 1970s has revealed that exchange rates exhibit the volatility of financial market prices. This experience, coupled with development of theory, led first to the "monetary" approach to exchange rate determination and then to the "asset market" approach. For a thorough review of these developments, see Mussa (1984). The term "asset market" approach appears in Branson (1975). Initial papers viewing exchange rates as determined proximately by financial markets were Branson (1977), Dornbusch (1976), Kouri (1976), and Mussa (1976).

The monetary approach to exchange rate determination had essentially one-way causation from money to exchange rates, sometimes via purchasing power parity. The broader asset market approach assumed two-way causation. The exchange rate, in the asset-market view, is proximately determined by financial-market equilibrium conditions. It, in turn, influences the trade balance and the current account. The latter, in its turn, is the rate of accumulation of national claims on foreignes, and this feeds back into financial market equilibrium. Thus the asset market approach contains a dynamic feedback mechanism in foreign assets and exchange rates.

This system is shown schematically in Figure 1. Initial stocks of assets and values for exogenous variables such as the government budget and technology determine "temporary equilibrium" values for endogenous variables such as the interest rate r, the exchange rate e, output y, and the price level P via an open-economy textbook model. These in turn determine the balance on current account which is the rate of change of foreign assets. This feeds back into financial markets, moving the system towards and equilibrium where the current account balances, if the system is stable.

This outlines what is called below a "fundamentals" model of exchange rate dynamics. Recent work on rational expectations adds a layer of expectations to the model. It is assumed that following an unexpected disturbance the market can anticipate where the fundamentals will move the system, and move the exchange rate in anticipation of that fundamentals path.

This paper provides an exposition of a popular model of the interaction between goods and asset markets in determining the interaction between exchange rates and the current account. It tries to integrate the traditional elasticities and absorption approaches into the general equilibrium fundamentals model, and then add the expectations layer. The model is used to interpret recent shifts in U.S. fiscal policy and portfolio preferences for the dollar.

Section II reviews the elasticities approach and its many special cases. This is integrated with the absorption approach in Section III, in a textbook macro model. Section IV then adds a financial sector and exchange-rate determination to develop a bare-bones fundamentals model. The expectations layer came in Section V, along with an interpretation of recent events. The model performs fairly well in this regard.

II. Effects of Changes in Exchange Rates on Trade.

The most convenient point to begin the analysis of the interdependence between trade and exchange rates is with the effects of changes in exchange rates on trade, the second arrow in Figure 1 above. This puts us on familiar starting ground, since the analysis revolves around the well-known "Marshall-Lerner" elasticities conditions. These can be derived from a log-linear model of export and import supply and demand, as is shown in Branson (1972) and Branson and Katseli (1980). Here the analysis is partial equilibrium, assuming domestic output and prices of non-traded goods are unchanged as the exchange rate changes. General equilibrium considerations will be brought into play in section III. One way to think about the trade elasticities conditions is as "impact effect" to be used as input to a large macro model which will calculate the subsequent general equilibrium response of the economy.

The full elasticities condition can be stated as follows:

$$dB = (p_x x)_0 \{ [\frac{d_x(1+s_x)}{d_x - s_x}] - (p_m m)_0 [\frac{s_m(1+d_m)}{s_m - d_m}] \} \hat{e} . \qquad (1)$$

Here dB is the change in the home-currency value of the trade balance; $(p_x x)_0$ and $(p_m M)_0$ are the initial values of exports and imports; s_x, $s_m > 0$ and d_x, $d_m < 0$ are the price elasticities of supply and demand for exports and imports; $\hat{e}$ is the percentage change in the exchange rate measured as units of home currency per unit of foreign exchange (so $\hat{e} > 0$ is a depreciation of the home currency). The elasticities condition in (1) gives the sign and magnitude of the effect on the trade balance over whatever run the elasticities are measured. We can interpret the condition in several special cases: the "insular economy," the "small country," and the "rigid economy."

The Insular Economy of Marshall and Lerner.

The usual statement of the Marshall-Lerner conditions assumes an economy that Kenen (1985) has labelled insular. In this case s_x and s_m go to infinity (all supply curves are flat). This would be likely in a country that is small in the world market so $s_m \rightarrow \infty$, and has a small export sector so $s_x \rightarrow \infty$. Here the elasticity condition (1) reduces to

$$dB = \{(p_x x_0)[-d_x] - (p_m m)_0[1+d_m]\}\hat{e}. \qquad (2)$$

If trade is initially balanced so $(p_x x)_0 = (p_m m)_0$ condition (2) reduces further to the usual statement of the Marshall-Lerner conditions: dB and $\hat{e}$ have the same sign if $1+d_x + d_m > 0$. (remember that d_x, $d_m < 0$).

As long as the trade demand and supply curves have the usual signs for their slopes, as assumed above, a devaluation with $\hat{e} > 0$ will increase the volume of imports. The elasticity conditions here tell us what happens to the real home-currency value of the trade balance. It is "real" because we are taking domestic non-traded prices as given and computing volume effects plus the relative price effect of the devaluation. As we see in the next section, the elasticities conditions take us from the partial equilibrium level of equations (1) and (2) to the macro level.

The assumptions associated with the "insular" economy, which simplify equation (1) to the usual Marshall-Lerner conditions, may call into question the relevance of this particular version of the elasticity condition. The combination of assumptions that (a) the economy is small in the world market for its imports, but (b) the export sector is a small and flexible part of the economy may be applicable only to a small set of countries, including the UK before World War II. The assumption that trade is balanced transforms the strict Marshall-Lerner conditions from a policy-relevant statement to a "thought experiment" about how a model works. Actual devaluation would generally take place with a trade deficit, i.e., $(p_m m)_0 > (p_x x)_0$. If the price-elasticity of demand d_m in equation (1) is greater than -1, this would give additional weight to the possibility that devaluation would have perverse results. These reservations about the strict Marshall-Lerner calculations lead us to consider alternative assumptions on elasticities: the small country and the rigid economy.

<u>The Small Country and the Rigid Economy</u>.

The trade theorist's small country takes world prices as insensitive to anything it does. In our framework, this translates into the assumptions that s_m, d_x go to infinity. In this case, the elasticities condition (1) reduces to

$$dB = \{(p_x x)_0[1+s_x] - (p_m m)_0[1+d_m]\}\hat{e}. \tag{3}$$

If trade is initially balanced, the elasticity condition further reduces to $s_x - d_m > 0$, which is necessarily so, except in the extreme case of the rigid economy, to be discussed just below. This is the basis for the conventional wisdom that devaluation will always improve the trade balance in a small, open economy. But if the initial condition is a trade deficit and $-1 < d_m < 0$, a perverse result may appear even in this case. It is not difficult to find examples of countries that devalue with $(p_m m)_0$ twice $(p_x x)_0$. See, for example, Branson (1986) in the Kenyan experience in 1979-80.

The rigid economy is a separate case from the small, open economy, but we can see the basic point by considering an economy that is both. The trade structure of many developing countries has a high percentage of exports coming from sectors with a low supply elasticity in the short run, but little domestic consumption of the exportable. This makes s_x low, and the extreme example of $s_x \to 0$ is illuminating. The same trade structure includes a high percentage of intermediate inputs such as oil in imports, with a low demand elasticity determined by a structure of production that is rigid in the short run. In the extreme, $d_m \to 0$. In the illustrative extreme case of a rigid small economy, these assumptions lend to the (non-elasticity) condition that

$$dB = \{(p_x x)_0 - (p_m m)_0\}\hat{e}. \tag{4}$$

It should be clear that (4) is a limiting case of (3); very low values s_x and d_m would give qualitatively similar results.

In the rigid economy, a devaluation shifts the export demand and import supply curves up along vertical export supply and import demand curves. This results in no change in volume and an equiproportionate increase in p_x and p_m, whether the economy is small or not. Thus the rigid economy looks like a fully escalated economy, as noted below and analyzed at greater length in Branson and Macedo (1985).

The importance of the Marshall-Lerner assumption of initial balance comes out with greatest force in conditions (3) and (4). Devaluation or depreciation generally occurs with a trade deficit. If this combines with relatively inelastic import demand for intermediate inputs, it can cause the initial deficit to increase with devaluation. Since the elasticities conditions here give the effect of the trade balance in home currency, this would result in a deflationary devaluation, to use the term of Cooper (1971) and Krugman and Taylor (1978). The devaluation would pull demand out of the system. Thus the elasticities condition controls the effect on home-currency aggregate demand of a change in the exchange rate. This will be the starting point for the macroeconomic analysis in section III.

Indexation and Non-traded Goods.

In the elasticities analysis, a change in the exchange rate alters trade volumes implicitly by changing the prices of traded goods relative to non-traded goods. The rigid economy is a limiting case in which inelasticity eliminates volume effects. This result can also be obtained with wage indexation, which eliminates relative price effects. The following model provides an illustration.

Suppose changes in home-currency prices of traded goods are given by changes in the exchange rate with world prices exogenous:

$$\hat{p}_T = \hat{e}. \tag{5}$$

Here a ^ denotes percentage change: $\hat{Z} \equiv dZ/Z$. The consumer price index i is a weighted average of the prices of traded and non-traded goods:

$$\hat{i} = \alpha\hat{p}_t + (1-\alpha)\hat{p}_N = \alpha\hat{e} + (1-\alpha)\hat{p}_N. \tag{6}$$

The price of non-traded goods is a mark-up over wage costs and wages are indexed to the CPI:

$$\hat{p}_N = \hat{W} = \hat{i}. \tag{7}$$

If we insert (2) into (6) for $\hat{p}_N$ we obtain the basic result that $\hat{i} = \hat{e}$ and then from (7), $\hat{p}_N = \hat{W} = \hat{e}$. So wage indexation links the price of non-traded goods to the exchange rate, eliminating the relative-price effects of a change in the exchange rate. This replicates the result of the rigid economy.

The initial, partial-equilibrium effects of exchange-rate changes calculated using elasticities formulas must be fed into a general-equilibrium macroeconomic model to obtain the full, if temporary, equilibrium results. This takes us to integration with the absorption approach. From this point on, we will assume that the appropriate elasticities condition holds, so that $dB/\hat{e} > 0$. Essentially, we assume a devaluation or depreciation increases demand in home-currency terms.

III. Exchange Rate Changes at the Macro Level.

The next step is to integrate the elasticities conditions into a simple macro model. This will allow us to see the general conditions under which a devaluation or depreciation will reduce a trade deficit, taking into account general equilibrium repercussions. The basic point that will emerge is that the domestic price reaction that reduces the relative price effect of the exchange rate change itself reduces real balances and expenditure, reducing domestic absorption. This makes room for the increase in the trade balance to persist in the temporary general equilibrium.

Our "model" is the national income equilibrium condition or IS curve, augmented by an aggregate supply curve. We look at a specialized country that produces a single exportable output, but consumes both the exportable and an import. This could be generalized to a world of countries producing differentiated bundles of outputs, and trading. The basic outline of the absorption approach, and its relation to the elasticities conditions can be shown clearly with this minimum model. We will expand it to include a financial sector in later sections.

The national income equilibrium condition is that output equals expenditure:

$$y = a(y,r,\frac{M}{P},g) + x(\frac{eP^*}{P}) - \frac{eP^*}{P}\, m(e,\frac{aP^*}{P}). \tag{8}$$

Here y is the real value of GDP, a is absorption as a function of income (= output with $0 < a_y < 1$, the interest rate r, real balances M/P, and exogenous government purchases. For the present, we assume the country is small in financial markets. Since we are analyzing the effects of an in the exchange rate here, we assume the <u>expected</u> change is zero, so r is fixed by an uncovered interest parity condition $r = r^*$. M is the money stock, fixed by the authorities in the temporary equilibrium. The price level P is endogenous.

The trade balance is stated in real home-currency terms. Exports depend on their price relative to world prices, with $P^* = 1$. Real imports depend on absorption and relative prices. The multiplicative term eP^*/P transforms nominal imports in foreign prices into real imports in home currency. The effects of relative price changes are the usual $x_e > 0$ and $m_e < 0$. The ambiguity associated with the elasticities conditions is expressed by the multiplicative price term on imports. We assume sufficient elasticity that an increase in e increases $[x - eP^*/P\cdot m]$, the real trade balance in home currency.

Equation (8) includes two endogenous variables y and P. An aggregate supply curve closes the system:

$$P = P(y). \tag{9}$$

Here we will make the Keynesian assumption that $0 < P_y < \infty$. The particular analytic results below would also hold if we made the neoclassical assumption that $P_y \to \infty$. This indeed will be the simplifying assumption of sections IV and V. Substituting the supply curve (9) into the national income condition gives us the aborption equation:

$$y(P) - a[y(P), r^*, \frac{M}{P}, g] = x(\frac{eP^*}{P}) - \frac{eP^*}{P} m(a, \frac{eP^*}{P}). \tag{10}$$

An increase in P increases output more than absorption since $a_y < 1$ and through the real balance effect on absorption. Either would be sufficient. If $P_y \to \infty$, a price increase leaves output unchanged but reduces abosrption via the real balance effect. If the appropriate elasticities conditions hold, an increase in P reduces the trade balance $x - eP^*\cdot m$. Equilibrium condition (10) is illustrated in Figure 2. The intersection of the y - a and trade balance curves gives the trade deficit (left of zero) in equilibrium.

A devaluation shifts the trade balance curve in Figure 2 up. This pulls up the domestic price level, increasing y - a. As the price level rises, output rises along the supply curve given by equation (9), and absorption rises less. A devaluation that put the trade balance curve through the point where y - a intersects the vertical axis would result in elimination of the initial deficit. A direct reduction in absorption via a reduction in M or y would shift y - a down, pushing the domestic price level down. A shift in y - a to the point where the trade balance curve intersects the vertical axis would also eliminate the intitial deficit. The devaluation, shifting the trade balance curve, is an example of "expenditure-switching" policy; the direct cut in absorption is "expenditure-reducing" policy. Clearly a combination of the two could eliminate the deficit with no predictable change in the price level. This is the usual macro policy prescription: devalue and reduce government spending.

The essential point of Figure 2 is the demonstration that the increase in the domestic price level following a devaluation in general will not be sufficient to eliminate the impact effect of the devaluation on the trade balance. This impact effect is the shift of the trade balance curve in Figure 2. The increase in P increases y - a, leaving a positive effect on the trade balance in the new temporary equilibrium.

The essential point of this section of the paper is to show how the elasticities calculations of the effects of exchange rate changes on trade, the second arrow in Figure 1, can be integrated into a macro framework without changing the qualitative results. So this step in the dynamics of Figure 1 is consistent with those dynamics being embedded in a broader macro framework. Next we will add asset markets with imperfect substitutability to the goods market equilibrium conditions (10) to study the effects of macroeconomic disturbances on exchange rates and exchange rate dynamics.

IV. Macroeconomic Effects on Exchange Rates.

In sections II and III we studied the effects of exogenous changes in exchange rates on trade and equilibrium output and the price level. Here we turn to macroeconomic determinants of the exchange rate and interest rates. We add a simple specification of financial-market equilibrium that includes just enough complexity to make the basic points. In this section we outline the "fundamentals" model with static expectations, filling in the first and third arrows in Figure 1. In the next section we study dynamics with rational expectations. A basic point in this section is that movements in interest rates and the exchange rate are determined by the interaction of the financial and real sectors. The particular example we will focus on is a major shift in fiscal policy.

National Income Equilibrium.

To simplify the analysis, we will assume here that the supply curve in equation (9) is vertical; $P_y \to \infty$. This can be interpreted as a neoclassical assumption. I would prefer to interpret this as implying that the focus is on full-employment effects. The point will be that various disturbances give rise to changes in interest rates and exchange rates at full employment, putting aside cyclical effects. We assume the appropriate trade elasticities conditions hold, so that a rise in eP^*/P increases the trade surplus in home currency. So we will write $x(\frac{e}{P}, a, \alpha)$ to denote the trade surplus in home currency, with $P^* = 1$, and α introduced as a shift parameter representing phenomena such as technical advance in traded goods production.

With these simplifications, the goods market equilibrium condition (8) can be re-written as

$$\bar{y} = a(r,\frac{W}{P},g) + x(\frac{e}{P},a,\alpha). \qquad (11)$$

Output y is suppressed in the absorption function since it is constant. We assume home and foreign assets are imperfect substitutes, so that r can move relative to the world interest rate r^*. Real wealth is an argument in the absorption function in place of real balances to allow for foreign asset holdings. Income on foreign assets is implicitly included in x in equation (11) for simplicity. Later it will be treated explicitly.

The goods market equilibrium condition (11) has three endogenous variables, r, P, and e. If we think of the three-dimensional space with r, P, and $\frac{1}{e}$ on the axes, this is a negatively-sloped plane in that space. An increase in the price level reduces demand via both absorption and net exports. This requires some combination of a reduction in interest rates or an increase in the exchange rate e to maintain goods market equilibrium.

Figure 3 shows the combinations of r, P, and e that yield goods market equilibrium for given M, g, and α. The exchange rate is inverted on the left-hand axis to permit us to see the plane in the positive orthant. An increase in M, g, or α will shift the plane out, increasing the intercepts. Any of these will increase demand for the home good, requiring some combination of an increase in P and r, and fall in e (appreciation) to hold demand equal to full-employment output. Below we will focus on the effects of a major shift in fiscal policy.

The Financial Sector and General Equilibrium.

The specification of the financial markets is a representation of the portfolio-balance model of Branson (1977, (1983), with restrictions similar to those in Katseli and Marion (1982) and Branson and Henderson (1985). We consider one country with two non-traded assets, a bond B and money M. The asset holders in the country also hold foreign-denominated assets F, which they accumulate or decumulate through a current-account surplus or deficit. We could think of this as a stylized specification of a medium-sized or small European economy.

The world interest rate is taken as given, and therefore suppressed. For a two-country model of this type, see Branson and Henderson (1985). Since the exchange rate is endogenous, we now assume that it is freely flexible; the previous sections give us the effects of exchange rate changes in trade, but now these are determined in the model.

To simplify (and perhaps improve realism), we assume that the demand for money is based only on transactions, not portfolio diversification. Thus increments to wealth at a given level of income go into B or F. With these restrictions, the financial market equilibrium is specified by the following equations:

$$\frac{M}{P} = m(r, \hat{e}); \tag{12}$$

$$B = b(r, \hat{e}, \rho)(W-M); \tag{13}$$

$$eF = f(r, \hat{e}, \rho)(W-M); \tag{14}$$

$$W = M + B + eF. \tag{15}$$

Given $\bar{y}$, the demand for real balances depends on the opportunity costs r and $\hat{e}$, the expected change in the exchange rate. In this section we will assume $\hat{e} = 0$; in section V we will assume rational expectations, i.e. that $\hat{e}$ is the actual rate of change of e.

The demands for bonds and foreign assets are scaled to total wealth less money holdings; this is the result of excluding a portfolio motivation for holding money. The holdings of net foreign assets F are multiplied by e to convert them to home-currency units. The demand for money increases as r or $\hat{e}$ falls. The demand for bonds rises as r increases and falls as $\hat{e}$ increases, and vice versa for the demand for F. The ρ parameter represents a shift of demand from foreign to domestic assets, so $f_\rho < 0$ and $b_\rho > 0$. This will represent a "safe haven" effect when we apply the model to the U.S. case. The adding-up constraint (15) imposes the usual constraint across equations, so that only two of (12)-(14) are independent. If we assume static expectations so $\hat{e} = 0$, and take P as given from the national income equilibrium, (12)-(15) can be solved for r and e, as in Branson (1977) (1983).

The financial market equilibrium values of r and e, given P, are given by the LM line in Figure 3. As P increases, the demand for money rises. This pulls r up, increasing the demand for bonds and reducing the demand for net foreign assets. This in turn reduces e and raises 1/e. An increase in ρ representing a shift in portfolio preferences from F toward B, would rotate the LM line in the direction of the arrow in Figure 3, parallel to the 1/e axis.

The simultaneous equilibrium of the real and financial sectors is given at point A, where the LM line pierces the IS plane. The two independent LM equations plus the IS equation give us three equilibrium conditions in the three endogenous variables r, P, e. We can now move on to study the effects of changes in the exogenous variables on the temporary equilibrium represented by point A. In particular, we wish to focus on fiscal policy g and the safe-haven effect ρ.

Effects of Fiscal Policy.

The first experiment we study is a fiscal expansion, represented by an increase in g. The direction of the impact effects on the exchange rate in this static expectations case gives the direction of the shift of the $\hat{e} = 0$ locus in the rational expectations case of section V. This is because here we assume $\hat{e} = 0$ and find the solution for the jump in e consistent with this. Thus while the static expectations case is of interest in itself, it also provides an input for the rational expectations analysis of section V. The discussion here will be heuristic, in terms of the graphical representation of the model. The mathematics are given in an appendix available from the author..

A fiscal expansion, represented by an increase in g, shifts the IS plane in Figure 3 out. With the LM line positively sloped in the positive orthant, this increases the temporary equilibrium values of P and r, and reduces e. The increase in demand raises P. This increases the demand for money and r. This, in turn, induces a portfolio shift out of foreign assets and reduces e.

A useful way to view the effects of the increase in g at full employment is to see that a combination of private absorption and the trade surplus must be reduced by an amount equal to the increase in g. This "crowding out" is achieved by a combination an increase in P and r that reduces private absorption, and a fall in the real exchange rate e/P that reduces the trade surplus. This is exactly the result obtained in the United States with the expansion of the "structural deficit" beginning in 1982. See Branson, Fraga, and Johnson (1985) for a full analysis of this case.

If the original equilibrium point A was a full equilibrium with balanced trade, so $\dot{F} = 0$, then the new equilibrium is only a "temporary" equilibrium. This is because the fall in e/P causes a trade deficit and capital inflow as part of the financing of the budget deficit implicit in the g increase. So in the new equilibrium $\dot{F} = x < 0$; the economy is decumulating net foreign assets. This takes us to the dynamic adjustment mechanism that carries the economy to a new full equilibrium. The path of that adjustment will be discussed below, after we introduce the effects of changes in F on the LM line.

Effects of a Shift in the Trade Balance.

The shift parameter α was included in net exports in equation (11) to represent changes in competitiveness that are exogenous to the model. An increase in α, generating a trade surplus, also shifts the IS plane out, increasing r and P and reducing e. The rise in r and P reduces absorption, so the real appreciation (fall in e/P) does not fully offset the original effect of α on the trade balance. The result is a trade surplus with reduced absorption. So in the new temporary equilibrium, $\dot{F} = x < 0$, and the economy is accumulating net foreign assets, shifting the LM line in a way to be discussed below.

Effects of Changes in Portfolio Preferences.

A shift in portfolio preferences from foreign to domestic assets for given return differentials is represented by an increase in ρ in the portfolio demand equations (13) and (14). If we think of the economy here as the United States, this could be a representation of the "safe haven" effect.

The increase in ρ rotates the LM line in the plane defined by the 1/e axis and the LM line, as indicated by the arrow in Figure 3. The temporary equilibrium point moves to the left and down along the IS plane, which remains fixed. The result is a decrease in r, P, and e. The portfolio shift moves r and e, and to stay on the IS plane P must fall. The fall in r and P both increase private aborption, so with given $\bar{y}$, x must fall. Therefore e/P must decrease, so e falls more than P. The result is a new temporary equilibrium with $\dot{F} = x < 0$, taking us to the dynamics.

Both the fiscal expansion and the safe haven effects generate a real appreciation, i.e., a fall in e/P. But they differ in their effects on the interest rate. The fiscal expansion raises it, while the shift in portfolio preference reduces it. This may lead us to conclude that fiscal expansion has dominated the safe haven effect in the United States since 1980.

Dynamics of Foreign Asset Accumulation.

The equilibrium conditions (11)-(15) define a "temporary equilibrium" in P, r, and e, given the existing stocks of M, B, and F.

But we see that a change in fiscal policy or portfolio preferences changes the trade balance, which in turn changes the rate of accumulation of net foreign assets F. Thus the original equilibrium was a full stock equilibrium with $\dot{F} = 0$, the new equilibrium has $F \neq 0$, so it is a temporary equilibrium. As net foreign assets accumulate or decumulate, the temporary equilibrium itself moves. If this dynamic process is stable, it moves toward a new stock equilibrium where $\dot{F}$ is again zero.

The equation of motion for the stock of net foreign assets is

$$\dot{F} = x\ (\tfrac{e}{P}, a, \alpha) - r^{*}F. \tag{16}$$

Here net exports x is in foreign exchange, and $r^{*}F$ is investment income. The exchange rate, the price level, and absorption all depend on the stock of net foreign assets F through the temporary equilibrium conditions (11-(15). If on balance $d\dot{F}/dF < 0$, the dynamic system moving F in the static expectations case is stable. The expression for $d\dot{F}/dF$ is

$$\frac{d\dot{F}}{dF} = x_e(\overset{-}{e} - \overset{?}{P_F}) + \overset{-}{x}_a[\overset{-}{a}_r\overset{-}{r}_F + \overset{+}{a}_W(1 - \overset{+}{P_F})] + r^{*}. \tag{17}$$

Here x_e is the derivative of net exports with respect to e/P, which is assumed to be positive. e_F and P_F are the effects of changes in F on e and P in the temporary equilibrium. e_F is negative, but the sign of P_F is unclear. An increase in F through a current account surplus has conflicting effects on demand. Since r_F is negative and wealth is in the absorption function, an increase in F increases absorption. But the effect on trade is negative because an increase in F reduces e. We assume that P_F is smaller than e_F in order to obtain this offsetting trade effect. In the absorption term x_a is negative, as is a_r. The wealth effect on absorption is positive, and we assume that an increase in F increases W/P, so $1 - P_F$ is positive. Thus the trade terms in expression (17) are negative, and they must exceed r^{*} to ensure stability. This is the "super Marshall-Lerner condition" of Branson (1977).

We can now trace the dynamics of fiscal expansion in the model with static expectations. This extends the analysis in Branson (1977) to include fiscal policy. The IS plane shifts out, reducing e and raising P and r. The real exchange rate e/P falls, and a current account deficit develops as a way to finance the budget deficit. The current account deficit gradually reduces the stock of net foreign assets F. This rotates the LM line up and towards the r, P plane in Figure 3.

The reduction in F increases e, reducing the trade deficit, and increases r, reducing absorption further. Here we see an example of "overshooting," with the initial fiscal expanding reducing e, and the subsequent dynamics increasing it. The combination of depreciation and a further increase is the interest rate progressively shifts the burden of financing the fiscal expansion away from the current account and toward absorption. This dynamic process continues until the current account is back in balance, and the increase in g has fully crowded out domestic abosrption at full employment.

Following a shift in portfolio preferences toward the home asset, a new temporary equilibrium is reached with $\dot{F} = x < 0$. The dynamic adjustment proceeds as in the fiscal policy case, with F decreasing and r and e rising. Here we see an example of undershooting in response to a real disturbance to the trade account. The exchange rate continues to rise until the current account is back to zero and the system has returned to stock equilibrium.

These examples provide illustrations of the dynamics of exchange rate and current account adjustment with static expectations. This is the "fundamentals" model of exchange rate dynamics. We now add to this model another layer of analysis by introducing rational expectations.

V. Exchange Rate Adjustment with Rational Expectations.

The static expectations solutions and dynamics give us the basic inputs needed to study the rational expectations dynamics that are likely to drive the actual interaction between exchange rates and the current account. The dynamic analysis of this section begins with the model of Branson (1983), which deals with the case of a net international creditor. We then go on to analyze the case of an international debtor, and the dynamics of a switch from creditor to debtor. This discussion is foreshadowed in Buiter (1984). Here we see most clearly the interaction of movements in exchange rate and the current account.

Financial Sector Equilibrium.

In a stochastic world, rational expectations mean that expectations are unbiased predictors of movements in the relevant variables. There may be a wide error distribution around the empirical forecast, however. Agents with rational expectations know they will always forecast incorrectly; their forecasts will be right only on average! We interpret the assumption in a non-stochastic model as "perfect foresight." The seeming precision of this assumption, however, is due to the need to simplify from a stochastic to a deterministic framework; it is not fundamental to rational expectations in general.

Now we assume that $\hat{e}$ in equations (12)-(14) is both the expected and actual percentage change on the exchange into the future. Two of these three equations can be solved for equilibrium values of r and $\hat{e}$, given e and F. The equation for $\hat{e}$ can be combined with equation (16) for $\dot{F}$ dynamic system in e and F. Begin with the total differentials of equations (12) and (14):

$$d(\frac{M}{P}) = m_r dr + m_{\hat{e}} d\hat{e};$$

$$d(\frac{eF}{W-M}) = f_r dr + f_{\hat{e}} d\hat{e} + f_\rho d\rho_\rho.$$

these can be solved for dr and $d\hat{e}$ in matrix form as:

$$\begin{pmatrix} dr \\ \\ d\hat{e} \end{pmatrix} = \frac{1}{|A|} \begin{bmatrix} f_{\hat{e}} & -m_{\hat{e}} & 1 & 0 & 0 \\ \\ -f_r & m_r & 0 & 1 & -f_\rho \end{bmatrix} \begin{pmatrix} d(\frac{M}{P}) \\ d(\frac{eF}{W-M}) \\ d\rho \end{pmatrix} \qquad (17)$$

where $|A| = m_r f_{\hat{e}} - f_r m_{\hat{e}} \overset{?}{<} 0$. The sign of the determinant is unclear. If m_r and f_r are the same order of magnitude and $f_{\hat{e}} < - m_{\hat{e}}$ as it must since $b_{\hat{e}} + f_{\hat{r}} + m_{\hat{e}} = 0$, then $|A| < 0$. We assume this is the case. It may even be plausible to assume that $m_{\hat{e}}$ is close to zero.

The solution for $d\hat{e}$ can be written out:

$$d\hat{e} = \frac{1}{|A|} [-f_r d(\frac{M}{P}) + m_r d(\frac{eF}{W-M}) - f_\rho m_r d\rho \ ].$$

the coefficients are the partial derivatives of the implicit dynamic equation for $\hat{e}$:

$$\hat{e} = \phi(\frac{M}{P}, \frac{eF}{W-M}, \rho); \ \phi_1 < 0; \ \phi_2 > 0, \ \phi_3 > 0. \qquad (18)$$

This is essentially the same solution as obtained in Branson [1983, eq. (9)], with the "safe haven" parameter added.

The e, F loci for $\hat{e} = 0$ are shown in Figure 4, which is the same as Buiter's (1984) Figure 2.C.1. These are the two branches of the rectangular hyperbola along which eF is constant at the value consistent with $\hat{e} = 0$, for given M/P and ρ. The eF solution could be positive (creditor) or negative (debtor). The $\hat{e} = 0$ loci give the adjustment of e to changes in F with static expectations. With rational expectations, movements of points not on the loci follow the vertical arrows. If F is positive, a value for e above the $\hat{e} = 0$ locus will be consistent with equilibriumn only if e is expected to rise, and vice versa below $\hat{e} = 0$. With F negative, a value of e higher than $\hat{e} = 0$ would be a debt greater than that consistent with the exchange rate expected to remain constant. This higher debt could be consistent with equilibrium only if the exchange rate is expected to fall, i.e. the debt to shrink, and vice versa below $\hat{e} = 0$.

Changes in M, P, or ρ in equation (18) shift the $\hat{e} = 0$ locus. Since $\phi_1 < 0_1$ and $\phi_2 > 0$, an increase in M/P will shift the positive $\hat{e} = 0$ locus up or the negative one down. An increase in ρ (shift from foreign to domestic assets) does the opposite.

Current Account Dynamics.

The current account dynamics are given by equation (16) fof $\dot{F}$. A current account surplus increases F, and vice versa. The slope of the $\dot{F} = 0$ locus in Figure 4 is indeterminate. It can be obtained by totally differentiating equation (16) with respect to F and e, setting dF equal to zero, and calculating $de/d\dot{F}$. The reason for the uncertainty about the slope is that an increase in F increases absorption and reduces net exports via a wealth effect, but increases investment income. Thus the effect on the current account is ambiguous, and so is the sign of the change in the exchange rate that will hold the current account at zero in the face of change in F. As in Branson (1984 a,b), we will assume that $\dot{F} = 0$ locus in Figure 4 is flat.

The horizontal arrows in Figure 4 show the direction of movement of F above and below the $\dot{F} = 0$ locus. Assuming the appropriate elasticities condition holds, above $\dot{F} = 0$ the depreciation of the currency (rise in e) generates a current-account surplus and $\dot{F} > 0$. Below the locus, $\dot{F} < 0$. An increase in α in equation (16), representing an improvement in competitiveness, shifts the $\dot{F} = 0$ locus down. An increase in g which raises the domestic price level and increases absorption, shifts the $\dot{F} = 0$ locus up. The direction of the shift gives the movement of the real exchange rate e/P needed eventually to restore current account balance.

Exchange Rate Dynamics.

The $\hat{e} = 0$ locus in the positive qudrant in Figure 4 gives the adjustment of the exchange rate as F accumulates or decumulates with static expectations. This is the stable adjustment pattern that was discussed in section IV. When a country is a creditor, a "high" F produces a "low" e along $\hat{e} = 0$. This means $\dot{F} < 0$ and F shrinks, etc. From equation (18), we see that as F decreases, the value of e that is consistent with $\hat{e} = 0$ increases.

In the negative quadrant of Figure 4, the situation is reversed. From equation (18), we see that if F is negative (a debtor country), to hold eF constant as F decreases (increases in absolute value), e must fall. So along $\hat{e} = 0$ in the negative quadrant, the static-expectations dynamics are unstable. In the positive qudrant, e and F move toward the equilibrium along $\hat{e} = 0$; in the negative quadrant they move away. This instability in the debtor case with static expectations was noted in Branson, Halttunen, and Masson (1979).

The instability with static expectations when $F < 0$ recalls the stability problems with income effects of net suppliers in Hicks Value and Capital (1946, ch.5). In the positive quadrant, with $F > 0$, an increase in F leads one to sell and this reduces e. In the negative quadrant, with $F < 0$, as F increases (decreases absolute value), net worth increases, so one is led to buy and e rises. This seems to be an asset-market analogy to the Hicksian income effect.

With rational expectations, both positive and negative equilibria exhibit "saddle path" stability. This has been previously noted by Henderson and Rogoff (1982), Buiter (1984), and Branson and Henderson (1985). To the northwest and southeast of either equilibrium lies a unique path into the equilibrium along which the exchange rate moves as expected and the system converges to the equilibrium. These are the saddle paths SS. Other dynamic paths such as those originating at A or B in Figure 4 cross the $\dot{F} = 0$ curve vertically or the $\hat{e} = 0$ curve horizontally and explode. These are speculative bubble paths. Along them expectations are met, but they do not converge to an equilibrium. The conventional assumption is that the market eventually eschews the bubble paths and moves along in the neighborhood of the saddle path. For any given non-equilibrium F, the market determines whether the equilibrium is a creditor or debtor position, and moves the exchange rate onto the appropriate saddle path (or to its neighborhood). The $\dot{F}$ and $\hat{e}$ dynamics then move the system toward the equilibrium.

Effects of Fiscal and Monetary Policy.

The effects of monetary policy in the model of Figure 4 have been thoroughly discussed elsewhere. See, for example, Branson (1983), (1983). Here we will focus on fiscal policy and shifts in portfolio preverences.

An expansionary full-employment fiscal shift would shift $\dot{F} = 0$ up a bit in Figure 4, and by raising the price level P either shift a positive $\hat{e} = 0$ locus down or a negative one up, depending on the location of the initial equilibrium. The exchange rate will then jump onto the relevant new saddle path, beginning the dynamics. This is shown in Figure 5, where the initial alternative equilibria E_0 of Figure 4 are reproduced as the starting points. The exchange rate jumps to the relevant E_1 point, and then the system proceeds along the saddle path to the relevant E_2 equilibria. [Ignore E_1' for now]. The jump appreciation throws the current account into deficit as a source of finance for the budget deficit. The exchange rate then depreciates as F falls toward the new equilibrium where domestic saving finances both the budget deficit and domestic investment.

A sufficiently large combination of shift to fiscal ease and monetary tightness can shift the entire equilibrium from positive to negative F. In Figure 5 this is illustrated by the sequence moving from the positive E_0 to E_1', and then to the negative E_2. A large enough cut M/P in equation (18) could change equilibrium F from creditor to debtor. This would move the equilibrium $\hat{e} = 0$ locus from the original positive position through E_0 to the new negative locus through E_2. The exchange rate would then jump to E_1', and the current account deficit would persist long enough to move F into the negative quadrant at E_2. This could possibly describe the fiscal and monetary shift that came about during the period 1979-82 in the United States, which is now an international debtor.

Shift in Portfolio Preferences.

A shift in portfolio preferences from foreign to domestic assets, the U.S. "safe haven" effect, would also shift the positive $\hat{e} = 0$ locus down or the negative one up, with no effect on $\dot{F} = 0$. The results would be qualitatively the same as in Figure 4. One would observe a jump appreciation that generates the deficit, and a gradual depreciation into the new equilibrium. The run-down of F in the adjustment process would effect the portfolio switch.

The difference between the monetary-fiscal scenario and the safe-haven effect is in the movement of the domestic interest rates for Section IV. In the former case they rise, with the shift in portfolio preferences they fall.

VI. Concluding Comments.

In this paper I have tried to integrate the elasticities and absorption approaches to the analysis of devaluation into a popular modern model of exchange-rate dynamics, and to provide an accessible exposition of the model. In doing this, important simplifications have been made, and potentially important channels of adjustment have been omitted.

First, the general equilibrium model of dynamics assumes full employment. We could go back and split all P changes into P and y changes using the supply curve, but it hardly seems worth the effort. In addition, we have seen significant shifts in full-employment fiscal positions in recent years, and analysis of their results seem relevant.

Second, we have not integrated into the model cumulation of stocks of domestic debt. This could be an important additional channel of influence on interest rates and exchange rates. One can imagine the market looking ahead to the integral of the new structural deficit in the United States, calculating the effect on bond prices and interest rates, and moving the latter as soon as the calculation is completed (say, mid-1981). This would move the exchange rate at the same time. This channel is explored in Branson, Fraga, and Johnson (1985).

Third, we have been fairly imprecise in specification of some aspects of the model, aiming at analytical clarity. For example, the price index P should include traded and non-traded goods with an exchange rate effect in it. Output should include a terms-of-trade effect. Perhaps the distinction between nominal and real interest rates should have been introduced. These are all in Branson and Buiter (1983), which simplifies in other directions.

Finally, we could more closely approximate recent events by observing that the fiscal and monetary shifts of the 1980s have not been clear-cut jumps as in Figure 4. Rather, they have been gradually perceived, as if the jumps in Figure 5 occurred over several years. A beginning on this kind of analysis is included in Branson, Fraga, Johnson (1985). Perhaps the next step would be to integrate some of these papers into a simple model. That would be a complicated task.

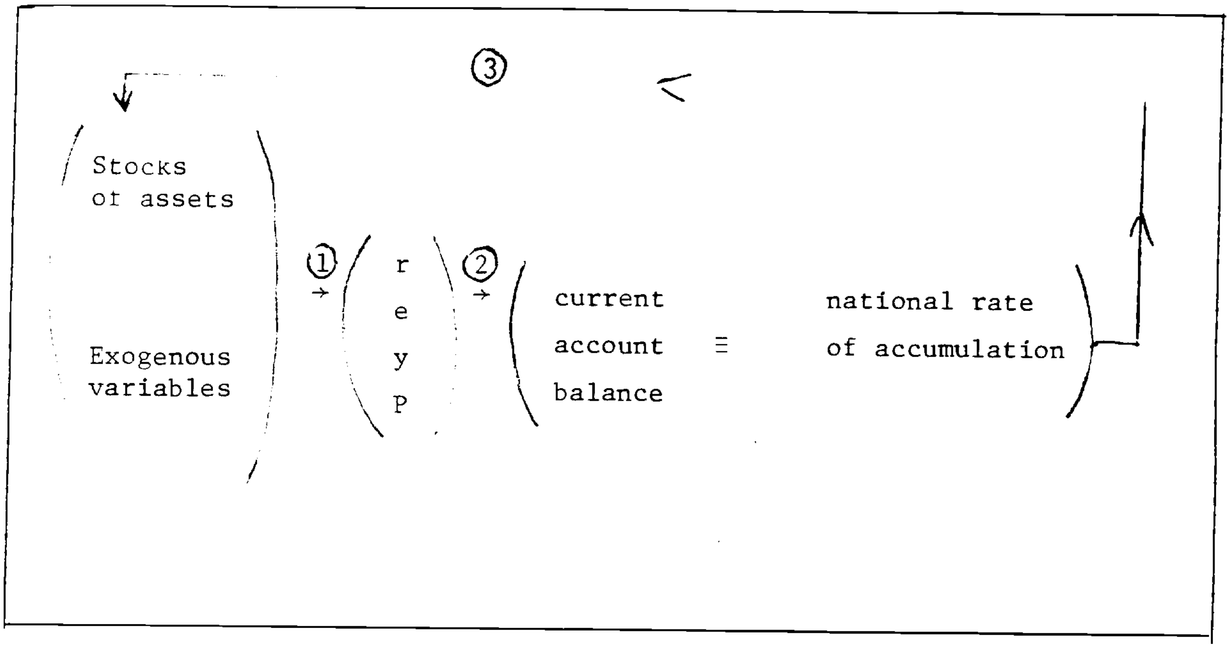

Figure 1: Accumulation and Exchange Rate Dynamics

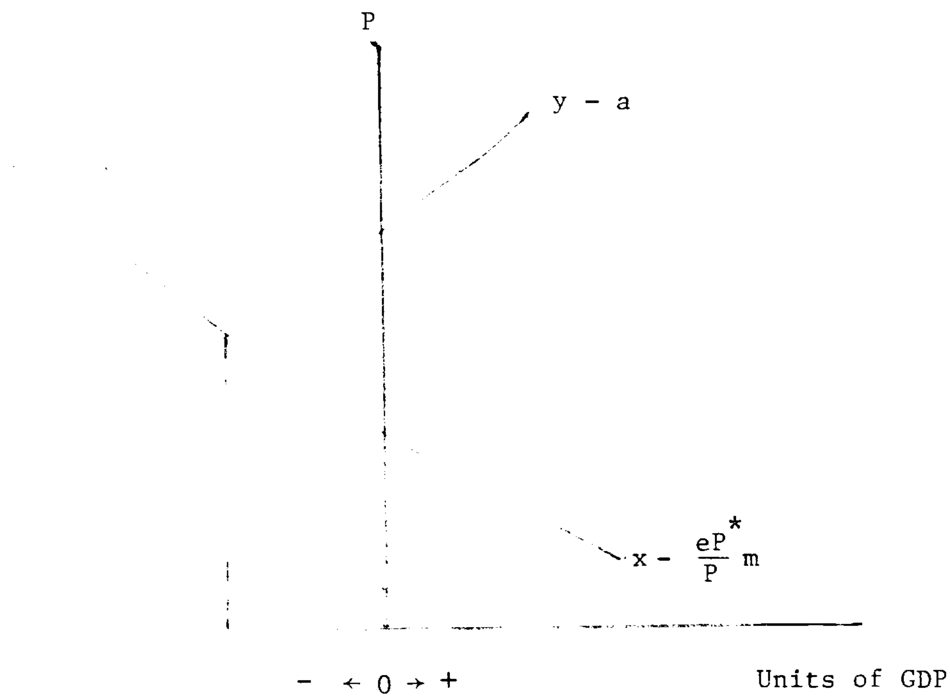

Figure 2: National Income Equilibrium

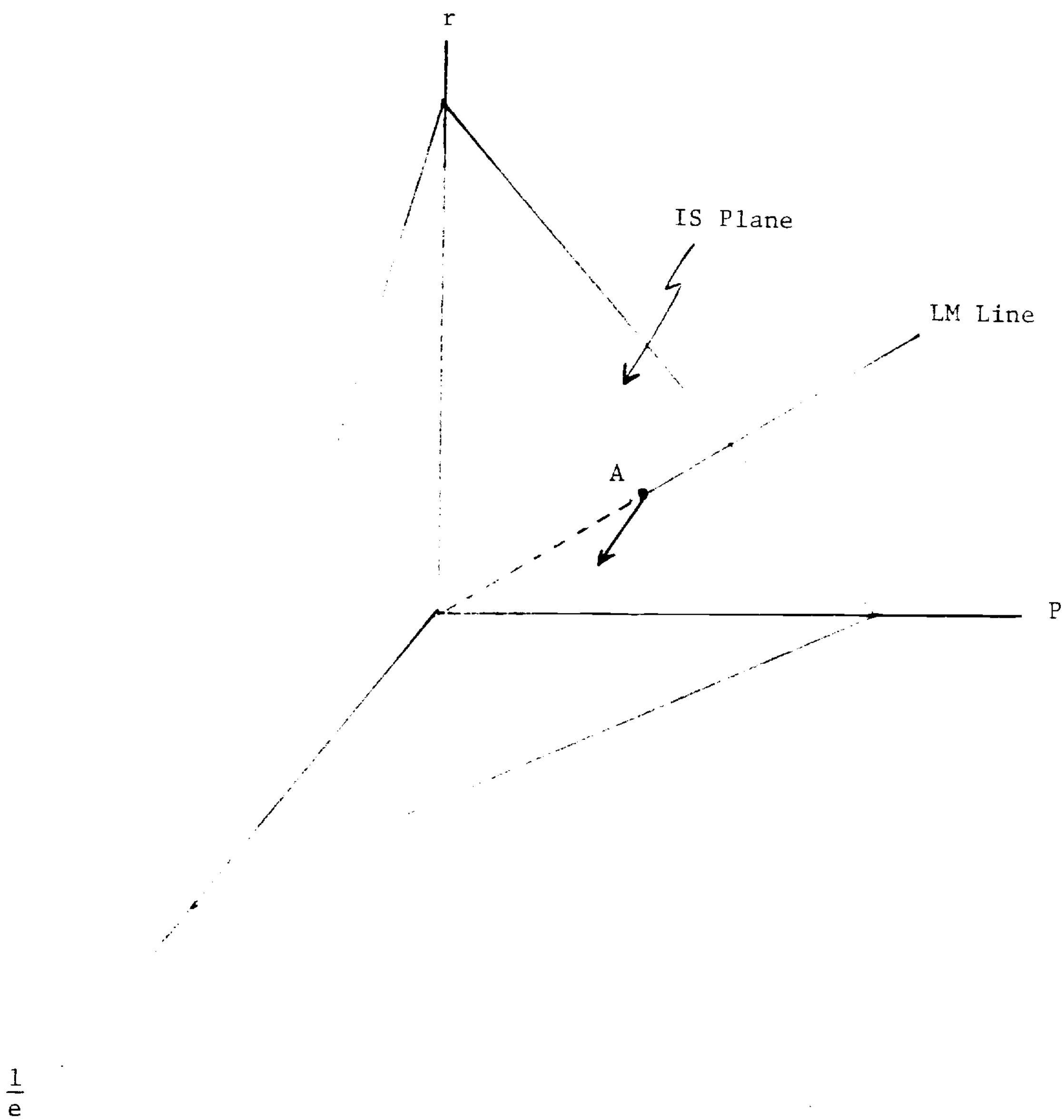

Figure 3: Equilibrium Determination of r, P, e.

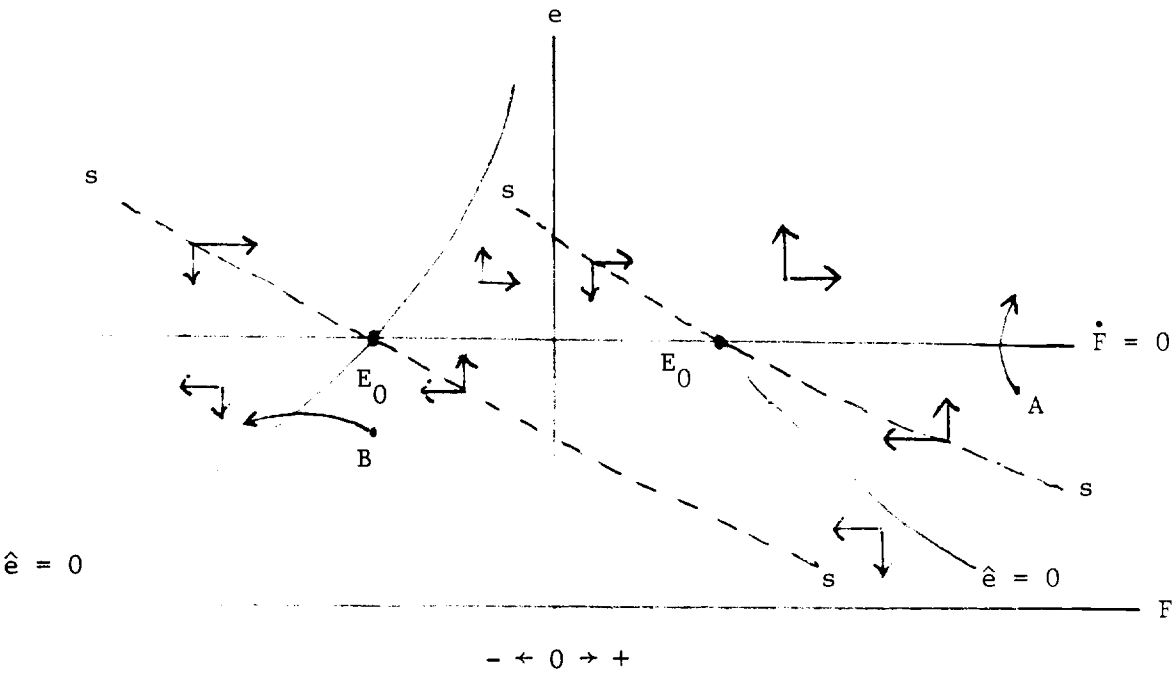

Figure 4: Rational Expectations Solutions for Exchange Rates and the Current Account.

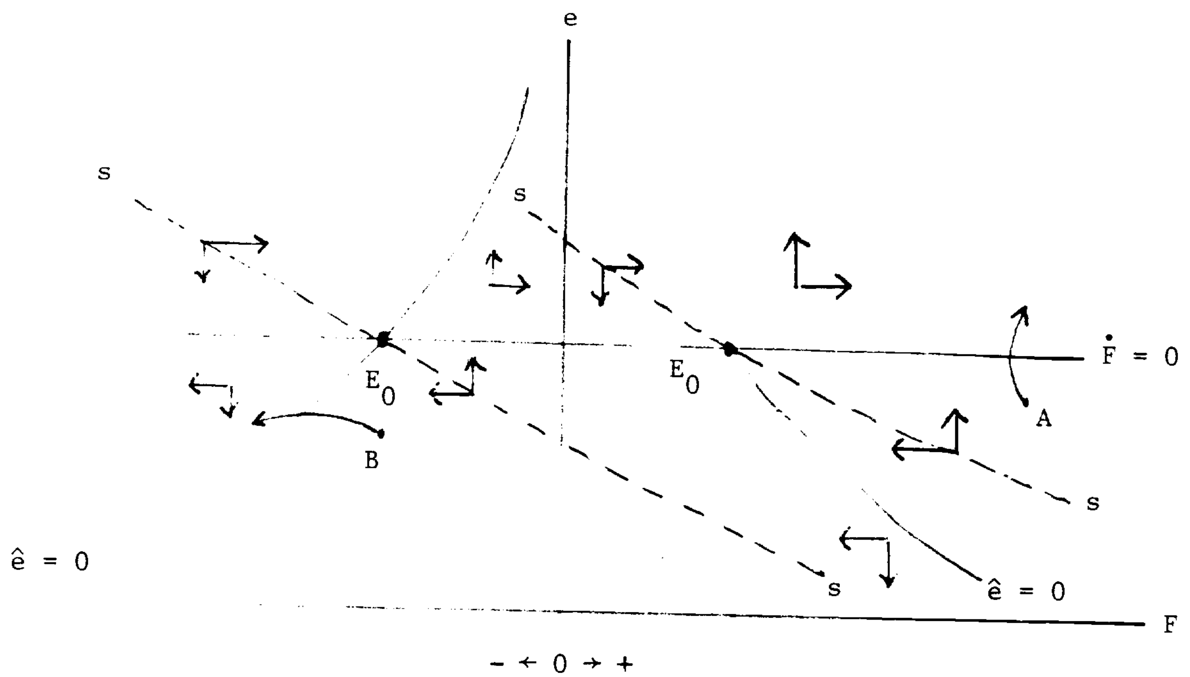

Figure 4: Rational Expectations Solutions for Exchange Rates and the Current Account.

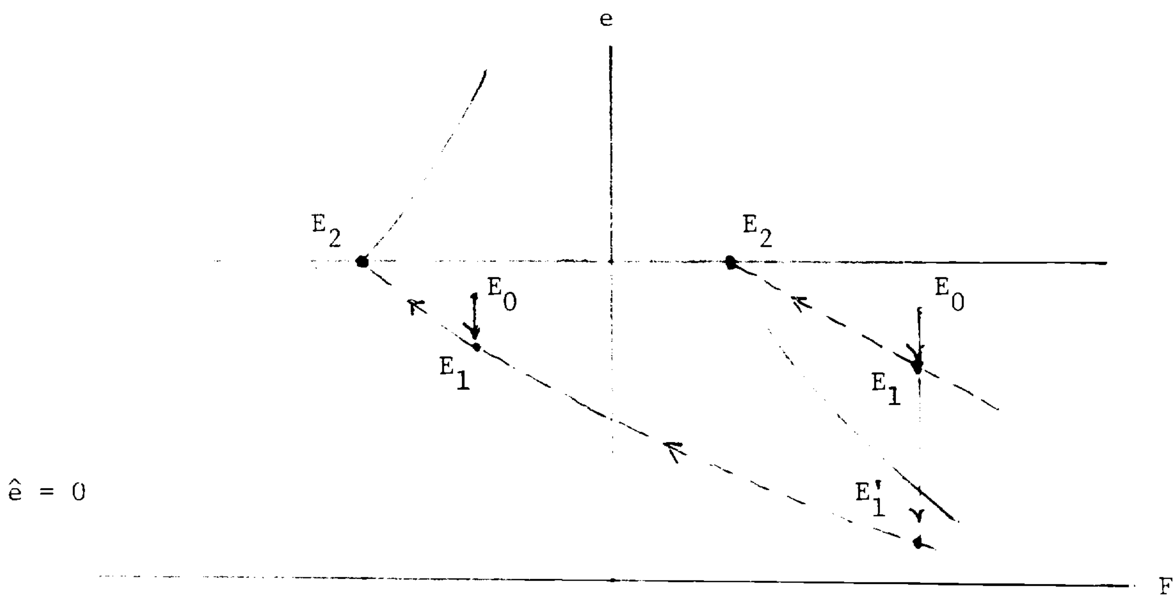

Figure 5: Effects of Fiscal Policy

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