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MONETARY AND FISCAL POLICY WITH FLEXIBLE EXCHANGE RATES

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ABSTRACT

The implications of "perfect" capital mobility for the effectiveness of monetary and fiscal policy and the transmission of disturbances under floating or fixed exchange rates were drawn in the classic paper by Mundell (1963). With fixed rates, fiscal policy moves output but monetary policy does not, and vice versa under flexible rates. These results are among the most enduring and best-known in international economics.

The flexible-rate version of the Mundell model was dynamized by Dornbusch (1976). A crucial feature of both the Mundell and Dornbusch analyses is the exclusion of the exchange rate from the money-market equilibrium condition. However, if the domestic price level is sensitive to changes in the exchange rate, then a movement in the rate changes real balances. Thus fiscal policy influences real balances through the exchange rate, opening the way for effects on home output in the Mundell model or the price level in the Dornbusch version.

In addition to excluding the exchange rate from money-market equilibrium, Mundell and Dornbusch do not consider constraints of long-run portfolio balance. In a stationary economy, these would require balance on the current account in the long-run equilibrium, while the Mundell-Dornbusch model permits current account imbalance indefinitely.

In this paper we revisit the Mundell-Dornbusch model to study its behavior with the price level dependent on the exchange rate, and with long-run portfolio balance constraints. We find that the flexible-rate fiscal policy result is a special case, dependent on the assumption of insensitivity of the price level to movement in the exchange rate.

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I. Introduction and Summary

The implications of "perfect" capital mobility for the effectiveness of monetary and fiscal policy and the transmission of disturbances under floating or fixed exchange rates were drawn in the classic paper by Mundell (1963). With fixed rates, fiscal policy moves output but monetary policy does not, and vice versa under flexible rates. These results are among the most enduring and best-known in international economics.

The ineffectiveness of monetary policy under fixed rates depends on perfect capital mobility and the inability of the monetary authorities to sterilize balance of payments surpluses or deficits. By now, it is well known that during the fixed rate period many countries did indeed sterilize to a large extent. Earlier evidence on this is cited in Whitman (1975); more recent empirical work confirming this proposition has been reported by Obstfeld (1980). Thus the sharpness of Mundell's result for monetary policy with fixed rates does not hold up in light of the empirical evidence on sterilization.

However, the flexible-rate result for fiscal policy has fared better. The model was dynamized by Dornbusch (1976). In his paper, a change in fiscal policy (for example, an increase in government purchases), gives rise to a change in the real exchange rate that yields an exactly offsetting change in the trade balance, transmitting the entire disturbance abroad. A crucial feature of both the Mundell and Dornbusch analyses, though, is the exclusion of the exchange rate from the money-market equilibrium condition. This is a focal point of this paper.

If the domestic price level is sensitive to changes in the exchange rate, then a movement in the rate changes real balances. Thus fiscal policy influences real balances through the exchange rate, opening the way for effects on home output in the Mundell model or the price level in the Dornbusch version. This reduces the effect transmitted abroad.

In addition to excluding the exchange rate from money-market equilibrium, Mundell and Dornbusch do not consider constraints of long-run portfolio balance. In a stationary economy, these would require balance on the current account in the long-run equilibrium, while the Mundell-Dornbusch model permits current account imbalance indefinitely. This is a point noted earlier by both of the present authors [see Branson (1972), Buiter (1978)].

In this paper we revisit the Mundell-Dornbusch model to study its behavior with the price level dependent on the exchange rate, and with long-run portfolio balance constraints. We find that the flexible-rate fiscal policy result is a special case, dependent on the assumption of insensitivity of the price level to movement in the exchange rate.

In section II below we review the Mundell-Dornbusch model, and in section III we present an example of the consequences of inclusion of the exchange rate in the money market equilibrium condition. Then in section IV we introduce a full prototype model with stock adjustment and rational expectations. Section V gives the complete results in a Mundell-style model with a rigid price of domestic output, and section VI gives the results with flexible prices. In general, with flexible exchange rates fiscal policy matters.

II. The Mundell-Dornbusch Model

With "perfect" capital mobility and a freely floating exchange rate, the exchange rate is the transmission belt by which monetary policy affects real output q, while movement in the exchange rate makes output invariant to fiscal policy. These are the results of Mundell's classic paper (1963), (1968). With the price level fixed and the interest rate determined by the world market (and static exchange-rate expectations), an increase in the money stock increases the level of real income consistent with money-market equilibrium. The increase comes through depreciation of the currency (a rise in the exchange rate e) until the increase in the real current account balance gives the requisite increase in income. However, an increase in government spending does not move the money-market equilibrium q; the currency appreciates until the trade balance deteriorates exactly to offset the fiscal expansion.

Dornbusch (1976) up-dated and extended Mundell's model. He added exchange-rate dynamics with "perfect foresight" expectations about movement in the long-run equilibrium exchange rate $\bar{e}$. In the basic model of Dornbusch's paper, the level of output is exogenous, and the rate of inflation $\dot{p}$ responds to the excess demand for goods. Here movements in p (or short-run effects on $\dot{p}$) are the analog to changes in output q in Mundell. Briefly, in section V of his 1976 paper, Dornbusch treats a case with short-run variability in output. Here the analogy to Mundell is clearer.

In both models, monetary policy moves the domestic price level in the long run, and the rate of inflation in the short run. This is the analog to Mundell's effectiveness of monetary policy. However, in Dornbusch as well as in Mundell, a change in government spending moves the exchange rate to create an exactly offsetting effect on the current account balance. Fiscal policy is "ineffective" in both cases; it has no effect on q in Mundell's version, and no effect on p or $\dot{p}$ in Dornbusch.

A. Fiscal Policy Effects

The ineffectiveness of fiscal policy in the Mundell model can be illustrated simply. Money-market equilibrium is given by an "LM" curve,

(1) $\frac{M}{p} = \ell(i, q)$,

where q is domestic output. The interest rate is fixed at the world rate i^* by "perfect" capital mobility:

(2) $i = i^*$.

If a forward discount on the domestic currency, ε, were included, (2) would be

(2') $i = i^* + \varepsilon$.

The IS curve describing goods market equilibrium is

(3) $q = a(q - T, i) + g + x(\frac{p}{e}, a)$.

Here a is private absorption, T is real tax revenue, g is government purchases, and x is net exports.

With i fixed by (2) and p given exogenously, or, alternatively, by a supply curve $p = p(q)$ with $p_q > 0$, equation (1) determines q. There is no room for fiscal effects here. Given T, i, g, and q, the exchange rate is determined by the goods-market equation (3) at the value which sets $x = q - a - g$. An increase in g will require a decrease in e to maintain goods-market equilibrium. Thus in the Mundell model, the exchange rate is determined by requirements of goods-market equilibrium, and fiscal policy changes generate offsetting changes in e.

The Dornbusch model is more complicated, being dynamic, but the result is the same. Dornbusch writes his model as linear in the logs of quantities and prices and the level of the interest rate. His "LM" curve, analogous to the combination of (1), (2'), and $\varepsilon = \theta(\bar{e}-e)$, is

(4) $p - m = -\phi q + \lambda i^{*} + \lambda\theta(\bar{e} - e)$,

where $\bar{e}$ is the long-run equilibrium exchange rate. (This is Dornbusch's equation (3), in our notation.) His "IS" curve (in the basic model with q exogenous) is given by

(5) $\dot{p} = \pi \ln(D/Y) = \pi[u + \delta(e - p) + (\gamma - 1)q - \sigma i]$.

This is Dornbusch's equation (8); his u is "exogenous" expenditure, our g. D is real demand, and Y is exogenous real output.

In long-run equilibrium $e = \bar{e}$, so (4) determines p independently of u (our g), just as in Mundell, money-market equilibrium determines q. An increase in u requires a change in e given by $de/du = -1/\delta$ to hold $\dot{p} = 0$ in (5). With perfect foresight, $d\bar{e} = de$, causing no disturbance in the money market. Thus again, the effect of a change in g (u here) is to generate an offsetting change in e.

B. The Role of Capital Mobility

The Mundell-Dornbusch assumption of "perfect" capital mobility combines two assumptions. This first is freedom of capital movement -- absence of impediments to capital flows in the forms of capital controls, taxes, etc. The second is perfect substitutability of assets denominated in home currency and foreign exchange. The Mundell financial "sector" of equations (1) and (2) can be obtained by simplifying a more general structure with imperfect substitutability as follows. Assume three assets -- money M, bonds B, and net claims on foreigners F. Then a plausible financial-market structure [see Branson (1977), Katseli-Marion (1980)] could be written:

(6) $\frac{M}{P} = m(i, q)$;

(7) $\frac{B}{P} = b(i, i^*, q, \frac{W-M}{P})$;

(8) $\frac{eF}{P} = f(i, i^*, \frac{W-M}{P})$;

(9) $W \equiv M + B + eF$.

If we assume that the foreign interest rate i^* is fixed by world-market conditions (small-country assumption) and that b_{i^*} and $f_i \to \infty$, then the B and F equations (7) and (8) collapse to the perfect capital mobility condition $i = i^*$. (In Branson (1977, p. 73) the FF and BB curves become vertical at $r = r^*$.)

In the more general case of less-than-perfect substitutability, i can move relative to i^* and the extreme form of the Mundell-Dornbusch fiscal policy result disappears. An increase in g will raise i relative to i^*. This will yield an appreciation of the currency and a decrease in x, partially offsetting the g increase. But the offset is only partial, because the increase in i raises velocity, permitting an increase in q, given M. Thus it is clear that the result of literally zero effect of fiscal policy on q (or $\dot{p}$ in the Dornbusch model) is an extreme case with assets being perfect substitutes it is not a general result with "high" substitutability. This is already a familiar result in the literature.

For example, in his earlier paper on "Flexible Exchange Rates and Employment Policy," Mundell (1961) showed that with zero capital mobility, flexible exchange rates increase the closed-economy effectiveness of fiscal policy. A fiscal expansion leads to a trade deficit and depreciation of the currency in that paper.[1/] This effect is also seen clearly in

[1/] In his 1968 adaptation of this paper, Mundell added a footnote calling attention to the difference between the zero and perfect capital mobility cases. See Mundell (1968, p. 247, fn. 9).

Branson (1976). In intermediate cases between zero and perfect capital mobility, the exchange rate may appreciate or depreciate, depending on the relative size of current-account and capital-account effects, thus partially offsetting or supplementing the effect of the critical fiscal expansion. See Branson (1976) and the discussion of Dornbusch (1980) for a fuller discussion of the empirical evidence on the capital-mobility question. In the discussion below we will follow the now-traditional literature in assuming perfect substitutability and the "arbitrage" condition with risk-neutral speculation, so that

$$i = i^* + (\frac{\hat{\dot{e}}}{e}) .$$

This will permit us to focus on the importance of exclusion of the exchange rate from the money-market equilibrium condition.

C. Stock vs Flow Equilibrium

In the conventional model with perfect capital mobility, movements in the current account balance offset the effects of fiscal policy on equilibrium outnut. In equation (3) above, the real exchange rate (p/e) adjusts to provide offsetting variation in x to movements in g. This implies that in momentary equilibrium the current account balance is in general non-zero. If in an initial equilibrium the current account is balanced, then the change in x that offsets a change in g must unbalance the current account. In the model of equations (1), (2), and (3), net foreign investment (= the current account) is non-zero indefinitely. This implies that the rest of the world is willing to accumulate claims on or liabilities to the home country in indefinite amounts and that the home country is willing to issue them. There is no requirement of portfolio balance in this model.

The current account imbalance in the Mundell-Dornbusch model will upset portfolio balance in both the home country and the rest of the world and, by altering wealth, change saving behavior. The IS and LM schedules will not settle to a full equilibrium as long as net foreign investment is non-zero. The implication is that in long-run equilibrium, the current account balance must be zero.[1/] The simplest form of this model was developed in Branson (1976), where it was apparent that the Mundell (1963) results can be obtained with any source of endogenous adjustment of the money stock; they are not unique to the international setting.

In sections IV and V below we will analyze monetary and fiscal policy in a framework that includes explicit consideration of stock vs flow equilibrium. In the instantaneous short run, with historically-given values of the stocks in the system, and with static expectations, flow equilibrium conditions determine the level of output and employment, the vector of prices and interest rates, including the exchange rate, and the rates of accumulation of the stocks. These provide the dynamics that move the system from one equilibrium to the next, and toward a steady state in which the relevant stocks are constant. This characterization of instantaneous and long-run equilibrium is developed, e.g., in Branson (1972, 1976) and Buiter (1975, 1978). Long-run equilibrium in section IV will include the requirement that the current account be in balance, so that the national rate of accumulation of net claims (or liabilities) on foreigners be zero. With rational expectations or perfect foresight even the current momentary equilibrium depends on the entire future path of the economy.

[1/] This assumes no real growth in long-run equilibrium.

III. The Exchange Rate and Money-market Equilibrium

The importance of the exclusion of the exchange rate from the money-market equilibrium condition (1) in the conventional model can be seen if we write $p = p(e)$ with $0 < p_e < 1$ there and in the IS curve (3). In this case, a change in government spending g moves the price level. This changes the real money stock, shifting the LM curve. The result is a change in the equilibrium level of output q, in either the Mundell or the Dornbusch version of the model. By writing $p = p(e)$, we convert equations (1) - (3) into a simultaneous system in e and q.

Consider the revision of equations (1) and (3) to include $p = p(e)$:

$$(1') \quad \frac{M}{p(e)} = \ell(i, q)$$

$$(3') \quad q = a(q - T, i) + g + x(\frac{p(e)}{e}, a) \ .$$

If we substitute $i = i^*$ from (2), this is a two-equation system in q and e. Initialize $p = e = 1$ and take the total differential of (1') and (3') with $di^* = 0$ to obtain

$$(10) \quad \overset{A}{\begin{bmatrix} \ell_q & Mp_e \\ 1-a_q(1+x_a) & (1-p_e)x_s \end{bmatrix}} \begin{pmatrix} dq \\ de \end{pmatrix} = \overset{B}{\begin{bmatrix} 1 & 0 & 0 \\ 0 & -a_q(1+x_a) & 1 \end{bmatrix}} \begin{pmatrix} dM \\ dT \\ dg \end{pmatrix} .$$

Here $x_s = \partial x/\partial(\frac{p}{e})$. The determinant of the coefficient matrix $Det(A) < 0$. The solutions for a change in g, with $dM = dT = 0$ are given by

$$\frac{dq}{dg} = \frac{1}{Det(A)} (-Mp_e) > 0 \ ; \quad \frac{de}{dg} = \frac{1}{Det(A)} \ell_q < 0 \ .$$

An increase in g causes an appreciation of the currency ($de/dg < 0$) but not enough to eliminate the effect on q. For comparison to section IV it is useful to note that a balanced-budget expansion with $dT = dg$ would multiply each of these multipliers by the quantity $1 > [1 - a_q(1 + x_a)] > 0$. This would preserve the signs of the fiscal-policy results, simply reducing their magnitudes. As long as the exchange rate enters the excess demand for money with a positive sign, $dq/dg > 0$ in the short run.

These results are illustrated in Figure 1. The g increase initially takes the IS curve to I_1S_1 . The result is upward pressure on the interest rate and appreciation of the currency (e falls). The rise of p/e shifts the IS curve back to the left. But as e falls, p falls, increasing the real money stock. LM shifts right to a new equilibrium at point 2. There e, p and p/e have fallen and q has increased. Fiscal policy has an effect through the exchange rate changing real balances.

Clearly this result can be generalized. Any argument for inclusion of the exchange rate in the demand function for nominal balances will eliminate the extreme result of the conventional model that $dq/dg = 0$. We chose to include p(e) both because it provides a clear example and because there is good econometric evidence for this link. [See Bruno (1978)]. However, the same result would be obtained if we include wealth as an argument in the money demand function. Then as the exchange rate falls, if the country is a net creditor in foreign denominated assets, the home-currency value of wealth falls, reducing the demand for M. Similarly, the inclusion of exchange-rate expectations in the demand for money would make the effect of fiscal policy non-zero.

Thus it is apparent that the usual result depends on a very strong assumption -- that the exchange rate can be excluded from the money-market equilibrium condition. Since there is ample evidence that it must be included at least through its effect on the price level, it seems clear that the conventional wisdom is too extreme. The basic model of monetary and fiscal policy with floating exchange rates needs modification to include the exchange rate properly in specification of the LM curve, or of the financial sector generally. We next turn to a full specification of the basic model with perfect capital mobility.

IV. A Model of Monetary and Fiscal Policy With Floating Exchange Rates: Mundell Revisited with Stock Adjustments and Rational Expectations.

When domestic and foreign bonds are perfect substitutes in private portfolios, the full model can be represented as in equations (11) - (24).

$$(11)\quad \frac{M}{p} = \ell(i,q,\frac{W}{p}); \qquad \ell_i < 0 \; ; \qquad \ell_q > 0 \; ; \qquad 0 \leq \ell_w \leq 1 \; .$$

$$(12)\quad a(y_d,\; i - (\hat{\dot{\frac{p}{p}}}),\; \frac{W}{p}) + g + x(s,a) = q \; .$$

$$0 \leq a_y \leq 1 \; ; \quad a_i \leq 0 \; ; \quad a_w > 0 \; ;$$

$$x_s < 0 \; ; \quad -1 \leq x_a \leq 0 \; .$$

$$(13)\quad i = i^* + (\hat{\dot{\frac{e}{e}}}) \; .$$

$$(14)\quad W \equiv M + B + eF \; .$$

$$(15)\quad p \equiv V^{\alpha} e^{(1-\alpha)}; \qquad 0 \leq \alpha \leq 1 \; .$$

$$(16)\quad y_d \equiv y + \frac{iB}{p} - T - \frac{ei^*R}{p} \; .$$

$$(17)\quad y \equiv \frac{V}{p} q + \frac{i^*e(F + R)}{p} \; .$$

$$(18)\quad s \equiv \frac{V}{e} \; .$$

$$(19)\quad \dot{M} + \dot{B} - e\dot{R} \equiv Vg + iB - ei^{*}R - pT \;.$$

$$(20)\quad e\dot{R} \equiv Vx + ei^{*}(F + R) - e\dot{F} \;.$$

$$(21)\quad \delta M + \delta B - e\delta R \equiv 0 \;.$$

$$(22)\quad \delta M + \delta B + e\delta F \equiv 0 \;.$$

$$\begin{matrix}(23a)\\(23b)\end{matrix}\quad \hat{\left(\frac{\dot{e}}{e}\right)} = \begin{cases} 0 \\ \dot{e}/e \;. \end{cases}$$

$$\begin{matrix}(24a)\\(24b)\end{matrix}\quad \hat{\left(\frac{\dot{p}}{p}\right)} = \begin{cases} 0 \\ \dot{p}/p \;. \end{cases}$$

Table 1 gives a list of definitions of symbols.

Equation (11) is the LM equation, equating the supply of real balances to the demand. Money demand depends negatively on the nominal interest rate, positively on a transactions variable, proxied by domestic value added, and (in principle) positively on real financial wealth. The price index used to deflate nominal money balances is the consumer price index which is a function both of the price of domestically produced goods and of the price of imports ep_f^*. (p_f^*, the foreign currency price of imports, is set equal to unity for simplicity). A depreciation of the exchange rate will therefore, _cet. par._, reduce the real stock of money. Equation (12) is the IS equation. Domestic private absorption (expressed in terms of domestic goods) plus government spending on goods and services plus the trade balance surplus (expressed in terms of domestic output) equals domestic production. Private absorption depends on real disposable income, the real interest rate and real private financial wealth. Net exports decline when the terms of trade improve and when private domestic absorption expands. The marginal propensity to import is less than unity. For simplicity we assume that all government spending is on domestic output. Private capital formation and real capital stock adjustment are omitted.

Table 1: List of Symbols

A. Notation

M : nominal stock of domestic money

B : nominal stock of domestic government bonds

F : stock of net private sector claims on the rest of the world, denominated in foreign currency

R : stock of official foreign exchange reserves, denominated in foreign currency

q : domestic output

y : real national income

y_d: real disposable private income

a : private absorption

g : government spending on goods and services

x : net exports (trade balance surplus)

T : real taxes net of transfers

i : domestic nominal interest rate

i^*: world nominal interest rate (exogenous)

p : domestic general price level (c.p.i.)

V : price of domestic value added

e : foreign exchange rate (number of $'s per unit of foreign currency)

s : terms of trade

$\dot{z} \equiv \frac{d}{dt} z$

δ : stock shift (differential) operator

$\hat{z}$: the expected value of z

B. Parameter Combinations

$$\Omega_1 = (1-\alpha)\frac{M}{pe} - \frac{\ell_w(M+B-\alpha W)}{ep} > 0$$

$$\Omega_2 = (1+x_a)\{a_y[(q-g)(1-\alpha)\frac{s^{1-\alpha}}{e} - \frac{\alpha i^*F}{p}] + \frac{a_w}{ep}\{M+B-\alpha W]\} + \frac{s}{e}x_s < 0$$

$$\Omega_3 = 1 - (1+x_a)a_y s^{1-\alpha} > 0$$

$$\Omega_4 \equiv x_s s^2 - i^*F + Vx_a\{a_y[(q-g)(1-\alpha)\frac{s^{1-\alpha}}{e} - \frac{\alpha i^*F}{p}] + \frac{a_w}{ep}(M+B-\alpha W)\} < 0$$

$$\Omega_5 \equiv e[Vx_a\frac{(a_y i^* + a_w)}{p} + i^*] < 0$$

$$\Omega_6 \equiv a_y[(q-g)(1-\alpha)\frac{s^{1-\alpha}}{e} - \frac{\alpha i^*F}{p}] + \frac{a_w}{ep}[M+B-\alpha W] > 0$$

$$\Omega_7 \equiv [\Omega_3\frac{\ell_i}{e} + \frac{a_i}{e}\alpha\ell_q]^{-1} < 0$$

$$\Omega_8 = \frac{\alpha s^{\alpha-1}}{p^2}[M-\ell_w W] > 0$$

$$\Omega_9 = (1+x_a)\{a_y[(q-g)(1-\alpha)\frac{s^{-\alpha}}{e} - \frac{\alpha i^*Fs^{-\alpha}}{V}] - \frac{a_w\alpha Ws^{\alpha-1}}{p^2}\} + \frac{1}{e}x_s < 0$$

$$\Omega_{10} = x+sx_s+Vx_a\{a_y[(q-g)(1-\alpha)\frac{s^{-\alpha}}{e} - \frac{\alpha i^*Fs^{-\alpha}}{V}] - \frac{a_w W\alpha s^{\alpha-1}}{p^2}\} < 0$$

$$\Omega_{11} = -(\frac{\ell_i\Omega_9}{e} - \frac{a_i\alpha}{e}\Omega_8)^{-1} < 0$$

Equation (13) reflects the assumption of risk-neutral speculation in the foreign exchange market: the domestic interest rate equals the exogenous world interest rate plus the expected proportional rate of depreciation of the home currency. Private financial wealth equals the sum of private holdings of domestic money, domestic government bonds and foreign bonds (equation 14). It is assumed that only domestic residents hold domestic government bonds. All foreign lending or borrowing is done in foreign currency-denominated bonds. The general price level used to deflate nominal assets and nominal income is defined in (15). The Mundell-Dornbusch analysis represents the special case where α , the weight of home goods prices in the c.p.i., is unity. Equation (16) defines real private disposable income. Real national income is defined in (17). Note that changes in the terms of trade can alter the real income corresponding to a given volume of domestic output. The open-economy government budget constraint is given in (19). It is assumed that a competitive interest rate is paid on official foreign exchange reserves. The balance of payments identity is given in (20). Complementing these flow constraints are the stock-shift constraints for the public sector (21) and the private sector (22). These constrain the instantaneous portfolio reallocations that public and private agents can engage in. Expectations are either static (23a and 24a) or rational (23b and 24b).

We shall make two further simplifying assumptions about government financing behavior. The first is that the government always balances its budget by endogenous changes in taxes. Thus, when we consider fiscal policy, we shall be deriving short-run and long-run balanced budget multipliers. This is represented by (25):

(25) $Vg + iB - ei^{*}R - pT \equiv 0$.

The second assumption is that the government does not engage in "flow" open market operations and does not sterilize balance of payments deficits or surpluses. This means that

(26a) $\dot{B} = 0$.

We shall assume that there is a pre-existing stock of government debt, i.e. that

(26b) $B > 0$.

The implication of (25) and (26a) is, from (19), that

(27) $\dot{M} = e\dot{R}$.

Our model is the standard neo-Keynesian open-economy model. The country is small in the market for its imports and in the world capital market but large in the market for its exportable. The terms of trade are therefore endogenous.

Under a freely floating exchange rate, $\dot{R} = \delta R = R = 0$, and therefore, given our assumptions of a balanced budget and of no continuous open market operations, $\dot{M} = 0$. The model can be summarized as in equations (28)-(30).

$$(28)\quad \frac{M}{V^{\alpha}e^{1-\alpha}} = \ell\left(i^{*} + \left(\frac{\hat{\dot{e}}}{e}\right),\ q,\ \frac{M+B+eF}{V^{\alpha}e^{1-\alpha}}\right) .$$

$$(29)\quad a\left(\left(\frac{V}{e}\right)^{1-\alpha}(q-g) + \frac{i^{*}eF}{V^{\alpha}e^{1-\alpha}}\ ,\ i^{*}+\alpha\left[\left(\frac{\hat{\dot{e}}}{e}\right)-\left(\frac{\hat{\dot{V}}}{V}\right)\right],\ \frac{M+B+eF}{V^{\alpha}e^{1-\alpha}}\right) + g + x\left(\frac{V}{e},\ a(.,.,.)\right) = q .$$

$$(30)\quad e\dot{F} = Vx\left(\frac{V}{e}\ ,\ a(.,.,.)\right) + ei^{*}F .$$

V. Adjustment With a Fixed Price of Domestic Output, V.

In this section we study the behavior of the model of section IV with a fixed price of domestic output V. This is the version of the model that is closest in spirit to the original Mundell model. The price rigidity permits us to observe output effects of policy experiments. In subsection A we study the model with static expectations; in subsection B we consider rational expectations.

A. Static expectations

If exchange rate expectations are static, $\dot{e} = 0$. The impact multipliers are derived from the matrix equation (31).

$$\begin{bmatrix} -(1-\alpha)\dfrac{M}{pe} + \dfrac{\ell_w(M+B-\alpha W)}{pe} & -\ell_q \\ -(1+x_a)\{a_y[(q-g)(1-\alpha)\dfrac{s^{1-\alpha}}{e} - \dfrac{\alpha i^* F}{p}] + \dfrac{a_w}{ep}[M+B-\alpha W]\} - \dfrac{s}{e}x_s & (1+x_a)a_y s^{1-\alpha} - 1 \end{bmatrix} \begin{bmatrix} de \\ dq \end{bmatrix} = \tag{31}$$

$$\begin{bmatrix} \dfrac{\ell_w - 1}{p} & \dfrac{\ell_w}{p} & \dfrac{\ell_w e}{p} & 0 \\ -(1+x_a)\dfrac{a_w}{p} & -(1+x_a)\dfrac{a_w}{p} & -(1+x_a)\dfrac{e}{p}[a_y i^* + a_w] & -(1-(1+x_a)a_y s^{1-\alpha}) \end{bmatrix} \begin{bmatrix} dM \\ dB \\ dF \\ dg \end{bmatrix} .$$

For future reference we define

(32a) $\Omega_1 \equiv (1-\alpha)\frac{M}{pe} - \ell_w \frac{(M+B-\alpha W)}{pe} > 0$.

(32b) $\Omega_2 \equiv (1+x_a)\{a_y[(q-g)(1-\alpha)\frac{s^{1-\alpha}}{e} - \frac{\alpha i^* F}{p}] + \frac{a_w}{ep}[M+B-\alpha W]\} + \frac{s}{e}x_s < 0$.

(32c) $\Omega_3 \equiv 1-(1+x_a)a_y s^{1-\alpha} > 0$.

Ω_1 is assumed to be positive. This will be the case if depreciation of the exchange rate, by raising the general price level, reduces the real supply of money balances by more than it reduces the demand for real money balances. This is more likely the larger the effect of import prices on the c.p.i. (the smaller α). If the country is a net external debtor ($F > 0$), exchange depreciation will increase the real value of debts to the rest of the world. This will reduce the demand for money if ℓ_w is positive. We assume that ℓ_w is sufficiently small for this demand effect to be dominated by the effect of changes in e on the real money supply. There probably is little loss of generality in assuming $\ell_w = 0$: money is dominated by short bonds as a share of value and wealth-related demand for money is likely to be small at the margin. See Ando-Shell (1975) for a case where it is literally zero. Ω_2 is assumed to be negative. This will be so if a depreciation of the exchange rate boosts total (domestic and foreign) spending on home goods. This is the traditional assumption of the elasticities approach: exchange rate depreciation shifts the IS curve to the right. This effect, captured by $\frac{s}{e}x_s$ is present but it is countered by two absorption-reducing effects of exchange rate depreciation. Subject to the qualification of net ownership claims on the rest of the world, exchange rate depreciation, by raising the general price level, reduces real wealth. This reduces absorption and is captured by $\frac{a_w}{ep}(M+B-\alpha W)$. Exchange rate depreciation, by turning the terms of trade against the depreciating country, reduces the real income corresponding to a given value of domestic output. This is reflected in $a_y(q-g)(1-\alpha)\frac{s^{1-\alpha}}{e}$. Against this goes the positive effect on real income represented by the increased real value of net property and interest income from abroad (if F is positive). This is captured by $-a_y \frac{\alpha i^* F}{p}$. We assume that the elasticity effects dominate the absorption reducing effects. Ω_3 is positive if an increase in output raises demand for output by less than the increase in output. We assume this to be the case.

Let the determinant of the matrix on the L.H.S. of (31) be denoted by Δ_1.

(33) $\Delta_1 = \Omega_1\Omega_3 - \ell_q\Omega_2 > 0$.

The impact effect of an open market purchase of bonds, a balanced budget increase in public spending and an increase in net claims on the rest of the world on the two short-run endogenous variables, e and q, are given below. The initial equilibrium is always assumed to be a full stationary equilibrium.

(34) $e = h^e(F;\ M,B,g)$.

(35a) $h^e_M - h^e_B = \frac{1}{p}\,\Omega_3\Delta_1^{-1} > 0$.

(35b) $h^e_g = -\Omega_3\ell_q\Delta_1^{-1} < 0$.

(35c) $h_F^e = -[\ell_w \frac{e}{p} \Omega_3 + (1+x_a) \frac{e}{p} (a_w+a_y i^*)\ell_q] \Delta_1^{-1} < 0$.

(36) $q = h^q(F; M,B,g)$.

(37a) $h_M^q - h_B^q = -\frac{1}{p} \Omega_2 \Delta_1^{-1} > 0$.

(37b) $h_g^q = \Omega_1 \Omega_3 \Delta_1^{-1} > 0$.

(37c) $h_F^q = [\Omega_1 (1+x_a) \frac{e}{p} [a_y i^* + a_w] + \frac{\ell_w e}{p} \Omega_2] \Delta_1^{-1} > 0$ if ℓ_w is small.

In the IS-LM space of Figure 2, an open market purchase of bonds shifts the LM curve to the right, at a given exchange rate. The resulting incipient demand for foreign bonds (capital outflow) causes the exchage rate to depreciate (35a). This depreciation shifts the IS curve to the right and, by raising the general price level, shifts the LM curve back to the left, although not all the way to its original position. In the Mundell-Dornbusch analysis the effect of the exchange rate on the LM curve is ignored. In that model the new short-run equilibrium would be at E_1' rather than at E_1 as in our model. The current account, which was balanced at E_o is in surplus at E_1 . Output increases.

An increase in public spending raises output, causes the exchange rate to appreciate and turns the current account into deficit. This case is essentially the same as shown in Figure 1 in section III earlier. The IS curve shifts to the right at a given exchange rate. The incipient stock-shift inflow of capital causes the exchange rate to appreciate. In the Mundell model the appreciation proceeds until net exports have fallen by the same amount as the increase in public spending. In our model, the appreciation of the exchange rate shifts the LM curve to the right, preserving effectiveness of fiscal policy under a floating exchange rate and perfect capital mobility.

An increase in net claims on the rest of the world shifts the IS curve to the right through the wealth effect on private absorption. Output expands and the exchange rate appreciates. Any wealth effect on the demand for money is assumed to be small enough not to reverse this result.

A.1 Long-run stock equilibrium

Long-run equilbrium is defined by the IS-LM equilibrium plus current account balance: $\dot{F} = 0$ in (30). The long-run equilibrium conditions determining the steady-state values of e, q, and F are

$$\frac{M}{V^{\alpha}e^{1-\alpha}} = \ell(i^{*}, q, \frac{M+B+eF}{V^{\alpha}e^{1-\alpha}}) \ .$$

$$a\left((\frac{V}{e})^{1-\alpha}(q-g) + \frac{i^{*}eF}{V^{\alpha}e^{1-\alpha}} \ , \ i^{*}, \ \frac{M+B+eF}{V^{\alpha}e^{1-\alpha}}\right) + g + x(\frac{V}{e} \ , \ a(.,.,.)) = q \ .$$

$$0 = Vx\left(\frac{V}{e} \ , \ a(.,.,.)\right) + ei^{*}F \ .$$

Note that these steady-state conditions and consequently the steady-state multipliers are the same for both static and rational expectations. These multipliers are obtained from (38).

(38)
$$\begin{bmatrix} -\Omega_1 & -\ell_q & -\ell_w \frac{e}{p} \\ -\Omega_2 & -\Omega_3 & (1+x_a)\frac{e}{p}(a_y i^* + a_w) \\ \Omega_4 & -Vx_a a_y s^{1-\alpha} & -\Omega_5 \end{bmatrix} \begin{bmatrix} de \\ dq \\ dF \end{bmatrix} =$$

$$\begin{bmatrix} \frac{\ell_w - 1}{p} & \frac{\ell_w}{p} & 0 \\ -(1+x_a)\frac{a_w}{p} & -(1+x_a)\frac{a_w}{p} & -\Omega_3 \\ \frac{V}{p} x_a a_w & \frac{V}{p} x_a a_w & -Vx_a a_y s^{1-\alpha} \end{bmatrix} \begin{bmatrix} dM \\ dB \\ dg \end{bmatrix}$$

where

(39a) $\Omega_4 \equiv x_s s^2 - i^* F + Vx_a \{a_y[(q-g)(1-\alpha)\frac{s^{1-\alpha}}{e} - \frac{\alpha i^* F}{p}] + \frac{a_w}{ep}(M+B-\alpha W)\} < 0$,

(39b) $\Omega_5 \equiv e[V\ x_a \frac{(a_y i^* + a_w)}{p} + i^*] < 0$.

Ω_4 is negative if exchange rate depreciation improves the current account. The elasticities effect is reinforced by the increase in the domestic currency value of service account income denominated in foreign exchange (assuming F is positive). It is also bolstered by an adverse terms-of-trade effect which reduces absorption and by the reduction in real financial wealth associated with the rise in the general prive level resulting from the depreciation. Ω_5 is negative if an increase in F worsens the current account. This will only be true if the current-account-improving effect of increased foreign interest income is more than offset by the boost to absorption caused by an increase in F via the wealth effect.

Given these assumptions, (38) has the following sign pattern:

$$\text{(38')}\quad \begin{bmatrix} - & - & -(0) \\ + & - & + \\ - & + & + \end{bmatrix} \begin{bmatrix} de \\ dq \\ dF \end{bmatrix} = \begin{bmatrix} -\frac{1}{p} & 0 & 0 \\ - & - & - \\ - & - & + \end{bmatrix} \begin{bmatrix} dM \\ dB \\ dg \end{bmatrix} .$$

Let Δ_2 be the determinant of the matrix on the LHS of (38).

$$\text{(39c)}\quad \Delta_2 \equiv -\Omega_1[\Omega_3\Omega_5 + Vx_a a_y s^{1-\alpha}(1+x_a)\frac{e}{p}(a_y i^* + a_w)] + \ell_q[\Omega_2\Omega_5 - \Omega_4(1+x_a)\frac{e}{p}(a_y i^* + a_w)] - \ell_w \frac{e}{p}[\Omega_2 V x_a a_y s^{1-\alpha} + \Omega_3\Omega_4] > 0 .$$

Note that the 2x2 submatrix indicated in (38') has a negative determinant. It simplifies the long-run comparative statics to assume that the marginal wealth effect on the demand for money is zero: $\ell_w = 0$. This is assumed in the derivation of the long-run multipliers below. The steady-state multipliers can now be derived easily.

$$\text{(40a)}\quad \frac{de}{dg} = \frac{\begin{vmatrix} 0 & - & 0 \\ - & - & + \\ + & + & + \end{vmatrix}}{\Delta_2} = \frac{-}{+} < 0 .$$

$$\text{(40b)}\quad \frac{de}{dM} - \frac{de}{dB} = \frac{\begin{vmatrix} -\frac{1}{p} & - & 0 \\ 0 & - & + \\ 0 & + & + \end{vmatrix}}{\Delta_2} = \frac{+}{+} > 0 .$$

$$\text{(40c)}\quad \frac{dq}{dg} = \frac{\begin{vmatrix} - & 0 & 0 \\ + & - & + \\ - & + & + \end{vmatrix}}{\Delta_2} = \frac{+}{+} > 0 \; . \qquad \text{(40d)}\quad \frac{dq}{dM} - \frac{dq}{dB} = \frac{\begin{vmatrix} - & -\frac{1}{p} & 0 \\ + & 0 & + \\ - & 0 & + \end{vmatrix}}{\Delta_2} = \frac{+}{+} > 0 \; .$$

$$\text{(40e)}\quad \frac{dF}{dg} = \frac{\ell_q[s^2x_s[1-a_ys^{1-\alpha}] - i^*F\Omega_3 + Vx_a\Omega_6]}{\Delta_2} = \frac{-}{+} < 0 \; ;$$

$$\text{(40f)}\quad \frac{dF}{dM} - \frac{dF}{dB} = \frac{\begin{vmatrix} - & - & -\frac{1}{p} \\ + & - & 0 \\ - & + & 0 \end{vmatrix}}{\Delta_2} = -\frac{1}{p}\,\frac{[s^2x_s[1-a_ys^{1-\alpha}]-i^*F\Omega_3 + Vx_a\Omega_6]}{\Delta_2} = \frac{+}{+} > 0 \; ;$$

where

$$\text{(41)}\quad \Omega_6 \equiv a_y[(q-g)(1-\alpha)\frac{s^{1-\alpha}}{e} - \frac{\alpha i^*F}{p}] + \frac{a_w}{ep}\,[M+B-\alpha W] > 0 \; .$$

The signs of these long-run multipliers are as expected. Expansionary fiscal policy creates a current account deficit in the short run and a lower stock of claims on the rest of the world in the long run (40e). Expansionary monetary policy has the opposite effect on $\dot{F}$ in the short run and on F in the long run (40f).

Assuming $\ell_w = 0$, the only direct consequence of the lower long-run stock of external net worth associated with an increase in g is on the IS curve. It shifts to the left relative to the new short-run equilibrium. The result is a depreciation of the exchange rate and a decline in output relative to the new short-run equilibrium. Relative to the initial equilibrium, however, the exchange rate appreciates and output expands.

The long-run effect of an open market purchase is to further increase output above its new short-run equilibrium level. The exchange rate appreciates relative to the new short-run equilibrium level but not enough to bring it below the initial equilibrium value: there remains a long-run depreciation of the currency.

A.2 Stability

The stability of the model under static expectations can be studied by substituting the short-run equilibrium solutions for e and q ((34) and (36)) into the dynamic equation for $\dot{F}$ given in (30). Linearizing the resulting expression at the long-run equilibrium yields:

$$(42)\quad \dot{F} = \Bigg[sx_a\{a_y(s^{1-\alpha}h_F^q - [(q-g)(1-\alpha)\frac{s^{1-\alpha}}{e} - \frac{i^*F\alpha s^{-\alpha}}{e}]h_F^e + i^*s^{-\alpha}) - a_w\frac{(M+B-\alpha W)}{ep}h_F^e - \frac{e}{p} - \frac{s}{e}(x+sx_s)h_F^e + i^*\Bigg] F .$$

This is the full version of the simpler "super Marshall-Lerner" condition in Branson (1977).

A clear destabilizing influence is exercised by the effect of larger external net worth on the service account ($i^* > 0$). Foreign asset accumulation causes exchange rate appreciation ($h_F^e < 0$) and provided the Marshall-Lerner conditions are satisfied this will cause the trade balance to deteriorate ($\frac{-s}{e}(x+sx_s)h_F^e < 0$). Increased service account income raises absorption and this causes the trade balance to deteriorate ($sx_a a_y i^* s^{-\alpha} < 0$). Larger F boosts output which will also increase absorption and reduce net exports ($sx_a a_y s^{1-\alpha}h_F^q < 0$). The exchange rate appreciation resulting from the larger stock of foreign assets has two further effects on private income. It improves the terms of trade, raising real income and absorption and reducing net exports $(-sx_a a_y(q-g)(1-\alpha)\frac{s^{1-\alpha}}{e} h_F^e < 0)$. It also reduces the real value of foreign interest income which works in the opposite direction $(sx_a a_y \frac{i^* F\alpha s^{-\alpha}}{e} h_F^e > 0)$. Larger F, by increasing wealth, raises absorption and worsens the trade balance $(sx_a a_w \frac{e}{p} < 0)$. The exchange rate appreciation further raises wealth by lowering the general price level. (This assumes the country is not a very large net foreign creditor in which case exchange rate appreciation would cause a large capital loss on external holdings). This again worsens the trade balance $(-sx_a a_w \frac{(M+B-\alpha W)}{ep} h_F^e < 0)$. Whether the stability condition that an increase in net claims on the rest of the world worsens the trade balance by more than it improves the service account is satisfied, is an empirical issue.

B. Rational Expectations

With rational expectations or perfect foresight, the model of equations (28), (29) and (30) becomes:

$$(43)\quad \frac{M}{V^{\alpha}e^{1-\alpha}} = \ell\left(i^* + \frac{\dot{e}}{e},\ q,\ \frac{M+B+eF}{V^{\alpha}e^{1-\alpha}}\right).$$

$$(44)\quad a\left(\left(\frac{V}{e}\right)^{1-\alpha}(q-g) + \frac{i^* eF}{V^{\alpha}e^{1-\alpha}},\ i^* + \alpha\frac{\dot{e}}{e},\ \frac{M+B+eF}{V^{\alpha}e^{1-\alpha}}\right) + g + x\left(\frac{V}{e},\ a(.,.,.)\right) = q.$$

$$(45)\quad \dot{F} = \frac{V}{e}x\left(\frac{V}{e},\ a(.,.,.)\right) + i^* F.$$

Linearizing this system at the long-run equilibrium where $\dot{e} = \dot{F} = 0$, we obtain:

$$(46)\quad \begin{bmatrix} \dot{e} \\ \dot{F} \end{bmatrix} = \begin{bmatrix} (-\Omega_3\Omega_1 + \ell_q\Omega_2)\Omega_7 & -(\Omega_3\ell_w \frac{e}{p} + \ell_q(1+x_a)(a_w+a_y i^*)\frac{e}{p})\Omega_7 \\ -(1-x_a a_y s^{1-\alpha}) \frac{s x_a a_i \alpha}{e} \Omega_1\Omega_7 & -(1-x_a a_y s^{1-\alpha}) \frac{s x_a a_i \alpha}{e} \frac{\ell_w e}{p} \Omega_7 \\ +(-\frac{\ell_i}{e} x_a a_y s^{-\alpha} + \frac{s x_a a_i \alpha}{e}) \Omega_2\Omega_7 - \frac{\Omega_4}{e} & -(-\frac{\ell_i}{e} x_a a_y s^{-\alpha} + \frac{s x_a a_i \alpha}{e})(1+x_a)(a_w+a_y i^*)\frac{e}{p}\Omega_7 + \frac{\Omega_5}{e} \end{bmatrix} \begin{bmatrix} e \\ F \end{bmatrix}$$

in $\dot{e}$, $\dot{F}$, plus

$$(47)\quad q = [-\frac{a_i \alpha}{e}\Omega_1 - \frac{\ell_i}{e}\Omega_2]\,\Omega_7 e + [-\frac{a_i}{e}\alpha\ell_w \frac{e}{p} + \frac{\ell_i}{e}(1+x_a)[a_w+a_y i^*]\,\frac{e}{p}]\,\Omega_7 F$$

for q , where

$$(48)\quad \Omega_7 \equiv [\Omega_3 \frac{\ell_i}{e} + \frac{a_i}{e}\alpha\ell_q]^{-1} < 0 .$$

The sign pattern of the matrix in (46) is

$$(46')\quad \begin{bmatrix} \dot{e} \\ \dot{F} \end{bmatrix} = \begin{bmatrix} + & + \\ ? & - \end{bmatrix} \begin{bmatrix} e \\ F \end{bmatrix} .$$

$\frac{\partial \dot{F}}{\partial F}$ is negative if the effect of an increase in F improving the service account is more than balanced by a deterioration in the trade account.

For this system to have a unique "saddle path" converging to the steady state, the determinant of the matrix in (46) must be negative. This will always be the case if $\frac{\partial \dot{F}}{\partial e}$ is positive. In e-F space, the $\dot{e} = 0$ locus is downward sloping. If the $\dot{F} = 0$ is upward-sloping, a unique downward-sloping saddle path exists. This is shown in Figure 3, where the saddle path is labeled SS' . if $\frac{\partial \dot{F}}{\partial e}$ is negative, the $\dot{F}=0$ locus too is downward-sloping. A unique convergent solution then exists only if the $\dot{F}=0$ locus is steeper than the $\dot{e}=0$ locus.

F is predetermined at any given moment but e is free to make discrete jumps in response to "news". Unanticipated current or future (announced) policy changes or other parameter changes cause e to jump onto the unique convergent solution path. This is the implication of the assumptions of complete (short-run and long-run) perfect foresight and an efficient foreign exchange market. For simplicity, we only consider the case where the policy changes are both unanticipated and implemented as soon as they are announced.

To obtain the complete solution under rational expectations, we combine the information of Figure 3 with the long-run comparative statics of equations 40a-f.

The long-run effect of an open market purchase is for both F and e to rise. In Figure 4, the initial long-run equilibrium is at E_0, the new one at E_1. In response to the unanticipated open market purchase, the exchange rate depreciates at once to e_{01}. With F predetermined, this is the only way the economy can move onto the convergent solution path through E_1. The exchange rate overshoots its long-run equilibrium and after the initial jump depreciation, appreciates smoothly towards e_1. Along the adjustment path, the current account is in surplus and external assets are accumulated.

With static expectation, too, the exchange rate depreciates in jump fashion and afterwards appreciates continuously towards the new long-run equilibrium.[1] It can be shown, however, that the jump will be smaller under rational extations. The intuitive reason is that with rational expectations speculators are aware of the future appreciation of the currency. This increases the demand for domestic money and reduces the amount of the initial depreciation.[2]

The comparison of the impact effects of an open market purchase under static and rational expectations is represented in Figures 4 and 5. In Figure 4, the economy moves to E'_{01} on the $\dot{e}=0$ locus with static expectations, above E_{01} , the rational expectations equilibrium. In Figure 5, with static expectations, the new momentary equilibrium is at E_1 , say . The domestic interest rate is equal to the exogenous world interest rate at i^* . With rational expectations, the new IS and LM curves have to intersect at an interest rate equal to $i^* + \frac{\dot{e}}{e}$. From Figure 4, we know that $\frac{\dot{e}}{e}$ is negative immediately after the unanticipated open market purchase. Since we know also from Figure 4 that the exchange rate sharply depreciates on impact, the new equilibrium must lie between A_1 and A_2 , i.e. at a point such as E_2 . e is higher at E_2 than at E_0 but lower than at E_1 . Thus, relative to E_1 , the IS curve shifts to the left and the LM curve to the right. q has increased at E_2 relative to E_0 , but it can be either below or above the value of output associated with E_1 .

1/ With static expectations, it is irrelevant whether the policy changes are anticipated or unanticipated.

2/ With static expectations the economy always moves along the $\dot{e}=0$ locus in Figure 3. This can be seen by noting that (35c) gives the same relationship between e and F under static expectations as does $\dot{e}=0$ under rational expectations (46).

The long-run effect of a balanced budget increase in public spending is for both e and F to fall. The solution in e-F space is shown in Figure 6. The original long-run equilibrium is at E_0, the new one at E_1. On impact, the exchange rate appreciates with a jump to E_{01}. It overshoots its new long-run equilibrium value. Afterwards, the country runs a current account deficit and the exchange rate depreciates smoothly toward E_1. Since $\dot{e}$ is positive along the adjustment path, the currency is at a forward discount throughout. The jump appreciation of the exchange rate is less under rational expectations than under static expectations because the forward discount reduces the demand for domestic money. The reasoning is identical to the case of an open market purchase. The impact effect on output under rational expectations is positive but many either fall short or exceed that under static expectations.

VI. Adjustment with a Flexible Price of Domestic Output

We now consider the case in which output is always equal to its full employment level and the price of domestic output, V, adjusts flexibly to clear the domestic goods market. This is the version of the model that is closest in spirit to Dornbusch (1976). Full employment output is taken to be constant. Changes in labour supply due to changes in the terms of trade are not considered. See Branson-Rotemberg (1980) for these complications. The recent paper by Dornbusch and Fischer (1980) treats a version of the model, simplified by the elimination of domestic bonds and the service account in the balance of payments. Our results can be considered an extension of theirs to include these aspects of portfolio choice and dynamic behavior.

A. Static Expectations

With static expectations, $\hat{\dot{e}} = \hat{\dot{V}} = 0$. Since q is exogenous, the two short-run endogenous variables determined by the LM and IS curves are V and e.

The impact multipliers relating the instantaneous change in e and V to the changes in the predetermined or exogenous variables M, B, F and g are obtained by totally differentiating (28) and (29):

$$\begin{bmatrix} -\Omega_1 & -\Omega_8 \\ -\Omega_2 & \Omega_9 \end{bmatrix} \begin{bmatrix} de \\ dV \end{bmatrix} = \begin{bmatrix} \frac{\ell_w - 1}{p} & \frac{\ell_w}{p} & \ell_w \frac{e}{p} & 0 \\ -(1+x_a)\frac{a_w}{p} & -(1+x_a)\frac{a_w}{p} & -(1+x_a)\frac{e}{p}[a_w + a_y i^*] & -\Omega_3 \end{bmatrix} \begin{bmatrix} dM \\ dB \\ dF \\ dg \end{bmatrix}, \quad (49)$$

where

50a) $$\Omega_8 = \frac{\alpha s^{\alpha-1}}{p^2}[M - \ell_w W] > 0 ;$$

50b) $$\Omega_9 = (1+x_a)\{a_y[(q-g)(1-\alpha)\frac{s^{-\alpha}}{e} - \frac{\alpha i^* F s^{-\alpha}}{V}] - \frac{a_w \alpha W s^{\alpha-1}}{p^2}\} + \frac{1}{e}x_s < 0 .$$

The effect of a change in V on money market equilibrium is given by Ω_8. If an increase in the price of domestic output reduces the real supply of money balances by more than it lowers the demand for real money balances, as we shall assume, Ω_8 is positive. Ω_9 measures the effect of V on domestic goods market equilibrium. An increase in V cet.par. worsens competitiveness and lowers net exports $(\frac{1}{e}x_s < 0)$. By raising the general price level, it also reduces absorption via the wealth effect $(-(1+x_a)a_w \frac{\alpha W s^{\alpha-1}}{p^2} < 0)$. An increase in V also represents an improvement in the terms of trade. This raises real income and boosts absorption $((1+x_a)a_y(q-g)(1-\alpha)\frac{s^{-\alpha}}{e} > 0)$. Finally, the real value of any net interest income from abroad is reduced by a higher value of V $(-(1+x_a)a_y \alpha i^* \frac{Fs^{-\alpha}}{V} \lesseqgtr 0$ as $F \gtreqless 0$).

We assume that, on balance, an increase in V will tend to create an excess supply of domestic output, i.e. that $\Omega_9 < 0$. Given these conditions, Δ_3, the determinant of the matrix on the L.H.S. of (49) is positive:

$$(51) \quad \Delta_3 = -[\Omega_1\Omega_9 + \Omega_2\Omega_8] > 0 \ .$$

From (49), we obtain the reduced form expressions for e and V.

$$52) \quad e = h^e(F;\ M,\ B,\ g),$$

with

$$53a) \quad h^e_M - h^e_B = -\frac{1}{p}\Omega_9\,\Delta_3^{-1} > 0\ ;$$

$$53b) \quad h^e_g = -\Omega_3\Omega_8\Delta_3^{-1} < 0\ ,$$

$$53c) \quad h^e_F = [\ell_w \frac{e}{p}\Omega_9 - (1+x_a)\frac{e}{p}(a_w + a_y i^*)\Omega_8]\,\Delta_3^{-1} < 0\ .$$

$$54) \quad V = h^V(F;\ M,\ B,\ g)\ ,$$

with

$$55a) \quad h^V_M - h^V_B = -\frac{1}{p}\Omega_2\Delta_3^{-1} > 0\ ,$$

$$55b) \quad h^V_g = \Omega_1\Omega_3\,\Delta_3^{-1} > 0\ ,$$

$$55c) \quad h^V_F = [\Omega_1(1+x_a)\frac{e}{p}(a_y\, i^* + a_w) + \frac{\ell_w e}{p}\Omega_2]\,\Delta_3^{-1} > 0 \quad \text{if } \ell_w \text{ is small.}$$

Qualitatively, these results are similar to those derived for the fixed domestic price level case (reported in 34-37), with the role of q as the short-run endogenous variable taken over by V. An open-market purchase causes exchange rate depreciation (53a) and a rise in the general price level (55a). Note that an increase in the money supply will only be neutral (i.e. will only lead to a depreciation of e and a rise in V by the same percentage as the rise in M) if nominally denominated public sector debt (bonds) is absent from the model. This will be the case either if bonds are not neutral but B happens to be zero or if bonds are neutral, in which case they cease to be part of private sector net worth. With B omitted from the model, it is immediately apparent from (28) and (29) that money is neutral in the short-run.[1/]

With a positive value of B entering into private sector wealth, a percentage rise in V and e equal to the percentage rise in M (brought about either by a helicopter drop or by an open market purchase) would not leave the real equilibrium unaltered: the real value of the stock of interest-bearing public debt would be reduced. With output given exogenously, there would be downward pressure on the interest rate. With perfect capital mobility and static expectations, this would be translated into further depreciation of the exchange rate. After an initial open market purchase, the original i,q equilibrium is regained via further depreciation of e and an increase in the price level.

A balanced budget increase in public spending raises V and causes the exchange rate to appreciate (53b and 55b). In i-q space, the IS curve shifts to the right at given e and V, creating excess demand for home goods and, by raising i above i^* threatening a stock-shift gain in reserves. The original i,q equilibrium is restored by a rise in V and a fall in e that shifts the IS curve back to its original position. The increase in V and the reduction in e exactly cancel each other out as regards their combined effects on money market equilibrium.

[1/] With $B = 0$, the effect of a change in M on e and V is given by h_M^e and h_V^e .

A larger value of net claims on the rest of the world will be associated with an appreciation of the currency (53c) and an increase in the price of domestic output (55c).

An increase in public spending will lead to a current account deficit (assuming the initial equilibrium to be a stationary state). An open market purchase will not affect the current account (or any other real variable), if money is neutral which in turn requires bonds to be neutral. If bonds are non-neutral, then e increases more (in percentage terms) than V. This improvement in competitive position should lead to a current account surplus.

A.1 Long-run Effects of Monetary and Fiscal Policy

The long-run comparative static results again apply to both the static and the rational expectations cases. The long-run multipliers are derived from (56) which is obtained by totally differentiating (28), (29) and (30) with $\dot{F} = 0$.

$$
(56) \quad \begin{bmatrix} -\Omega_1 & -\frac{(M-\ell_w W)\alpha}{pV} & -\ell_w \frac{e}{p} \\ -\Omega_2 & \Omega_9 & (1+x_a)\frac{e}{p}(a_y i^* + a_w) \\ \Omega_4 & -\Omega_{10} & -\Omega_5 \end{bmatrix} \begin{bmatrix} de \\ dV \\ dF \end{bmatrix} =
$$

$$
\begin{bmatrix} \frac{\ell_w - 1}{p} & \frac{\ell_w}{p} & 0 \\ -(1+x_a)\frac{a_w}{p} & -(1+x_a)\frac{a_w}{p} & -\Omega_3 \\ -\frac{V}{p} x_a a_w & \frac{V}{p} x_a a_w & -V x_a a_y s^{1-\alpha} \end{bmatrix} \begin{bmatrix} dM \\ dB \\ dg \end{bmatrix},
$$

where

$$(57)\quad \Omega_{10} = x+sx_s + V\, x_a\{a_y[(q-g)(1-\alpha)\frac{s^{-\alpha}}{e} - \frac{\alpha i^* Fs^{-\alpha}}{V}] - a_w \frac{W}{p^2}\alpha s^{\alpha-1}\} < 0 .$$

Ω_{10} is negative if an increase in the price of domestic output tends to worsen the current account. The elasticities approach suggests that this will be so, provided the Warshall-Lerner conditions are satisfied $(x+sx_s<0)$. Against this, the monetary approach focuses on the effect of changes in the general price level on the real value of given stocks of nominal assets and thus in private spending. A higher value of V would tend to improve the current account through this channel $(-Vx_a a_w \frac{W}{p^2}\alpha s^{\alpha-1} > 0)$.

Similarly, if F is positive, a higher value of V reduces the real value of income from foreign ownership $(-Vx_a a_y \alpha i^* \frac{Fs^{-\alpha}}{V} \gtrless 0$ as $F \lessgtr 0)$. The improvement in the terms of trade associated with an increase in V increases the real income corresponding to any given amount of domestic output. This will boost spending and worsens the current account $(Vx_a a_y(q-g)(1-\alpha)\frac{s^{-\alpha}}{e} < 0)$. On balance, we assume that an increase in V will cause the current account to deteriorate.

A sufficiently small value of ℓ_w is again sufficient (although not necessary) to ensure that Δ_4, the determinant of the matrix on the LHS of (56), is positive.

$$(58)\quad \Delta_4 = \Omega_1[\Omega_9\Omega_5 - \Omega_{10}(1+x_a)\frac{e}{p}(a_y i^* + a_w)] + (\frac{M-\ell_w W}{pV})\alpha[\Omega_2\Omega_5 - \Omega_4(1+x_a)\frac{e}{p}(a_y i^* + a_w)] - \ell_w \frac{e}{p}[\Omega_2\Omega_{10} - \Omega_4\Omega_9] > 0 .$$

The long-run monetary and fiscal policy multipliers (assuming that $\ell_w=0$) are given by

(59a) $$\frac{de}{dg} = \frac{\begin{vmatrix} 0 & - & 0 \\ - & - & + \\ + & + & + \end{vmatrix}}{\Delta_4} = \frac{-}{+} < 0$$

(59b) $$\frac{de}{dM} - \frac{de}{dB} = \frac{\begin{vmatrix} -\frac{1}{p} & - & 0 \\ 0 & - & + \\ 0 & + & + \end{vmatrix}}{\Delta_4} = \frac{+}{+} > 0 .$$

(59c) $$\frac{dV}{dg} = \frac{\begin{vmatrix} - & 0 & 0 \\ + & - & + \\ - & + & + \end{vmatrix}}{\Delta_4} = \frac{+}{+} > 0 .$$

(59d) $$\frac{dV}{dM} - \frac{dV}{dB} = \frac{\begin{vmatrix} - & -\frac{1}{p} & 0 \\ + & 0 & + \\ - & 0 & + \end{vmatrix}}{\Delta_4} = \frac{+}{+} > 0 .$$

(59e) $$\frac{dF}{dg} = \frac{[\frac{M-\ell_w(M+B)}{ep}]\left\{(x+sx_s)(1-a_y s^{1-\alpha})+Vx_a[a_y((q-g)(1-\alpha)\frac{s^{-\alpha}}{e} - \frac{\alpha i^* Fs^{-\alpha}}{V}) - \frac{a_w Was^{\alpha-1}}{p^2}]\right\}}{\Delta_4}$$

$$+ \frac{\frac{\alpha[M-\ell_w W]}{pV}\left\{x_a a_y s^{1-\alpha} i^* F + Vx_a(1+x_a)\frac{a_w}{ep}(M+B)\right\}}{\Delta_4} < 0(?)$$

(59f) $$\frac{dF}{dM} - \frac{dF}{dB} = \frac{-\frac{1}{p}(\Omega_2\Omega_{10} - \Omega_4\Omega_9)}{\Delta_4} = \frac{-\frac{1}{p}[\frac{a_w}{ep}(M+B)(1+x_a)x + sx_s]}{\Delta_4} > 0 . \; 1/$$

1/ Note that to obtain the result that money is neutral, it is not sufficient to set B=0 in (59f). One also has to replace (59f) by

$$\frac{dF}{dM} = \begin{vmatrix} -\Omega_1 & -\frac{(M-\ell_w W)\alpha}{pV} & \frac{\ell_w - 1}{p} \\ -\Omega_2 & \Omega_9 & (1+x_a)\frac{a_w}{p} \\ \Omega_4 & -\Omega_{10} & \frac{V}{p} x_a a_w \end{vmatrix} \Delta_4^{-1}$$

The neutrality results is more easily established through inspection of the long-run equilibrium conditions (28, 29 and 30).

The long-run effect of an expansionary open-market operation is to raise the price of domestic output (59d), depreciate the exchange rate (59b), and to increase the stock of private claims on the rest of the world (59f), with no effect on i and q. The impact effect with flexible prices is to create a current account surplus, which increases the long-run stock of external wealth. If there are no domestic bonds or if domestic government debt is neutral, an increase in M causes e, V, and p to rise in the same proportion as the increase in M with no effect on F. In that case, the impact effect and steady state effect are identical.

A balanced-budget increase in public spending leads to long-run exchange rate appreciation (59a), an increase in the price of domestic output (59c), and (probably) a net loss of external wealth (59e). The impact effect of a balanced budget increase in g is to create a current account deficit. This is matched by a decline in the long-run stock of external wealth.

Note that with e falling and V increasing, there is a magnified long-run appreciation of the real exchange rate (or loss of competitiveness) as a result of an increase in g. To maintain current account equilibrium, private absorption has to fall. This fall in absorption is brought about by a reduction in external wealth.[1/] For both fiscal and monetary policy, the long-run endogeneity of F reduces the magnitudes of the effects on e and V but does not reverse them.

A.2 Stability

To analyze the stability of the system under static expectations, we substitute (52) and (54) into (20). This yields:

[1/] We must assume that the loss of service account income when F falls is not too strong.

$$(60)\quad \dot{F} = \frac{h^V(V;\cdot)}{h^e(F;\cdot)} \times \left[\frac{h^V(F;\cdot)}{h^e(F;\cdot)},\ a\left(\left(\frac{h^V(F;\cdot)}{h^e(F;\cdot)}\right)^{1-\alpha} (q-g) + \right.\right.$$

$$\left.\left. + \frac{i^* F}{h^V(F;\cdot)^{\alpha} h^e(F;\cdot)^{-\alpha}},\ i^*,\ \frac{M+B\ h^e(F;\cdot)F}{h^V(F;\cdot)^{\alpha} h^e(F;\cdot)^{1-\alpha}}\right)\right] + i^* F .$$

This external wealth adjustment equation will be stable if an increase in F causes the trade balance to deteriorate by enough to offset the increased service income from the rest of the world. Since a higher value of F raises V and lowers e, a significant deterioration in the trade balance due to loss of competitiveness is certainly possible. The precise stability condition (for local stability) is $\frac{\partial \dot{F}}{\partial F} < 0$.

B. <u>Rational Expectations</u>

With rational expectations and a flexible domestic price level, the dynamic model of (28), (29) and (30) becomes:

$$\frac{M}{V^{\alpha} e^{1-\alpha}} = \ell\left(i^* + \frac{\dot{e}}{e},\ q,\ \frac{M+B+eF}{V^{\alpha} e^{1-\alpha}}\right) .$$

$$a\left(\left(\frac{V}{e}\right)^{(1-\alpha)} (q-g) + \frac{i^* eF}{V^{\alpha} e^{1-\alpha}},\ i^* + \alpha\left(\frac{\dot{e}}{e} - \frac{\dot{V}}{V}\right),\ \frac{M+B+eF}{V^{\alpha} e^{1-\alpha}}\right) +$$

$$+ g + x\left(\frac{V}{e},\ a(\cdot,\cdot,\cdot)\right) = q .$$

$$\dot{F} = \frac{V}{e}\, x\left(\frac{V}{e},\ a(\cdot,\cdot,\cdot)\right) + i^* F .$$

Satisfactory treatment of this model would involve dealing with a system of three simultaneous differential equations, in e , V and F. To be able to continue our convenient diagrammatic analysis, it is necessary to remove $\dot{V}$ from the model. This can be done provided one of the following three conditions is satisfied:

1. Absorption is interest inelastic $(a_i = 0)$;
2. It is the nominal rather than the real interest rate that affects absorption, in which case $i^* + \frac{\dot{e}}{e}$ is the appropriate argument in the a function;
3. While exchange rate expectations are rational, expectations about the price of domestic output are static. In this case, $i^* + \alpha\frac{\dot{e}}{e}$ is the appropriate argument in the a function.

We shall include $i^* + \alpha\frac{\dot{e}}{e}$ as the interest rate argument in the absorption function to stay as close as possible to the analysis of the fixed domestic price level case.

Linearizing the system at the long-run equilibrium where $\dot{e} = \dot{F} = 0$, we obtain:

(61)

$$\begin{bmatrix} \dot{e} \\ \dot{F} \end{bmatrix} = \left[\begin{array}{c|c} (\Omega_9\Omega_1 + \Omega_8\Omega_2)\Omega_{11} & \left(\frac{\Omega_9 \ell_w e}{p} - \Omega_8\,(1+x_a)(a_w + a_y i^*)\,\frac{e}{p}\right)\Omega_{11} \\ \hline \left(\frac{-a_i\alpha}{e}\Omega_{10} + \frac{s x_a a_i \alpha}{e}\Omega_9\right)\Omega_1\Omega_{11} & \left(-\frac{a_i\alpha}{e}\Omega_{10} + \frac{s x_a a_i \alpha}{e}\Omega_9\right)\frac{\ell_w e}{p}\,\Omega_{11} \\ +\left(-\frac{\ell_i\Omega_{10}}{e} + \frac{s x_a a_i \alpha}{e}\right)\Omega_2\Omega_{11} - \frac{\Omega_4}{e} & -\left(\frac{-\ell_i\Omega_{10}}{e} + \frac{s x_a a_i \alpha}{e}\right)(1+x_a)(a_w + a_y i^*)\frac{e}{p}\Omega_{11} \\ & + \frac{\Omega_5}{e} \end{array}\right] \begin{bmatrix} e \\ F \end{bmatrix}$$

for $\dot{e}$ and $\dot{F}$, plus

$$(62) \quad V = -\left(\frac{a_i\alpha}{e}\Omega_1 + \frac{\ell_i}{e}\Omega_2\right)\Omega_{11}\,e + \left[-\frac{a_i\alpha}{e}\,\ell_w\,\frac{e}{p} + \frac{\ell_i}{e}\,(1+x_a)(a_w + a_y i^*)\frac{e}{p}\right]\Omega_{11}\,F$$

for V, where

(63) $$\Omega_{11} = -\left(\frac{\ell_i \Omega_9}{e} - \frac{a_i \alpha}{e} \Omega_8\right)^{-1} < 0 .$$

The sign pattern of the matrix in (62) is (assuming ℓ_w to be small)

(61') $$\begin{bmatrix} \dot{e} \\ \dot{F} \end{bmatrix} = \begin{bmatrix} + & + \\ +(?) & -(?) \end{bmatrix} \begin{bmatrix} e \\ F \end{bmatrix}$$

For reasons of space, we shall ignore the possible ambiguities, indicated in (61'), attached to the signs of $\frac{\partial \dot{F}}{\partial e}$ and $\frac{\partial \dot{F}}{\partial F}$.

We therefore have a saddlepoint equilibrium with the same general properties as the one drawn in Figure 3.. Combining the downward slope of the convergent saddle path with our long-run comparative static results, the complete dynamic adjustment paths after an unanticipated open market purchase and an unanticipated balanced budget increase in public spending can be derived. The diagrams drawn from the fixed domestic price level case can also serve for the flexible price level case. Thus in Figure 4, after an unanticipated open market purchase, the currency jump-depreciates from E_0 to E_{01}, overshooting its long-run equilibrium. The current account goes into surplus. After the initial jump, the currency gradually appreciates to E_1 with F rising along the way.[1/] The absence of long-run neutrality may seem surprising even if bonds are net worth, as domestic and foreign bonds are perfect substitutes. The reason that a restoration of the original value of private bond holdings (domestic and foreign) does not take place in the long run is the following. Let the open-market

[1/] We assume that bonds are net worth and that money therefore is not neutral.

purchase increase M by a fraction λ. $M+B$ is constant. If this operation were to be neutral in the long run, e and V would have to increase by the same fraction λ. To maintain real net worth at its original level with $M+B$ constant, F will have to increase by a fraction δ, defined by: $(1+\lambda)(M+B+eF) = M+B+(1+\lambda)e(1+\delta)F$. However, any change in F will affect the current account equilibrium through its effect on the term i^*F (it will also affect disposable income). Therefore, unless there is debt neutrality, changes in portfolio composition effected through current account deficits or surpluses will not make open market purchases neutral, even in the long run.

The dynamics of a government spending increase under rational expectations are shown in Figure 6. The impact effect of an unanticipated increase in g is a jump appreciation of the exchange rate from E_0 to E_{01} which overshoots its long-run equilibrium. The economy runs a current account deficit. After the initial shock, the exchange rate depreciates smoothly towards E_1 with the economy reducing its stock of claims on the rest of the world.

As with a fixed V, rational expectations reduce the magnitude of the initial jump in e relative to what it would be under static expectations. Under static expectations, the impact effect on e exceeds the long run effect. For example, with an open market purchase, the initial jump depreciation overshoots the long-run equilibrium depreciation. After the jump, the currency appreciates steadily. Speculators and arbitrators endowed with rational expectations are aware of this steady future rate of appreciation. They immediately increase their demand for the domestic currency, thus reducing but not eliminating the magnitude of the initial jump and the extent to which the exchange rate overshoots its long-run equilibrium.

Figure 1: Effect of Fiscal Policy

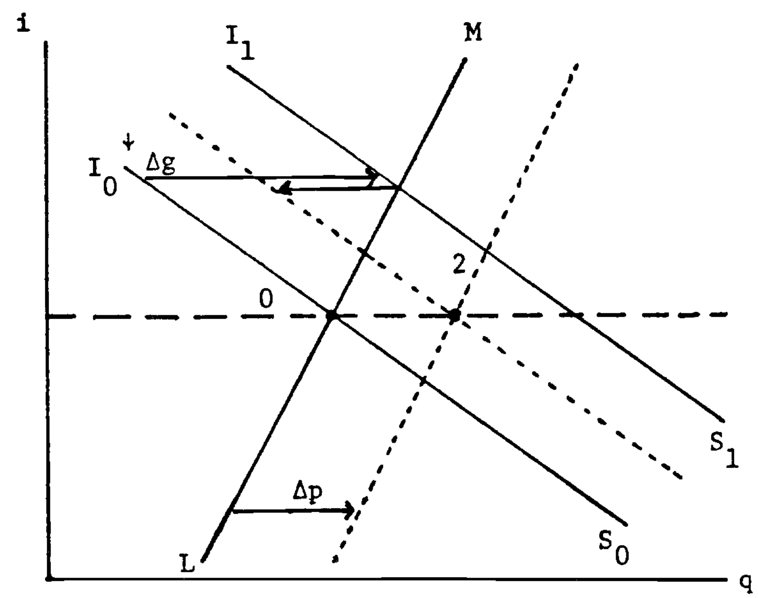
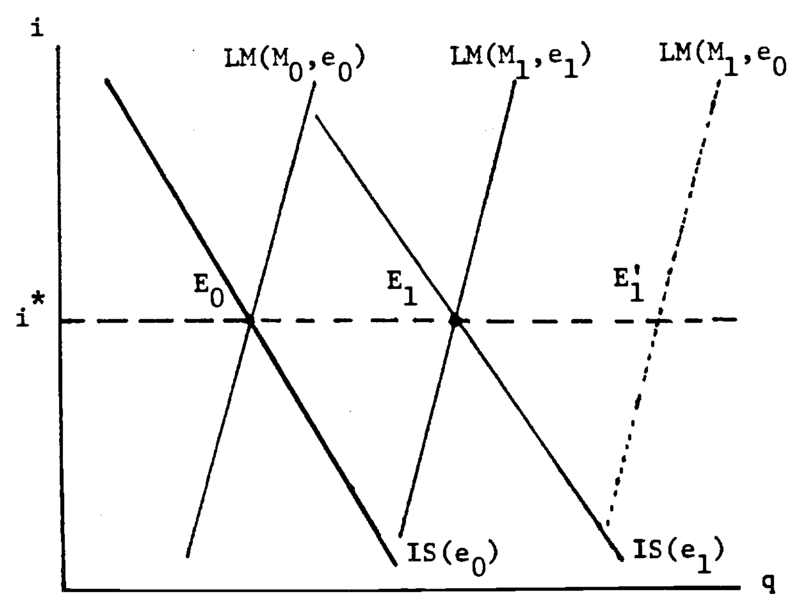


Figure 2: Static Expectations, Short-run Effects of Open Market Purchase



$e_1 > e_0$; $M_1 > M_0$

Original equilibrium E_0 ; New equilibrium E_1

Figure 3: Equilibrium With Rational Expectations

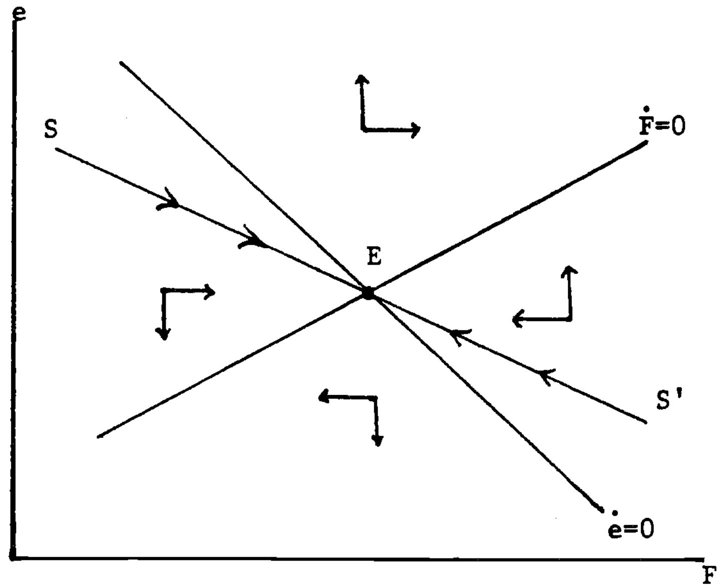


Figure 4: Rational Expectations, Open Market Purchase

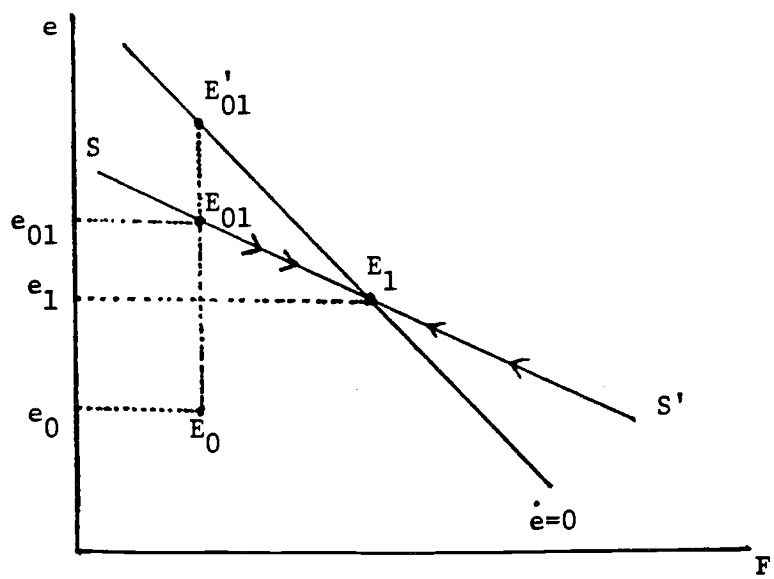
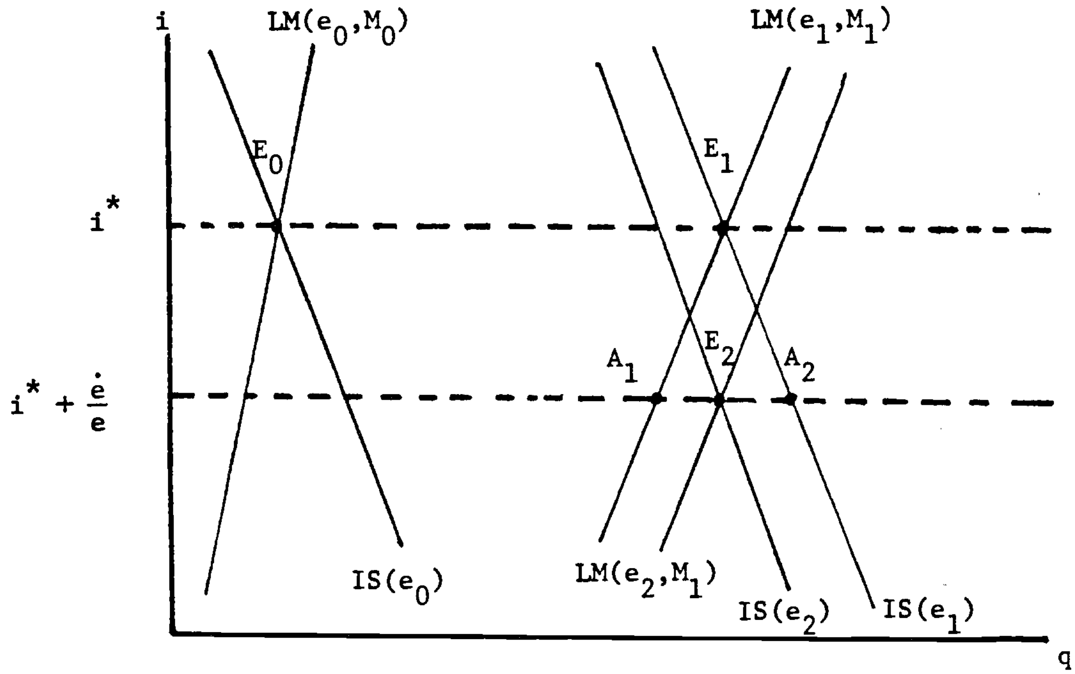


Figure 5: Open Market Purchase, Comparison of Impact Effects Under Static and Rational Expectations



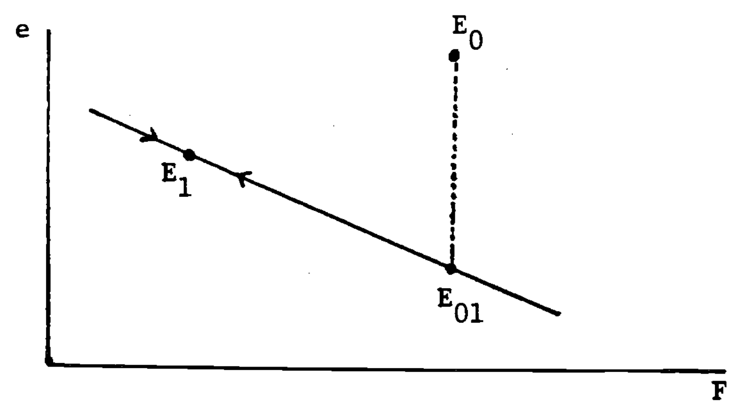
Initial Equilibrium: E_0

Short-run Equilibrium under Static Expectations: E_1

Short-run Equilibrium Under Rational Expectations: E_2

$M_1 > M_0; e_1 > e_2 > e_0$

Figure 6: Rational Expectations, Public Spending Increase



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