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STABILIZATION POLICIES IN OPEN ECONOMIES

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ABSTRACT

This study analyzes the theory of stabilization policy as it has developed from the trade oriented models of the 1950's to the recent models employing rational expectations. Throughout the study one model is presented with appropriate modifications to take into account international capital mobility, wage flexibility, and rational expectations. The Mundell-Fleming model is presented but with an asset sector based on modern portfolio theory. This same model is analyzed under conditions of full wage and price flexibility, and the propositions associated with the monetary approach to the balance of payments and the exchange rate are discussed. A simplified version of the model is then used to examine the policy ineffectiveness propositions of the new classical economics (as applied to open economies). The study concludes with a brief review of the literature on the choice between exchange rate regimes.

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1. Introduction

The modern open economy is not the one found in most macroeconomic textbooks, an economy that occasionally imports Bordeaux wine but which produces most of what it consumes at prices determined domestically. It is rather an economy integrated with those abroad through commodity and financial linkages which limit the scope for national stabilization policy. How that happens is the subject of this chapter.

Many of our ideas about stabilization policy can be traced to what McKinnon (1981) calls the "insular economy" which we discuss in section 2. In such an economy, which was the paradigm most common in the 1950's and earlier, international capital mobility is low or non-existent, money supplies are controlled by the national authorities and price linkages across countries are limited. (Chapter 13 describes this economy in detail.) The literature on stabilization since the 1950's has modified this paradigm in several essential ways. The final product might not be recognized by its original craftsmen.

It is useful to classify these progressive modifications in three categories:

1) Capital mobility. Mundell (1963) and Fleming (1962) showed the importance of international financial linkages in determining the effects of stabilization policy. Their work will be the focus of section 3, but the propositions associated with Mundell and Fleming will be reexamined in the light of recent portfolio balance theories of the asset markets.

2) Wage and price flexibility. Many recent studies, including those associated with the monetary approach to the balance of payments and with the new classical economics, have replaced the rigid wage assumption of Mundell and Fleming with various forms of wage flexibility. In section 4 we introduce wage flexibility into the Mundell-Fleming model and show how much difference

this makes in determining the effectiveness of government policy. When wages are flexible, wealth effects become of primary importance with the accumulation of wealth moving the economy from short run equilibrium to a long run steady state. We illustrate this wealth accumulation process using Dornbusch's (1973) version of the monetary approach to devaluation.

3) Rational expectations and the natural rate hypothesis. No study of stabilization policy is complete without the "new classical macroeconomics." This literature combines the long-run wage and price flexibility of the classical model with an explicit treatment of expectations that includes assumptions about the availability of information which are crucial in determining the effectiveness of stabilization policy. In section 5 we reexamine standard propositions about policy using rational expectations and a stochastic supply function; in section 6 we use the same model to reexamine the choice between exchange rate regimes and the insulating properties of flexible rates.

Throughout the chapter, one general model is used to interpret developments in the literature, with the model being progressively modified to include international financial linkages, wage flexibility and stochastic features. It focuses on a single national economy, although a foreign economy is added later in the chapter. This economy is assumed to produce its own (composite) good and to issue its own interest-bearing bond. In limiting cases commodity arbitrage pegs the price of the good at purchasing power parity and financial arbitrage pegs the interest rate at (uncovered) interest parity. The chapter will show how stabilization policy is affected by each of these linkages.

A chapter which treats such a broad range of issues must draw the line somewhere. We do not attempt to discuss the literature on non-traded goods or bonds. Nor do we discuss in detail the dynamic responses to policy changes that have been a dominant feature of some recent models. (Chapters 15 and 18 analyze this literature.) Even so, our general model will be required to span a wide range of recent developments. A single unifying framework will serve to place these developments in a clear perspective.

2. Stabilization policy in the insular economy

The balance of payments and exchange rate play very different roles in stabilization policy depending upon whether or not there is capital mobility. We begin the analysis of stabilization policy using a model without any capital account. This is the model of Harberger (1950), Tinbergen (1952), Tsiang (1961), and above all Meade (1951), which dominated the literature on international monetary economics until the 1960's.

The model varies from one study to another, but a number of characteristics are typical of most of the studies. First, the model is "Keynesian" in that nominal wages are fixed, at least over the time horizon relevant for policy. Second, the money supply is regarded as a policy instrument under the complete control of the authorities. (Alternatively, the interest rate may be controlled by the authorities.) All balance of payments flows are sterilized by open market sales or purchases of securities or by other policy actions. Third, the financial sector is simplified considerably by the immobility of capital. Usually, portfolios contain only one asset other than money, and the market for that asset is treated only implicitly. Finally expectations are ignored.

We introduce below a model of a small country that illustrates all of these characteristics. The country is small in that it does not significantly affect foreign variables such as the price of foreign output.[1] Next we summarize some of the main conclusions about stabilization policy that can be derived from this model. Some of these conclusions are very sensitive to the precise specification of the model, so we conclude the section by discussing modifications of the model.

2.1. A model of trade and output

Since this model is a standard one in most respects, the description will be brief. The model consists of six equations:[2]

$$Y = Z + G_0 + B, \tag{2.1}$$

$$Z = Z'(Y,\ r,\ A/P),\ 0 < Z'_Y < 1,\ Z'_r < 0,\ Z'_A > 0, \tag{2.2}$$

$$B = B(Z,\ Z^f,\ P/P^f X),\ -1 < B_Z < 0,\ B_f > 0,\ B_P < 0, \tag{2.3}$$

$$Y = Q(P/\bar{W}),\ Q_P > 0, \tag{2.4}$$

$$M/P = m'(Y,\ r,\ A/P),\ m'_Y > 0\ ,\ m'_r < 0,\ 0 \leq (A\ m'_A/M) \leq 1, \tag{2.5}$$

$$X\ \dot{F}^m = B. \tag{2.6}$$

Equation (2.1) describes the demand for output in the home country; it must

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[1]The term small country often refers to a country producing the same good as other countries, but the country in this model is assumed to produce its own good except in the limiting case where domestic and foreign goods are perfect substitutes.

[2]The prime notation, Z' and m', is used to distinguish these functions from the corresponding ones in the next section. Restrictions on the partial derivatives are given directly following the function. The notation used for derivatives is straightforward; Z'_Y, Z'_r, Z'_A refer to the partial derivatives with respect to the three arguments of the function. To simplify the expressions, the derivatives are calculated at a stationary equilibrium where all prices (and the exchange rate) are equal to one.

equal expenditure by domestic residents (Z), and the government (G_0) plus the trade balance (B), all measured in units of domestic output. Expenditure by residents (2.2) is a function of income (Y), the interest rate (r), and the real wealth of domestic residents; real wealth is the sum (A) of money and domestic bonds deflated by the domestic price (P).[3] The trade balance (2.3) is a function of domestic expenditure, foreign expenditure (Z^f), and the terms of trade, defined as P/P^fX where P and P^f are the prices of domestic and foreign goods, respectively, and X is the domestic currency price of foreign currency. The trade balance is assumed to be negatively related to the terms of trade ($B_p < 0$), which is the case if the Marshall-Lerner condition is satisfied.[4]

The aggregate supply curve (2.4) describes the response of output (income) to an increase in the price of the domestic good, holding constant the nominal wage (W). Some models of this type fix the price of the good itself, but not much is gained by this further simplification of the model. The demand function for money (2.5) has a standard form familiar from models of the closed economy. The restriction on the wealth elasticity includes two limiting cases; the demand for money can be independent of wealth, as in the quantity theory, or can be homogeneous of degree one in wealth, as in some

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[3]We assume that all bonds are issued by the government. We discuss below the issue of whether bonds can be included in wealth.

[4]That condition states that with initially balanced trade, a fall in the terms of trade improves the trade balance if the sum of the import and export demand elasticities exceeds unity. Note that the trade and current account balances are identical in this model since we ignore transfer payments and services.

asset models. Equation (2.6) is a balance of payments equation describing the accumulation of foreign exchange reserves (F^m).

The four equations jointly determine four variables: the domestic price, output, interest rate and either foreign exchange reserves or the exchange rate, depending upon the exchange rate regime. We begin by describing the flexible exchange rate regime.

2.2. Flexible exchange rates

With capital immobile, the exchange rate is determined entirely by flow conditions, as indicated by the balance of payments equation (2.6). Since the balance of payments consists of the trade account only, the exchange rate must adjust to keep the trade balance at zero:

$$B(Z, Z^f, P/P^f X) = 0. \tag{2.3}'$$

This leads to very strong conclusions about domestic policy. Domestic output is determined as it would be in a closed economy:

$$Y = Z + G_0. \tag{2.1}'$$

The three equations determining domestic variables, (2.1)', (2.4), and (2.5), are now independent of the exchange rate and the parameters of the trade balance function, so monetary and fiscal policies have effects similar to those in a closed economy.

Without describing the full solution of the model, we can illustrate the effects of stabilization policy by calculating the multiplier for government spending. As is usually the case, it is obtained by assuming that the domestic price is constant (here we assume that Q_p is infinite) and that the domestic interest rate is pegged by monetary policy. Therefore,

$$\frac{dY}{dG_0} = \frac{1}{1- Z_Y} > 0. \tag{2.7}$$

The multiplier is identical to that of a closed economy; in particular, it is independent of the parameters of the trade balance.

A second striking conclusion is closely related to the first: domestic output and other domestic variables are independent of all foreign disturbances. The exchange rate completely insulates the economy from changes in foreign prices and foreign expenditure, the two foreign variables affecting the trade balance, so no foreign disturbance can affect the economy. This strong conclusion about insulation has often been used as an argument for flexible rates, even though it is very sensitive to assumptions about capital mobility.

2.3. Fixed exchange rates

With fixed exchange rates, the trade balance directly affects output in equation (2.1), so the effects of domestic policy are modified by interaction with the foreign sector. Both monetary and fiscal policies are generally less effective in changing domestic output than under flexible rates, because of the leakage of expenditure onto imports. The multiplier for government spending, for example, is

$$\frac{dY}{dG_0} = \frac{1}{1 - Z_Y'(1 + B_Z)}, \tag{2.8}$$

which is smaller than before, since $-1 < B_Z < 0$. A rise in government spending leads to a leakage of private expenditure onto imports, whereas there is no net effect on the trade balance under flexible rates.[5]

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[5]In the general model where interest rates are variable, a rise in government spending could raise output more under fixed rates than under flexible rates if expenditure were sufficiently sensitive to the interest rate; a rise in the interest rate could reduce (crowd out) expenditure and thus reduce imports. The trade balance would improve under fixed rates, so the domestic currency would appreciate under flexible rates. This result is precluded in versions of the open economy model where the trade balance is expressed as a function of domestic output rather than expenditure.

Foreign disturbances now affect the economy through the trade balance. An expansion abroad that raises foreign output, the foreign price, or both leads to an expansion of domestic output. The domestic economy becomes sensitive to foreign developments, including policies pursued by foreign governments.

Another much discussed result emerges from this same model. Under fixed exchange rates, there is a conflict between internal and external balance when a country is in one of two situations: with a balance of payments deficit and unemployment or a balance of payments surplus and full employment.[6] In either case, fiscal and monetary policies have undesirable effects on either internal or external balance. If there is a balance of payments deficit and unemployment, for example, an expansionary policy can eliminate unemployment, but it also leads to a deterioration of the trade balance. What is required in this situation, according to Johnson (1958), is an "expenditure switching" policy which is aimed at lowering the trade deficit at any given level of output. Corden (1960) examines various ways this policy could be carried out.

One such expenditure-switching policy is a devaluation. In this model, it unambiguously raises domestic output while improving the trade balance. In the simplest version, with fixed prices and a pegged interest rate, the multiplier for the change in the exchange rate is

$$\frac{dY}{dX} = \frac{-B_P}{1 - Z'_Y(1 + B_Z)} > 0, \qquad (2.9)$$

while the change in the trade balance is

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[6]The second of these situations is usually described as a balance of payments surplus and "inflation", but models of this type are not well suited for describing inflationary situations.

$$\frac{dB}{dX} = \frac{-B_P(1 - Z'_Y)}{1 - Z'_Y(1 + B_Z)} > 0. \tag{2.10}$$

Using these expressions, we can interpret the two analytical approaches to devaluation often discussed in connection with models of this type, the elasticities and absorption approaches. (For the two approaches, see Robinson, 1937, and Alexander, 1952). According to the former, the trade balance improves following a devaluation if the Marshall-Lerner condition is satisfied, or $B_P < 0$. This condition is clearly based on a partial equilibrium analysis of the trade sector alone. The absorption approach is more concerned with the macroeconomic response to a devaluation; the trade balance is said to improve following a devaluation if output rises more than expenditure. That is the case in (2.10) provided the marginal propensity to spend is less than one. We discuss a more recent approach to devaluation, the monetary approach, in detail below.

2.4. Modifications of the model

Many results obtained above depend upon characteristics of the model which are more appropriate for a closed economy. Real domestic income, for example, is defined to be equivalent to real domestic output. But in an open economy real income is more appropriately defined as PY/I, where I is a general price index including foreign as well as domestic prices:

$$I = P^a \, (P^f X)^{1-a}. \tag{2.11}$$

Real expenditure should similarly be redefined as PZ/I and expressed as a function of real income. This respecification of the expenditure function leads to what is known as the Laursen-Metzler effect of a change in the terms of trade.[7] A fall in the terms of trade, which reduces P/I, leads to a fall

[7]See Laursen and Metzler (1950). Dornbusch (1980, pp. 78-81) has a clear explanation of this effect.

in domestic expenditure measured in terms of the general price index but a rise in domestic expenditure measured in terms of the domestic good itself.

Other changes in specification might be made for similar reasons. All assets and wealth might be deflated by the general price index. Thus real money balances might be defined as M/I and treated as a function of real wealth, A/I, as well as real income. To the extent that expectations are explicitly modelled, the interest rate in the aggregate demand function might be specified in real terms as the nominal rate less the expected inflation rate of the general price index (the latter denoted by π_I). Finally, aggregate supply might be made a function of the price index, if wages vary at all. The first three of these changes will be adopted in the model introduced in the next section; wages will be made a function of the price index in a later section.

How much difference do all of these changes make? The answer certainly depends upon the actual magnitude of each effect. But notice that one dramatic result is overturned in the model used above once the general price level (and hence the exchange rate) is able to influence expenditure directly. Flexible rates no longer insulate the domestic economy from foreign disturbances. Indeed there are several channels through which the general price level, and therefore the exchange rate itself, can affect domestic variables.

3. Capital mobility and the Mundell-Fleming propositions

Few studies in international economics have had as much impact on the direction of research as those of Mundell (1963) and Fleming (1962). These studies showed how important capital mobility is to the conduct of stabilization policy, thus overturning many earlier propositions about policy, while redirecting attention towards the capital account and financial phenomena in general.

The two studies differed in their assumptions about the degree of capital mobility, Mundell assuming that there was perfect capital mobility between domestic and foreign countries. Their propositions about stabilization policy differed accordingly. Mundell's propositions were particularly dramatic. In a small open economy,

(1) monetary policy is ineffective in changing output under fixed exchange rates because capital flows offset a monetary expansion or contraction;

(2) fiscal policy is ineffective in changing output under flexible rates because the exchange rate induces adjustments in the trade account which run counter to the fiscal policy.

In Fleming's model, where capital mobility was imperfect, each policy retained some effectiveness under both exchange rate regimes. His conclusions concerned the relative effectiveness of the two policies:

(1) Monetary policy is more effective in changing output under flexible rates than under fixed rates;

(2) fiscal policy is more effective in changing output under fixed exchange rates when capital is highly mobile, but this conclusion is reversed with low capital mobility.[8]

Both sets of propositions are modified in more general models, as we shall see below, but they have had a powerful influence on subsequent thinking about

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[8]Capital mobility is relatively low in his model if an increase in government spending leads to a trade deficit larger than the capital inflow induced by the corresponding increase in the interest rate. See Whitman (1970) for a full discussion.

stabilization policy. Whitman (1970) has provided a concise summary of these and other studies in the same tradition.

We will review these propositions within the context of a model somewhat different from those used by Mundell and Fleming. We retain the fixed nominal wage assumption characteristic of Keynesian models but modify the expenditure function to incorporate terms of trade and wealth effects that may be particularly important when there is a flexible exchange rate. The most important change, however, is on the financial side. Fleming specified capital flows as a function of the level of the interest rate, but modern portfolio theory indicates that the stock of assets rather than the flow should be a function of the interest rate.[9] According to this latter view, capital flows occur as a result of more general portfolio adjustments encompassing money balances as well as domestic and foreign bond holdings. In place of the balance of payments flow (the time derivative of foreign exchange reserves), which was the center of attention in the Fleming model, we have an equation explaining the stock of foreign exchange reserves; it is one of the equations explaining asset market equilibrium.[10] Other differences between

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[9]One implausible implication of the Fleming specification is that a rise in the domestic interest rate causes a continuing inflow of capital, whether portfolios are growing or not. Branson (1968) and Willett and Forte (1969) were among the first to formulate the portfolio balance approach to the capital account. In Mundell's (1963) model, with perfectly mobile capital, this question of specification does not arise.

[10]As is the case with most portfolio balance models, the model is specified in continuous time. It can be specified in discrete time, as in Henderson (1981) and Tobin and de Macedo (1980), and a balance of payments (continued)

the model here and its antecedents are discussed below.

This section focuses on many of the issues that Mundell and Fleming emphasized and on which later authors expanded, including the offsetting effect of capital flows and the feasibility of sterilization. In addition, we compare the relative effectiveness of stabilization policies under fixed and flexible rates. The discussion draws on an excellent survey of these issues by Henderson (1977).

3.1. A model with internationally mobile capital

The model introduced in this section will be used to describe stabilization policy in both this section and the next (where we consider a classical model with flexible wages). The model is complicated because it includes price and wealth effects and because domestic and foreign securities are treated as imperfect substitutes. Behavior in the model, however, can be summarized in a simple diagram which will be used to illustrate the effects of different stabilization policies.

We begin with the market for the domestic good:

$$Y = Z + G_0 + B \ , \tag{3.1}$$

$$\frac{PZ}{I} = Z\left[\frac{P(Y-T)}{I},\ r-\pi_I,\ r^f+\pi_X-\pi_I,\ \frac{A}{I}\right] \ , \tag{3.2}$$

$$0 < Z_Y < 1,\ Z_r < 0,\ Z_f < 0,\ Z_A > 0 \ ,$$

$$B = B(Z,\ Z^f,\ P/(P^f X)), \quad -1 < B_Z < 0,\ B_f > 0,\ B_P < 0 \ , \tag{3.3}$$

$$Y = Q(P/\overline{W}), \quad Q_P > 0 \ . \tag{3.4}$$

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equation can be derived from the rest of the model, but such a model bears little resemblance to the earlier capital flow specification of Fleming and others.

The model is identical to the earlier one except for the expenditure equation (3.2), where expenditure and disposable income are deflated by the general price index, thus incorporating the Laursen-Metzler effect of a change in the terms of trade. Disposable income is defined as income less taxes, the latter being exogenous to the model.[11] Expenditure is also a function of real wealth, where wealth is now defined as the sum of money, domestic bonds and foreign bonds held by the domestic private sector: $A = M + H^d + X F^d$. Finally, expenditure is expressed as a function of the domestic and foreign <u>real</u> interest rates. The nominal return on the foreign bond is defined as the nominal foreign interest rate plus the expected appreciation of the foreign currency, π_X; both interest rates are then expressed in real terms by subtracting the expected rate of inflation of the general price index, π_I:

$$\pi_I = a\,\pi_p + (1-a)\pi_X ,$$

$$\pi_P = e_P(\overline{P}/P - 1),\ 0 < e_P < 1 ,$$

$$\pi_X = e_X(\overline{X}/X - 1),\ 0 < e_X < 1 .$$

For this part of the analysis, expectations are modeled in two alternative ways found frequently in the literature: <u>regressive</u> expectations (with e_P and e_X being positive constants less than or equal to one) where a rise in the current price or exchange rate leads to an expected fall in that variable towards some stationary value ($\overline{P}$, $\overline{X}$) and <u>static</u> expectations (with e_P and e_X

[11]Interest receipts and payments are ignored in the model. Alternatively, they could be explicitly introduced into the expressions for disposable income and the current account but neutralized by taxes and transfers. Allen and Kenen (1980, 40-42) describe how this can be done.

being equal to zero) where the expected level of the price or exchange rate rises with the current level so that no further change is expected. We postpone until a later section a discussion of rational expectations.

The equations for the goods market contain four endogenous variables of interest to the analysis: Y, P, r, and either X or XF^m (the level of foreign exchange reserves). According to equation (3.4), however, changes in P are always related to changes in Y as follows, $dP = dY/Q_P$, so that we can eliminate price from all expressions in the model and thus concentrate on only three variables.

The curve labelled GG in figure 1 describes combinations of Y and r that give equilibrium in the goods market. The slope of this curve reflects the direct effects of output and the interest rate on expenditure (as well as the indirect effect of the domestic price). To obtain an expression for this slope, we first take the total differentials of equations (3.1)-(3.4) and combine them in the compact form shown in the first row of the matrix in table 1. The matrix itself describes equilibrium under either flexible rates ($XdF^m = 0$) or fixed rates ($dX = 0$). The expression $G_Y + G_P/Q_P$ reflects the direct and indirect effects of higher output on the goods market, while G_r reflects the direct effect of a higher interest rate. Since increases in Y or r both raise the excess supply of the domestic good (i.e., $G_Y + G_P/Q_P$ and G_r are positive), the goods market curve GG must have a negative slope.

The definitions and signs of G_Y and all other coefficients are given in the table. (To simplify these expressions, we have assumed that all prices, including the exchange rate, are initially equal to one). All of the signs follow directly from the earlier assumptions, with two exceptions: For λ to be positive, the elasticity of expenditure with respect to disposable income must be less than one. This condition ensures that the Laursen-Metzler effect

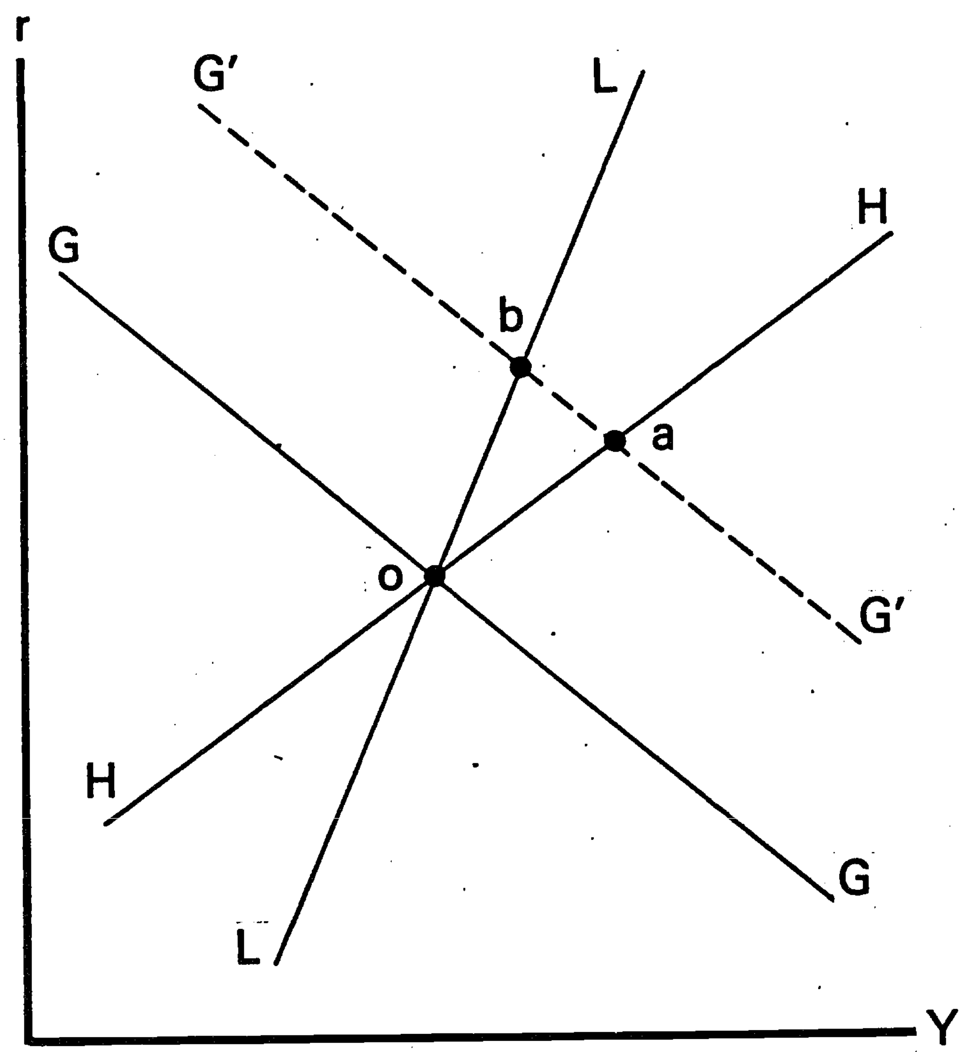

Figure 1. Increase in Government Spending

TABLE 1. MODIFIED MUNDELL-FLEMING MODEL

$$\begin{bmatrix} (G_Y + G_P/Q_P) & G_X & 0 & G_r \\ (L_Y + L_P/Q_P) & L_X & -(1+s) & L_r \\ (H_Y + H_P/Q_P) & H_X & s & H_r \end{bmatrix} \begin{bmatrix} dY \\ dX \\ XdF^m \\ dr \end{bmatrix} = \begin{bmatrix} dG_0 \\ dH_0^m \\ -dH_0^m \end{bmatrix}$$

$G_Y = [1 - (1 + B_Z)Z_Y] > 0$,

$G_P = (1 + B_Z)[\lambda - a\ e_P(Z_r + Z_f) + a\ Z_A A] - B_P > 0$,

$\lambda = (1-a)[Z - Z_Y(Y - T)] > 0$,

$G_X = -(1 + B_Z)[\lambda + e_X(Z_r(1-a) - Z_f(a)) + Z_A(F^d - A(1-a))] + B_P < 0$,

$G_r = -(1 + B_Z)\ Z_r > 0$,

$L_Y = m_Y > 0$,

$L_r = m_r < 0$,

$L_P = [m_Y\ Y(1-a) + a(m(\cdot) - m_A\ A)] > 0$,

$L_X = [(1-a)(m(\cdot) - m_Y\ Y) - m_f\ e_X + m_A(F^d - A(1-a))] > 0$,

$H_Y = h_Y < 0$,

$H_r = h_r + h_r^f > 0$,

$H_P = [h_Y\ Y(1-a) + a(h(\cdot) - h_A\ A)] < 0$,

$H_X = [(1-a)(h(\cdot) - h_Y Y) + h^f(\cdot) + (h_r^f - h_f)e_X + h_A(F^d - A(1-a))] > 0$.

obtains; a fall in the terms of trade raises expenditure measured in terms of the domestic good. The other exception concerns the sign of G_X. This model allows the exchange rate to affect the goods market through three channels: (a) relative price effects that work directly on the trade balance and through the Laursen-Metzler effect on expenditure; (b) exchange rate and inflationary expectations that drive the two real interest rates in different directions; and (c) the effect of the exchange rate on real wealth (which can either rise or fall in response to a rise in the exchange rate).[12] For G_X to be negative, the relative price effect must outweigh the latter two effects (if either or both are negative).[13] When G_X is negative, a rise in the exchange rate (a devaluation or a depreciation of the domestic currency) shifts the GG schedule to the right.

The behavior of the financial markets is of central interest to the

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[12]A rise in the exchange rate has two effects on real wealth: it raises the nominal value of wealth by $F^d\,dX$ (when F^d is positive), but it lowers the real value of any given amount of nominal wealth by $A\,dI = A(1-a)dX$, since it raises the cost of imported goods in the price index.

[13]Under plausible conditions, these latter effects could both be equal to zero. The net effect of a change in the expected exchange rate is equal to zero when the partial derivatives of expenditure with respect to the two real interest rates are proportional to the shares of domestic and foreign goods in the consumption basket, $Z_r/Z_f = a/(1-a)$. The wealth effect of an exchange rate change is equal to zero when the ratio of foreign assets to wealth is the same as the proportion of foreign goods in the consumption basket, $F^d/A = (1-a)$. Such a diversification rule is given in Dornbusch (1982). But G_X could be negative under much weaker conditions.

following discussion. The asset model described below is an open economy version of the Tobin-Brainard model as developed by Black (1973), Boyer (1975), Branson (1974), Girton and Henderson (1976, 1977) among others. Three assets are assumed to be available to domestic investors; money, (M), domestic bonds (H^d) and foreign bonds (F^d), the latter available at an exogenous interest rate. There is no banking system in the model, so M also represents the monetary base. Foreign investors may hold domestic bonds but do not hold domestic money. The domestic demands for the two domestic assets are described by equations (3.5) and (3.7), the domestic demand for the foreign bond by (3.9), and the foreign demand for the domestic bond by (3.8).

$$M = m[\frac{PY}{I}, r, r^f + \pi_X, \frac{A}{I}] I = H^m + X F^m , \tag{3.5}$$

$$0 < Y m_Y/M < 1, m_r < 0, m_f < 0, 0 < A m_A/M < 1,$$

$$H^d + H^f = H_0 - H^m, \tag{3.6}$$

$$H^d = h[\frac{PY}{I}, r, r^f + \pi_X, \frac{A}{I}]I, \tag{3.7}$$

$$h_Y < 0, h_r > 0, h_f < 0, 1 < A h_A/H^d,$$

$$H^f/X = h^f[Y^f, r - \pi_X, r^f, A^f/P^f]P^f , \tag{3.8}$$

$$h^f_Y < 0, h^f_r > 0, h^f_f < 0, h^f_A > 0,$$

$$X F^d = f[\frac{PY}{I}, r, r^f + \pi_X, \frac{A}{I}]I, \tag{3.9}$$

$$f_Y < 0, f_r < 0, f_f > 0, 1 < Af_A/(X F^d).$$

The real demands for these assets are functions of real income, the expected returns on domestic and foreign bonds, and real wealth. The restrictions on the partial derivatives of the asset demands reflect the following assumptions: (a) all assets are assumed to be gross substitutes, i.e., a rise in the own (cross) return raises (lowers) the demand for that asset; (b) a rise in income raises the demand for money and lowers the demands for the other assets, but the income elasticity of money demand is assumed to be less than or equal to one; (c) a rise in wealth leads to an equal or more than proportionate rise in the demand for domestic and foreign bonds, and an equal or less than proportionate rise in the demand for money. These are all plausible assumptions that have been frequently adopted in the literature.[14]

The asset demands of domestic residents as well as the expenditure function introduced above are expressed as functions of real (domestic) wealth, where wealth includes bond holdings as well as money holdings. Barro (1974) has recently revived interest in the proposition that government bonds do not represent net wealth. The basic question at issue is whether individuals fully discount the future taxes implicit in any issue of government debt. Buiter and Tobin (1979) discuss the strong assumptions necessary for this proposition to hold, such as the absence of intergenerational distribution effects.[15] Here we adopt the conventional definition of financial wealth that ignores future taxes; this definition thus may overstate the magnitude of the real effects discussed below when there is

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[14]Gross substitutibility is not a necessary consequence of expected utility maximization, although it is almost always assumed in asset market studies. Money demand is often assumed to be insensitive to wealth or to be homogeneous of degree one in wealth; these assumptions are limiting cases of the one adopted here.

[15]Voluntary intergenerational gifts can neutralize the real effects of involuntary redistribution by the government, but only under certain conditions. See Buiter and Tobin (1979).

at least partial capitalization of future taxes.[16]

Equations (3.5) and (3.6) equate the demands for money and domestic bonds, respectively, to their supplies. The supply of money is equal to the assets held by the central bank, which consist of domestic and foreign bonds. (We have omitted a balancing item which is needed to cancel capital gains earned by the monetary authority on changes in the foreign exchange rate.) The supply of domestic bonds consists of the total government issue less that held by the central bank. The supplies of these assets are related by sterilization policy. We consider below two possibilities, that the authorities sterilize all foreign exchange flows or do not sterilize any. In the former case, the domestic bonds held by the central bank become endogenous, so it is useful to describe the change in its domestic assets as the sum of two components:

$$dH^m = d\ H_0^m + s\ X\ dF^m. \tag{3.10}$$

The first term represents a discretionary change in domestic assets, independent of sterilization policy; the second term describes the endogenous response of domestic assets to a change in foreign exchange reserves. The parameter s is the sterilization coefficient, which is assumed to vary between zero and minus one. When no sterilization is carried out (s = 0), the supply of money is an endogenous variable under fixed exchange rates with the change

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[16]A related issue is whether exchange market intervention, which transfers ownership of foreign assets from the private sector to the government, can have any real effects. Obstfeld (1981) discusses the case where the private sector "sees through" these transactions; it capitalizes future transfers from the government financed by foreign interest payments (in effect regarding official foreign exchange holdings as its own).

in that supply given by $dH_0^m + X\ dF^m$. When full sterilization is practiced ($s = -1$), the supply of bonds available to the public becomes endogenous, with the change in that supply given by $-dH_0^m + X\ dF^m$.

In figure 1, the curves labelled LL and HH describe combinations of Y and r that give equilibrium in the markets for money and domestic bonds.[17] The slopes of these curves can be obtained from the equilibrium conditions for the two asset markets summarized by the second and third rows of the matrix expression in table 1. The signs of the asset coefficients follow from the earlier assumptions, with one exception. For L_X and H_X to be positive, the transactions and expectations effects must outweigh the wealth effect in cases where the latter is negative. (As discussed below, assumptions are frequently adopted which make $L_X = 0$). The relative slopes of LL and HH depend upon the two assumptions adopted earlier regarding gross substitutability and wealth elasticities.[18]

One additional characteristic of the HH schedule is of special interest. It becomes infinitely elastic when domestic and foreign bonds are

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[17]Stabilization policy has often been illustrated in a diagram with a balance of payments curve instead of a bond market curve. Most of the studies of the 1960's which specified capital flows as a function of the interest rate level used such a diagram. Henderson (1981) uses a balance of payments curve in a discrete time model based on asset demand functions like those presented here. The alternative diagram presented here was developed by Boyer (1978a) and Henderson (1979).

[18]The relative slopes of these curves can be established under weaker assumptions, as is evident from the expressions for $(H_Y + H_P/Q_P)$ and $(L_Y + L_P/Q_P)$.

perfect substitutes. (HH becomes flat as $H_r = h_r + h_r^f$ goes to infinity). This was the assumption adopted by Mundell (1963) as well as by many other authors since. We shall discuss its important implications below.

Before proceeding further, we should clarify the nature of the short run equilibrium described in table 1. All asset markets are assumed to be in continuous equilibrium in the sense that existing stocks of assets are willingly held. In this model, however, there is nothing to prevent asset stocks from changing continuously through time. In particular, a government deficit will generate a flow supply of government bonds: $\dot{H}_0 = P(G_0 - T)$, where $\dot{H}_0$ denotes the time derivative, dH_0/dt. This flow supply is to be distinguished from a discrete change in the supply of bonds at one point in time associated, for example, with an open market operation, dH_0^m. Similarly, a balance of payments surplus under fixed exchange rates will generate a flow supply of foreign exchange reserves: $X \dot{F}^m = P B + \dot{H}^f - X \dot{F}^d$. This flow supply is to be distinguished from the discrete change in foreign exchange reserves, $X\ dF^m$, which occurs as a result of an instantaneous switch in portfolios or a single exchange market operation.

These flow supplies of assets, whether due to government deficits or payments imbalances, affect output and other variables in the model by altering gradually the stock of each asset, thereby moving the economy, in the words of Blinder and Solow (1973), from one instantaneous equilibrium to another.[19] Because the stocks of assets change through time, the cumulative effects of stabilization policies vary with the time span over which policies are examined. (The longer the time span, however, the less tenable is the

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[19]Branson (1974) applied the closed economy analysis of Blinder and Solow to the case of an open economy under fixed exchange rates.

Keynesian assumption of fixed nominal wages.) To simplify the discussion below, we focus mostly on the impact effects of policies and thus ignore the effects of these flow supplies.[20] In table 1, for example, only the impact effects of policies are shown. Readers interested in the longer run effects of the policies are referred to McKinnon and Oates (1966) and other studies.[21]

3.2. Stabilization policy under fixed exchange rates

Under fixed exchange rates, the equations of table 1 determine domestic output and the interest rate on domestic bonds as well as foreign exchange reserves ($X F^m$). The system of equations, in fact, is recursive under two alternative assumptions regarding sterilization:

(1) With no sterilization ($s = 0$), the equations describing equilibrium in the goods and bond markets determine output and the interest rate, with the money market equation determining the (instantaneous) change in foreign

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[20] With rational expectations or perfect foresight, however, future changes in stocks can affect endogenous variables immediately. Chapter 15 shows how, under perfect foresight, the eventual accumulation of wealth through the current account affects the current values of endogenous variables, including the exchange rate; chapter 18 analyzes other dynamic models under perfect foresight. We discuss rational expectations in section 5, but in models where the dynamics of asset accumulation are not essential to the analysis.

[21] McKinnon and Oates analyze a long run (stationary state) equilibrium where wealth accumulation has ceased. Turnovsky (1976) examines the dynamics around such a stationary state equilibrium using flow equations such as those introduced above. See also Branson (1974) and Allen and Kenen (1980, especially chapters 6 and 10).

exchange reserves. In terms of figure 1, equilibrium is determined by the GG and HH schedules, with the LL schedule shifting in response to changes in foreign exchange reserves.

(2) With full sterilization ($s = -1$), the equations for the goods and money markets determine output and the interest rate, with the bond equation determining the change in foreign exchange reserves. Equilibrium is determined by the GG and LL schedules, with the HH schedules shifting in response to changes in foreign exchange reserves.

In this section we use this system of equations together with accompanying diagrams to interpret two types of stabilization policies: an increase in government spending and an open market expansion of the money supply. The role of sterilization will be discussed in connection with government spending where a geometric illustration of its effects is particularly simple.

The increase in government spending is assumed to fall exclusively on domestic goods. The spending is financed by the issue of government bonds rather than by taxes, with the government deficit generating a flow supply of bonds but no discrete change in the bond supply capable of affecting current variables. With no sterilization, an increase in spending leads to a rise in output and the interest rate. In figure 1, point a is reached where the new G'G' schedule intersects with a constant HH schedule. The effect of the policy on foreign exchange reserves is evident from the figure, since money market equilibrium requires a rightward shift (not shown) of the LL curve to point a and thus a rise in the money supply. The magnitude of the increase in foreign exchange reserves depends upon the degree of substitutability between domestic and foreign bonds, as reflected in the slope of HH. Since foreign exchange reserves increase under fixed exchange rates, we should expect the domestic currency to appreciate under flexible rates as discussed below.

Perfect substitution between domestic and foreign bonds (HH horizontal) leads to no qualitative differences in the effects of fiscal policy on output or foreign exchange reserves, although the interest rate would in that case remain constant. Perfect substitution between domestic and foreign goods, a limiting case where the law of one price holds, on the other hand, renders government spending powerless to affect output.[22] As the private sector is willing to exchange foreign for domestic goods at unchanged prices, government spending on domestic (or foreign) goods can have no effect on prices or output. (In this polar case, the GG schedule becomes a vertical line and shifts only in response to a change in the exchange rate or price of foreign output.)

Sterilization modifies the effects of fiscal policy, but output and the interest rate still increase. If there is complete sterilization, then the new equilibrium is found on an unchanged LL schedule at point b. The increase in the money supply associated with the influx of foreign exchange reserves is neutralized by the sale of bonds to the public. The bond supplies available to the public become endogenous, with HH shifting to the new equilibrium.

There is a serious problem with sterilization, however, when domestic and

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[22]For a description of the law of one price, see Katseli-Papaefstratiou (1979). She distinguishes between the law of one price, which is a commodity arbitrage relationship linking the prices of identical goods in different countries, and a more general form of purchasing power parity (PPP) reflecting a reduced form relationship between prices and exchange rates. For empirical evidence on PPP, see Isard (1977), Kravis and Lipsey (1978), and Frenkel (1981).

foreign bonds are highly substitutable. The more substitutable are the bonds, the greater is the change in foreign exchange reserves associated with the fiscal policy.[23] This can be seen by expressing the change in foreign exchange reserves given in table 1 in terms of the changes in output and the interest rate:

$$X\, dF^m = (H_Y + H_p/Q_p)\, dY + H_r\, dr. \tag{3.11}$$

Since the changes in Y and r (to point b in figure 1) are the same whatever the degree of substitutability between bonds, the change in foreign exchange reserves must increase with higher substitutability (a larger H_r). In the limiting case of perfect substitution between assets, the problem of foreign exchange flows becomes overwhelming, as Mundell (1963) emphasized. In that case, sterilization implies an infinite gain of foreign exchange reserves.

During the 1950's, analyses of macroeconomic policy almost invariably assumed full sterilization of reserve flows, with monetary policy being characterized by a constant money supply or interest rate. In the early 1970's, the monetary approach to the balance of payments largely ignored sterilization or argued that sterilization was infeasible because of perfect substitution between assets. Since that time empirical evidence has accumulated showing that sterilization was indeed practiced widely under the

[23]In the case of an increase in government spending, foreign exchange reserves rise rather than fall, so the country is in no danger of running out of reserves as it might be in the case of a decline in government spending or an increase in the money supply. This is one aspect of a fundamental asymmetry between surplus and deficit countries under fixed exchange rates.

Bretton Woods system of fixed exchange rates.[24] But many of the same studies have also shown the empirical importance of the offset effect, a phenomenon which was central to the monetary approach to the balance of payments. It is to the offset effect that we now turn.

The subject of monetary policy under fixed rates has generated intense controversy, with many economists contending that monetary policy is powerless to affect the domestic interest rate or output. That is because any expansionary open market operation by the central bank may be completely offset by a loss of foreign exchange reserves. (This offset controversy is distinct from the controversy associated with monetary policy under rational expectations to be discussed below.)

The monetary policy to be analyzed here is a simple open market purchase of domestic bonds by the central bank, which increases the supply of money and reduces the supply of bonds by dH_0^m. Figure 2 illustrates the effects of this operation: output rises while the domestic interest rate falls as HH shifts to the right to point a. Figure 2 also can be used to illustrate the offset to the monetary policy. In the absence of changes in foreign exchange reserves, the LL curve would shift to the right to L'L' as a result of the open market purchase. This is the shift shown in the figure. With changes in reserves, however, the money supply is endogenous, and LL shifts back to point a in response to a loss in foreign exchange reserves. In figure 2, the offset is negative, but it is smaller (in absolute value) than the open market

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[24]For studies of sterilization in the 1960's, see Argy and Kouri (1974) and Herring and Marston (1977, ch. 5). Black (1982) and Obstfeld (1982) present evidence of sterilization in the more recent period of managed floating.

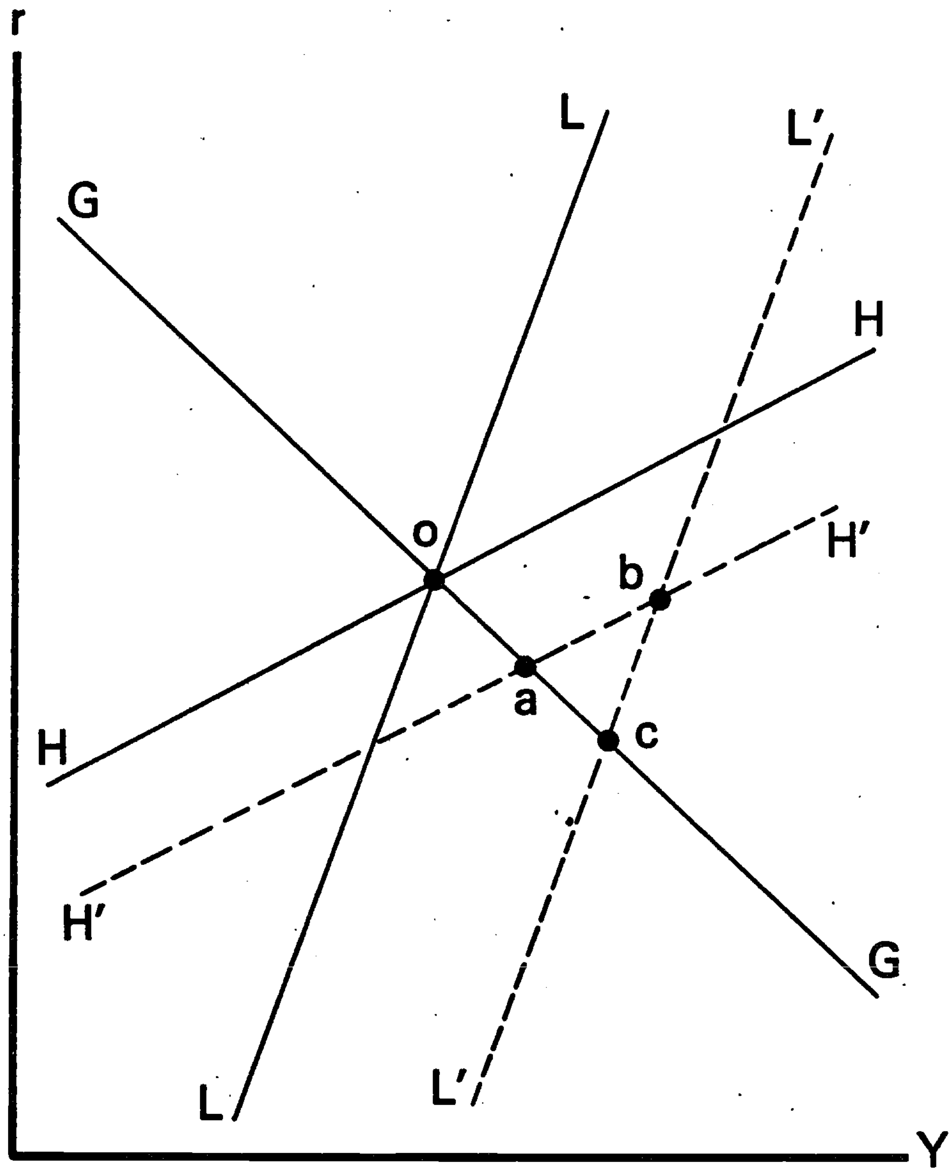

Figure 2. Open Market Operation

purchase. Hence monetary policy still retains some effectiveness.

To determine under what conditions the offset is complete, we express the change in foreign exchange reserves as follows:[25]

$$\frac{XdF^m}{dH_0^m} = -1 - \frac{[L_r(G_Y + G_P/Q_P) - G_r(L_Y + L_P/Q_P)]}{[H_r(G_Y + G_P/Q_P) - G_r(H_Y + H_P/Q_P)]} \,. \qquad (3.12)$$

It is clear from this expression that if there is perfect substitutability between assets (H_r infinite), the offset coefficient is equal to -1. In that case, monetary policy is powerless to affect output or the interest rate. In figure 2, HH becomes horizontal and is unaffected by changes in bond supplies, so point a coincides with point o. Short of perfect substitutability, however, the offset is less than complete ($XdF^m/dH_0^m > -1$). Note that the offset could be positive rather than negative in the perhaps unlikely case where the increase in output (and price) causes a net shift out of foreign bonds to satisfy the demand for transactions balances.[26]

The empirical evidence on offset behavior suggests that the offset coefficient is negative and large, but significantly different from minus one. Kouri and Porter (1974), for example, estimated that the offset

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[25]This expression is obtained by solving the equations of table 1 for the case of no sterilization.

[26]See Branson (1974) for a discussion of this case. Using (3.12), it can be shown that high substitutibility between domestic and foreign bonds or low sensitivity of expenditure to real interest rates is sufficient to rule out a positive offset. Geometrically, a positive offset occurs when L'L' and H'H' intersect below the GG line.

coefficient for Germany was -.77 based on evidence from the 1960's.[27] There are two ways of looking at such evidence. One is to say that the offset is less than complete, so the central bank retains control over the money supply. But there is another side to this good news. An offset as large as -.77 implies a sizable change in foreign exchange reserves for any given (net) change in the money supply. The higher the degree of asset substitutability, in effect, the greater the change in foreign exchange reserves associated with any active monetary policy. For this very reason, countries such as Germany became increasingly disenchanted with fixed exchange rates during the late 1960's. Germany's attempts to pursue a tight monetary policy led to large surpluses in its overall balance of payments which in turn generated pressure from its trading partners for changes in its policies. Exchange rate flexibility seemed to provide a solution; the German money supply could then be under the full control of its authorities. Controlling one's money supply, however, is a necessary but not sufficient condition for an effective monetary policy, as we shall see below.

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[27] For the same period, Herring and Marston (1977, ch. 6) present estimates of a net offset coefficient which takes into account sterilization behavior. Most estimates of the offset effect are based on financial behavior only, whereas the general expression for the offset coefficient presented in 3.12 also takes into account behavior in the goods market (which affects the size of the offset coefficient when $G_r \neq 0$). For an estimate of the offset effect based on an economy-wide econometric model, the RDX2 for Canada, see Helliwell and Lester (1976).

3.3. Stabilization policy under flexible exchange rates

Under flexible rates, the equations of table 1 determine domestic output, the interest rate and the exchange rate. Foreign exchange reserves are exogenous. Figure 1 and 2 continue to describe the determination of output and the interest rate for any given exchange rate.[28] But changes in the exchange rate generally shift all three schedules.

The effect of exchange rate flexibility on an expansionary stabilization policy depends first of all upon whether the domestic currency appreciates or depreciates. An expansionary fiscal policy invariably leads to an appreciation in the model outlined, just as it unambiguously leads to an increase in foreign exchange reserves under fixed exchange rates. (In the Fleming analysis, by contrast, the exchange rate could appreciate or depreciate depending upon the relative effect of the policy on the capital and current accounts of the balance of payments.) The effect of the rise in government spending and of the ensuing appreciation of the domestic currency are illustrated in figure 1.[29]

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[28]We adopt the usual assumption that behavioral parameters are insensitive to the change in regimes, an assumption which has been criticized by Lucas (1972, 1973) and others in a closed economy context. Cooper (1976) suggests that in comparing exchange rate regimes, we should take into account likely changes in both trade and financial behavior, but to do so would require the explicit modelling of the microeconomic behavior of trading firms and investors. In section 5, we discuss the influence of policy rules on private behavior, and address more directly the Lucas critique.

[29]For a similar diagramatic analysis of private sector disturbances see Henderson (1979).

The rise in the demand for the domestic good shifts the GG curve upward, but the appreciation dampens this movement. The appreciation also induces shifts in the asset schedules (not shown). As X falls, the demands for money and bonds both fall. (Recall that L_X and H_X are both positive because of the combined influence of price level changes, expectations and wealth effects on the demand for these assets.) As a result the LL curve shifts to the right and HH to the left. The economy ends up somewhere in the triangular area bounded by abo, with output and the domestic interest rate rising.

Under certain conditions, output remains fixed despite the government's increased demand for domestic goods; this is Mundell's well-known result that fiscal policy is powerless to change output under flexible rates. To show this, we follow Mundell in assuming that domestic and foreign bonds are perfect substitutes (H_r is infinite, so that HH is flat). But we also need to assume that the exchange rate has no net effect on the demand for money ($L_X = 0$, so that the LL schedule does not shift). The following are sufficient conditions for the demand for money to be independent of the exchange rate: (a) static expectations, (b) a zero wealth elasticity of the demand for money or an insensitivity of real wealth to exchange rate changes, and (c) a unitary income elasticity of the demand for money, which ensures that the fall in the general price level raises the transactions demand for money and real money balances by the same amount.[30] If money demand is independent of the exchange

[30]For a similar set of conditions, see Henderson (1981). Argy and Porter (1972) previously emphasized the importance of static expectations for Mundell's result. This assumption also implies that HH remains stationary as X changes. In the case of perfect substitutability between bonds, the position of HH is determined by the uncovered parity condition, $r = r^f + \pi_X$, which is unchanged if $\pi_X = 0$.

rate and if the domestic interest rate is tied to the foreign interest rate through perfect substitution, then only a constant output (and domestic price) are consistent with a constant money supply. Thus output remains at point o in figure 1. Notice, however, how many assumptions are needed for this result. Under more general conditions, domestic output must rise.

The effect of monetary policy under flexible rates is shown in figure 2, where we illustrate the normal case in which an open market purchase of domestic bonds leads to a depreciation of the domestic currency. The shifts of the asset market schedules illustrate the direct effect on asset supplies: the increase in the money supply shifts LL to the right to L'L', while the reduction of the bond supply shifts HH to the right as well to H'H'. The depreciation itself then leads to an equilibrium somewhere in the triangle abc, with output increasing and the interest rate declining.[31] Under those conditions that produce a positive offset under fixed rates, an open market purchase can lead to an appreciation rather than a depreciation under flexible rates, but an appreciation is unlikely for the same reasons cited in connnection with a positive offset.[32]

In the limiting case of perfect substitution between bonds, monetary policy is still effective in changing output, since there are no changes in foreign exchange reserves to offset the open market operation. Output and the domestic price still increase; the interest rate remains constant if expectations are static, and it falls if expectations are regressive (because

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[31]The depreciation shifts L'L' to the left, H'H' and GG to the right, so the final equilibrium must be in the triangle bounded by L'L', H'H' and GG.

[32]If an appreciation occurs, the triangle is below the GG schedule, but output still increases and the interest rate declines.

HH shifts down by the change in the foreign interest return, $d\pi_X = -e_X\ dX$). In this limiting case, an open market operation and foreign exchange intervention are equivalent in effects, if the latter is defined as an exchange of foreign bonds for domestic money, since it cannot matter whether domestic or foreign bonds are exchanged for money. But sterilized foreign exchange intervention, involving an exchange of foreign for domestic bonds with no change in the money supply, must be totally ineffective in changing output, price or the interest rate.[33]

3.4. The relative effectiveness of policies and other issues

Having discussed fiscal and monetary policy in detail, we can briefly review the relative effectiveness of each policy in changing output under fixed and flexible rates. Fiscal policy is always less effective under flexible rates than under fixed rates, because an expansionary policy leads to an appreciation of the domestic currency, thereby dampening the rise in aggregate demand. Figure 1 illustrates this result clearly: With fixed exchange rates (and no sterilization) the economy reaches point a; with flexible rates, the economy ends up somewhere in the triangular area oab. Thus there is no ambiguity about the relative effectiveness of fiscal policy, a result which differs from Fleming's. The difference, of course, is that the movement of the exchange rate is governed by asset market behavior (the relative slopes of HH and LL) rather than by the trade and capital accounts of the balance of payments as in Fleming's study.

Fleming's conclusion with respect to the relative effectiveness of monetary policy is also modified in this model. Monetary policy is not

[33] Girton and Henderson (1977) discuss both types of intervention. See also Kenen (1982) and ch. 15 by Branson and Henderson in this volume.

necessarily more effective under flexible rates. But under the normal conditions in which the offset effect is negative, Fleming's conclusion is upheld. Figure 2 illustrates this result: under fixed exchange rates, an open market expansion of the money supply leaves the economy at point a, while under flexible rates the economy expands further to some point in the triangle abc. Only if the offset is positive is monetary policy less effective under flexible rates.

This type of analysis has often been used as a basis for comparing fixed and flexible rates. One regime is preferable to another if it makes a given policy instrument more effective in changing output. But the analysis has frequently been turned on its head. Instead of analyzing the effects of policy-induced changes in the money supply, some studies have analyzed the effects of monetary <u>disturbances</u>, unwanted changes in money demand or supply.[34] Similarly, aggregate demand disturbances originating in private behavior (e.g., shifts in demand from domestic to foreign goods) have often been analyzed in place of changes in government spending. The choice between exchange rate regimes then hinges on which regime <u>minimizes</u> the effects of the disturbances on output. This different perspective is commonly found in the new stochastic literature to be discussed in sections 5 and 6. When it comes to analyzing foreign disturbances, however, it does not usually matter whether they are policy-induced or private in origin; in both cases we would normally choose the regime that best insulates the economy from those

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[34]There could be unwanted changes in the money supply in any economy with a banking system if the authorities control bank reserves but not the money supply. Bryant (1980) analyzes several important issues involved in the conduct of monetary policy in such an economy.

disturbances.[35] We shall discuss the insulating properties of exchange rate regimes in detail below.

Another important issue concerns the role of country size in determining the effectiveness of monetary and fiscal policies. The size of a country does make a difference, most particularly with respect to the strong conclusions reached by Mundell (1963) about monetary policy under fixed exchange rates and fiscal policy under flexible rates. We shall briefly review the modifications made to his analysis by drawing on his follow-up study, Mundell (1964).

If the domestic country is large enough to affect economic conditions in the rest of the world, monetary policy under fixed exchange rates regains its effectiveness. But with perfect substitutability between domestic and foreign bonds, the money supplies of different countries are fully linked through capital movements, and the domestic country can change its own money supply only by changing the money supply of the world as a whole. For the same reason, an open market operation abroad has as much effect on <u>domestic</u> output as an open market operation at home of equal magnitude.

As far as fiscal policy under flexible rates is concerned, this policy also regains its effectiveness, even under Mundell's assumptions, if the domestic country is large enough to influence foreign conditions. An increase in government spending in the domestic country leads to an appreciation of the

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[35]A specific policy initiative by a foreign government could very well be welcomed by the domestic country if it happened to have beneficial effects on the domestic economy, but in general countries prefer to be insulated from policy initiatives abroad. Domestic and foreign initiatives, however, might be coordinated by the governments concerned. Cooper (1969) and Bryant (1980) discuss problems of policy coordination.

domestic currency and a deterioration of the trade balance, as it did in the small country case. But the foreign country thereby experiences a boom, so that outputs and interest rates rise in both countries. Mundell considers an interesting special case where the two countries have identical income elasticities of the demand for money. In this case, the rise in government spending at home raises output at home relative to output abroad in proportion to the ratio of domestic to foreign output. Two countries of equal size, for example, would share equally in the expansion even though the increase in government spending fell solely on domestic goods. It is only when this ratio approaches zero that fiscal policy becomes ineffective in changing output. For further discussion of these and other results from two country models, the reader is referred to the excellent survey of macroeconomic interdependence by Mussa (1979).

Until this point we have evaluated fiscal and monetary policies separately and have judged each according to its effects on domestic output. We might also be concerned with the balance of payments or other external effects of the policies, however, and might therefore ask if it is possible to achieve both internal and external balance using fiscal and monetary policies together.[36] According to Tinbergen's (1952) famous rule, to achieve a given number of independent targets we must have as many independent instruments. Here we have two instruments, monetary and fiscal policy, and they can be varied to achieve two independent targets, since the policies generally differ in their relative impacts on output and external balance (defined in this

[36]We confine our discussion to fixed exchange rates, although similar issues arise under flexible rates.

model as a desired value of foreign exchange reserves).[37]

To the requirement that the number of instruments be as large as the number of targets, Mundell (1962) added another condition: that each policy instrument be directed toward that target for which it has relatively greater impact; he termed this the "principle of effective market classification."[38] In the flow models of the 1960's, monetary policy had a comparative advantage over fiscal policy in achieving balance of payments equilibrium under fixed exchange rates. In the model specified here, however, that comparative advantage no longer holds in all cases. If the substitutability between domestic and foreign bonds is low enough, for example, monetary policy may have no net effect on foreign exchange reserves (the razor's edge case between a negative and positive offset). With perfect substitutability between bonds, on the other hand, the only effect of monetary policy is on foreign exchange reserves, as discussed before. So the degree of asset substitutability is also crucial in determining the comparative advantage of the two policies.

Today, concern over the balance of payments (or the exchange rate under flexible rates) would probably be replaced by concern over the price level or inflation rate. And assumptions about decentralized decisionmaking that lay

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[37]In the asset model specified here, it is more natural to define external balance in terms of a desired level of foreign exchange reserves rather than a desired value for their time derivative (the balance of payments).

[38]This condition was necessary for dynamic stability in Mundell's model, when two different authorities controlled monetary and fiscal policy. Note that in this study, unlike the other cited earlier, Mundell assumed imperfect substitutability between domestic and foreign bonds.

behind Mundell's analysis would probably be replaced with assumptions about information asymmetries between the government and private agents. We discuss price behavior in the next section and those following, while information asymmetries are discussed in section 5.

4. Flexible wages and the monetary approach

The macroeconomic model introduced so far displays the rigid nominal wages characteristic of Keynesian models of the 1960's and earlier, even while it incorporates asset behavior reflecting portfolio theory as it has developed in the 1970's. With the rise in inflation in the late 1960's, the assumption of rigid wages became increasingly untenable. As a result, some form of wage flexibility has become a feature of many open economy models. In the next section we will discuss contract models of wage determination which fix wages only temporarily. But before doing so we will introduce a simple classical model with perfectly flexible wages. This model will help to clarify the role of wealth effects in the economy's adjustment to long run equilibrium. In the monetary approach to the balance of payments, these wealth effects constitute the main channel through which a devaluation affects the real sector of the economy. In addition, the model will describe a full information equilibrium which will serve as a benchmark for the new classical models to be described in the next section.

4.1. A model with flexible wages

The behavior of the model introduced in earlier sections changes markedly when wages become flexible. In an open economy, however, output does not become exogenous under this classical assumption; instead, aggregate supply becomes a function of the terms of trade, P/P^fX. To see why this is true, first consider labor supply behavior in an open economy. If labor consumes both domestic and foreign goods, the supply of labor should be responsive to the nominal wage relative to the general price level, I, rather than the price of domestic goods, P:

$$N^s = N^s(W/I). \tag{4.1}$$

The domestic producer, on the other hand, measures wages relative to the price of the good which he produces, so the demand for labor should be of the form:

$$N^d = N^d(W/P). \tag{4.2}$$

W/I is often called labor's real wage, while W/P is called the producer's real wage.[39] If the supply and demand equations are solved for an equilibrium wage and quantity of labor, and if the production function (3.4) is used to determine output, the result is a new supply equation of the form:

$$Y = Q^s(P/P^fX), \quad Q^s_P > 0 . \tag{4.3}$$

Any disturbance that changes the terms of trade also changes output.

With the new aggregate supply equation replacing (3.4) in the original model, we still have a four equation system determining Y, P, r, and X or XF^m. This system is more difficult to describe, however, since the domestic price can no longer be easily eliminated from the system. To make the system more manageable, we replace the bond equation with an uncovered parity condition, $r = r^f + \pi_X$, by assuming that domestic and foreign bonds are perfect substitutes. This assumption, in fact, is almost always adopted in the monetary approach and in the stochastic models to be discussed shortly. In addition, we assume that all expectations are static, i.e., π_X is zero and so the domestic interest rate is equal to the exogenous foreign rate. We

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[39]Chapter 16 by Bruce and Purvis discusses labor market behavior in more detail. For a similar description of the labor market, see Salop (1974), Purvis (1979), Branson and Rotemberg (1980) and Sachs (1980). Later we discuss models where labor's real wage is kept rigid by indexation.

briefly discuss the more general case below.

The parity condition allows us to eliminate the domestic interest rate from the aggregate demand and aggregate supply equations and from the equilibrium conditions for the money market. We can write the aggregate demand and supply equations in differential form, solving for the change in the domestic price in order to show the adjustment of this price more clearly:

$$dP = dX + dY/Q_P^s \, , \tag{4.4}$$

$$dP = -\frac{G_X}{G_P}\,dX - \frac{G_Y}{G_P}\,dY + \frac{dG_0}{G_P} \tag{4.5}$$

These two equations can be illustrated in Y-P space as in figure 3. Under fixed exchange rates, the two schedules alone determine domestic output and price. The money market equation determines the change in foreign exchange reserves recursively. The system of equations under fixed exchange rates is thus qualitatively similar to the Keynesian system outlined above, at least as long as the foreign price is constant. If the exchange rate changes, however, both schedules in figure 3 are affected. (For a similar diagramatic analysis in a stochastic model, see Marston, 1982b).

4.2. Effects of a devaluation with flexible wages

How much difference the new aggregate supply equation makes to the behavior of the model can be seen by examining the effects of a devaluation. As in the Keynesian model, a devaluation leads to an increase in aggregate demand, which in figure 3 is represented by an upward shift of the dd schedule. Whether this movement is proportional to the change in the exchange rate is crucial in determining the net effect of the devaluation, so we use equation (4.5) and the definitions of table 1 to express the (vertical) shift of the dd curve as follows:

$$\frac{dP}{dX} = 1 - \frac{(1+B_Z)Z_A(A-F^d)}{G_P} \, . \tag{4.6}$$

The upward shift of the aggregate demand schedule is less than proportional if $Z_A > 0$, where Z_A is the derivative of expenditure with respect to real wealth. With money and domestic bonds fixed in nominal value at any point in time, the devaluation reduces the real value of domestic wealth (in proportion to $A - F^d = M + H^d$); the sensitivity of aggregate demand to real wealth then holds down the increase in aggregate demand. Aggregate supply also adjusts upward because of the increase in nominal wages induced by the higher domestic price for the foreign good. In the case of the supply schedule, the upward shift is proportional because equal increases in X and P would raise wages proportionally and would leave output unchanged.

From figure 3 it is evident that output actually declines and the domestic price rises less than proportionately in response to the devaluation. (See point a). With changes in exchange rates affecting real wealth because some assets are fixed in nominal value, the devaluation has real effects despite the flexibility of wages. This is a familiar result in classical models.[40] The fall in output and the terms of trade generates a trade surplus for the devaluing country. As a result, the immediate impact of the devaluation on domestic prices and output is different from its long run impact. That is because the trade surplus leads to a (flow) increase in wealth,

$$\dot{A} = P\,B > 0 \,, \tag{4.7}$$

which moves the short run asset market equilibrium continuously toward a long run steady state. In that steady state, the trade account reaches equilibrium with total nominal assets increasing proportionally to the change in the exchange rate: $dA/A = dX/X$. Wages and prices also increase proportionally in

[40] See Metzler's (1951) treatment of monetary policy in a closed economy.

the long run, so output returns to its initial level.

This process of wealth accumulation is an essential feature of the monetary approach to the balance of payments.[41] In many versions of this approach, money is the only asset so that real money balances rather than real wealth drive the accumulation process. As long as the domestic credit component of the monetary base is kept constant, moreover, foreign exchange reserves grow along with money balances so that the equation describing wealth accumulation explains the balance of payments.

Consider a simple version of this approach taken from Dornbusch's (1973) well-known study of devaluation

$$M^d = k\ P\ \overline{Y} \tag{4.8}$$

$$P = \overline{P}^f\ X \tag{4.9}$$

$$\dot{M} = \gamma(k\ P\ \overline{Y} - M), \quad \text{where } M = H^m + X\ F^m\ . \tag{4.10}$$

The first equation is a quantity theory formulation for the demand for money. The second equation states the law of one price reflecting the assumption that domestic and foreign goods are perfect substitutes. The third equation specifies a wealth accumulation process that relates the rate of hoarding (income less expenditure) to the difference between money demand and

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[41]Frenkel and Johnson (1976) trace the origins of this approach back to the writings of Mill, Hume and other classical economists. Johnson (1972) provides one of the earliest formal descriptions of it. For references to the extensive literature that has emerged since, see Whitman (1975) and ch. 14 by Frenkel and Mussa.

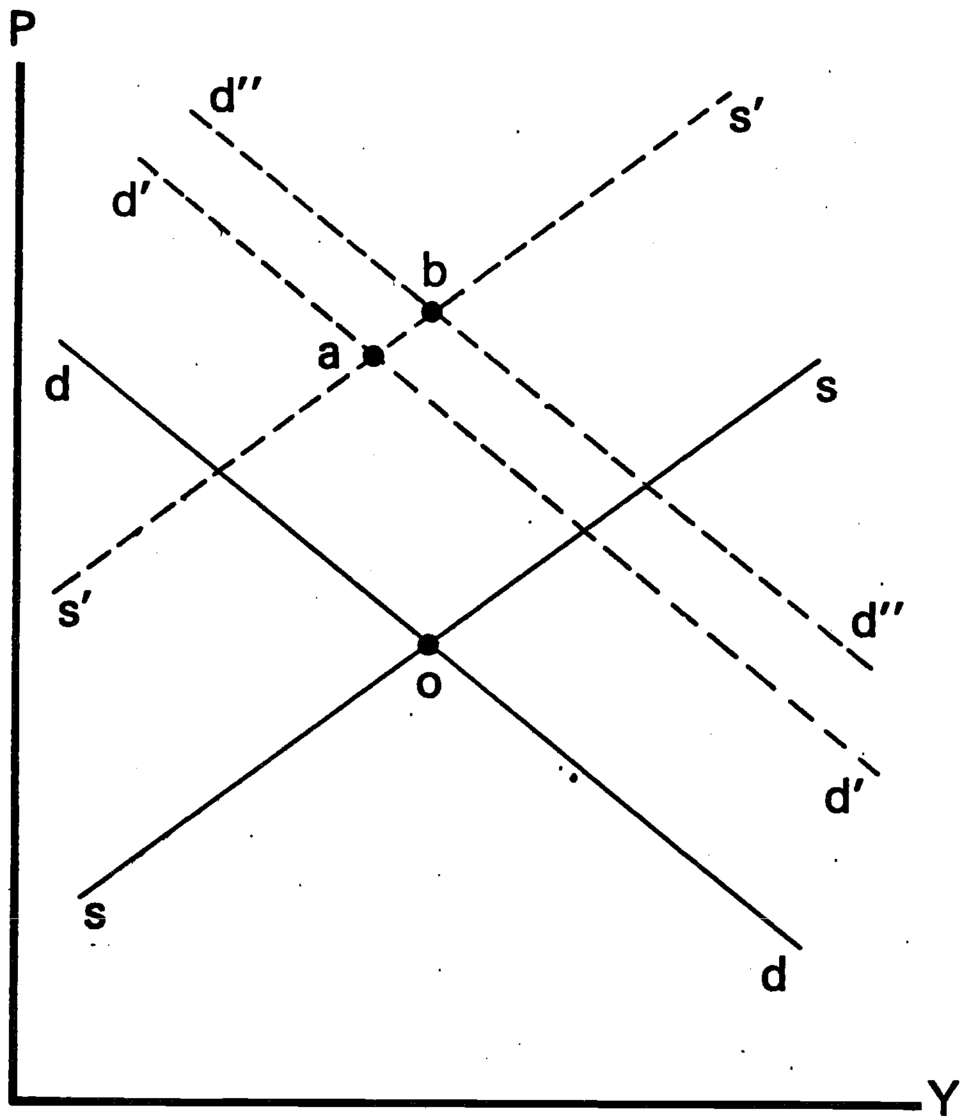

Figure 3. Devaluation or Depreciation in the Classical Model

supply.[42] According to this model, a devaluation has only temporary effects on the trade balance with the rate of asset accumulation being in proportion to the difference between the stock demand and supply of money. Through the accumulation of foreign exchange reserves the money supply in time reaches a new equilibrium with the money supply having risen in proportion to the exchange rate, $dM/M = dX/X$.

Results similar to Dornbusch's can be derived using the model with internationally mobile capital developed in this chapter. If we follow Dornbusch by assuming that the law of one price holds, then output is unaffected by the devaluation. (In the aggregate supply function (4.3), output is fixed by the constant terms of trade.) The price level rises in response to the devaluation, however, so the demand for money immediately rises. With bonds as well as money included in the menu of assets, there is no longer short run disequilibrium between the stock demand and supply of money as in equation (4.10). Instead, asset holders can instantaneously adjust their money holdings to the desired level by buying or selling bonds. If money balances are a positive function of wealth as in equation (3.5), then money balances rise immediately following the devaluation, but less than proportionally to the exchange rate (and the price level):

$$\frac{dM}{M} = \left(1 - \frac{m_A}{M}(A - F^d)\right)\frac{dX}{X} \qquad (4.11)$$

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[42]In the same paper, Dornbusch extended his model to include non-traded goods and showed that a devaluation could have effects on the allocation of resources between sectors during the period when money balances are adjusting. In ch. 14, Frenkel and Mussa discuss a wider class of models showing how the monetary adjustment mechanism is affected by relaxing these assumptions.

The trade balance also rises as can be seen by solving the income-expenditure relationship (3.1):

$$dB = dY - dZ = Z_A(A - F^d)\ dX > 0 \tag{4.12}$$

The improvement in the trade account is directly proportional to the change in real wealth rather than to the change in real money balances as in Dornbusch's model.[43] The trade account surplus, in turn, generates a flow increase in wealth as in (4.7). How that increase in wealth is divided between assets depends upon the sensitivity of money demand to real wealth (as reflected in m_A):

$$\dot{M}/P = m_A(\dot{A}/P) \tag{4.13}$$

The wealth accumulation process ends when money balances as well as other assets have increased in proportion to the devaluation just as in the simpler Dornbusch model.

This description of how an economy responds to a devaluation differs markedly from the earlier elasticity and absorption approaches.[44] In the elasticities approach, a devaluation improves the trade balance by changing

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[43]If domestic bonds did not represent net wealth, the wealth effect would be proportional to money balances only, $A - F^d = M$, just as in Dornbusch's model.

[44]For a discussion of these approaches, see section 2.3 above. Earlier studies of devaluation did not necessarily ignore monetary factors. In his paper on the absorption approach, Alexander (1952) included a real balance effect, while in his synthesis of the elasticity and absorption approaches Tsiang (1961) emphasized the importance of monetary policy in determining the effects of a devaluation. In both studies, however, the authors were more concerned with the impact effects of a devaluation than with the dynamic adjustment process which is central to the monetary approach.

the relative prices of imports and exports, but in the present model there is only one traded good. In the absorption approach, a devaluation works at least in part by increasing output relative to spending, but here output is fixed at full employment. The law of one price combined with flexible wages shuts off both of these traditional channels so that the devaluation must work through wealth effects alone.

If there are no real wealth effects in the aggregate demand function (Z_A=0), then this dynamic accumulation process is eliminated. The devaluation then leads immediately to a proportionate rise in the domestic price even when domestic and foreign goods are imperfect substitutes. (Aggregate demand rises to point b in figure 3.) The terms of trade are constant, and there is no change in output or employment. Furthermore, there is no change in the balance of trade, since it is a function of real expenditure and the terms of trade, both of which are constant under these conditions.

Regardless of the presence or absence of wealth effects, we must not lose sight of the vital role played by wage and price flexibility in obtaining these results. The contrast between the results obtained in this section (with or without wealth effects) and the results obtained with the Keynesian model could not be sharper. The Keynesian model predicts that a devaluation will raise output and improve the balance of trade, while the classical model predicts that its main if not exclusive effect will be on domestic prices. When the trade balance improves because of wealth effects, moreover, the classical model predicts a decline in output rather than the expansion associated with Keynesian models.

In choosing between the two alternative models, the time frame becomes very important. If we believe that wages are sticky in the short run, then we should expect output to expand and the trade balance to improve following a devaluation, as the Keynesian model predicts. But once wages adjust, the classical model becomes relevant, with an improvement in the trade balance occuring only to the extent that there are wealth effects on expenditure. If we believe that wages adjust rapidly, whether through recontracting or indexation, we should expect the classical model to hold in the short run too so that the immediate effects of a devaluation may be primarily on nominal rather than real variables. The timing of wage and price adjustments is evidently crucial, and that timing is likely to vary across countries depending upon the extent of indexation and other factors.

4.3 Effects of monetary and fiscal policy with flexible wages

In both Keynesian and classical models, the effects of monetary policy depend upon the exchange rate regime. In section 3 we showed that in the Keynesian model monetary policy under fixed exchange rates is powerless to affect output as long as domestic and foreign bonds are perfect substitutes. That must also be the case in the classical model, since the offset effect is independent of wage conditions in this limiting case. Monetary policy can affect output, however, even in the classical model if there is imperfect substitutability in the asset markets.

The effects of monetary policy under flexible rates, by contrast, depend upon the specification of supply and demand behavior in the model. In general, the open market purchase of bonds causes the domestic currency to depreciate. The effects of this depreciation on the domestic price and output can be illustrated by figure 3, the same figure used to illustrate the effects of a devaluation. As in the case of a devaluation, a monetary expansion leads to a rise in the domestic price but a fall in output (to point a), because the higher price of domestic output and the depreciation reduce real wealth. The trade account goes into surplus thereby generating a flow increase in wealth just like in the case of a devaluation. The long run equilibrium similarly involves a return of real wealth to its original level.

If domestic and foreign goods are perfect substitutes, so that the law of one price links domestic and foreign prices at purchasing power parity, however, then output is unaffected even in the short run. The primary effect of the monetary expansion is to drive up prices in proportion to the depreciating exchange rate. This is a common result in many versions of the monetary approach to the exchange rate. Consider one version consisting of three so-called "building blocks" of the approach: a quantity theory equation for the demand for money (with real balances a function of the interest rate), the law of one price, and uncovered interest parity:[45]

$$M^d = k(r)\, P\, \overline{Y}\ , \tag{4.14}$$

$$P = \overline{P}^f X\ , \tag{4.15}$$

$$r = \overline{r}^f + \pi_X\ , \tag{4.16}$$

where $\pi_X = 0$ if expectations are static. According to this model, an increase in the money supply has no effect on output, but raises the domestic price and exchange rate in proportion to the increase in the money supply: $dP/P = dX/X = dM/M$.[46] Even in this model, however, the monetary expansion causes a

[45]Frenkel (1976) applies these three building blocks to explain the exchange rate during the German hyperinflation. For a more detailed discussion of the monetary approach to the exchange rate, see ch. 14 by Frenkel and Mussa.

[46]Note that the depreciation of the domestic currency is less than proportional to the increase in the money supply if expectations are regressive rather than static.

temporary trade imbalance if expenditure (not shown) is a function of real wealth.

In order for there to be no real effects of the monetary expansion, we need to assume that expenditure is unaffected by changes in real wealth. In that case the economy is driven to point b in figure 3 just as in the case of a devaluation. Both output and the trade balance are unaffected by the monetary expansion as prices rise in proportion to the exchange rate.

Leaving aside the issue of wealth effects, we can ask how much difference flexible wages make to the effectiveness of monetary policy. The introduction of flexible wages into the Mundell model undermines his conclusions and those of similar studies about the relative effectiveness of monetary policy. Monetary policy is not more effective in raising output under flexible exchange rates. On the contrary, it loses all of its effectiveness when wages are flexible, and may even reduce output if expenditure is a function of real wealth. Its principal effect, in fact, is to raise domestic prices. Monetary policy under fixed rates, in contrast, leaves the economy at point o, where price and output are constant, just as in the Keynesian model.

Increases in government spending have very different effects than monetary policy if, as is traditionally assumed, the government spending falls entirely on domestic goods. Whether exchange rates are fixed or flexible, the rise in government spending causes a <u>rise</u> in the <u>terms of trade</u> between domestic and foreign goods. To the extent that labor supply is sensitive to real wages, this rise in the terms of trade increases domestic output. Thus fiscal policy has real effects even though wages are perfectly flexible.

Consider first the case of fixed exchange rates, using figure 4. The increase in government spending leads to an upward shift in the aggregate demand schedule to d'd', raising domestic output and price to point a. With

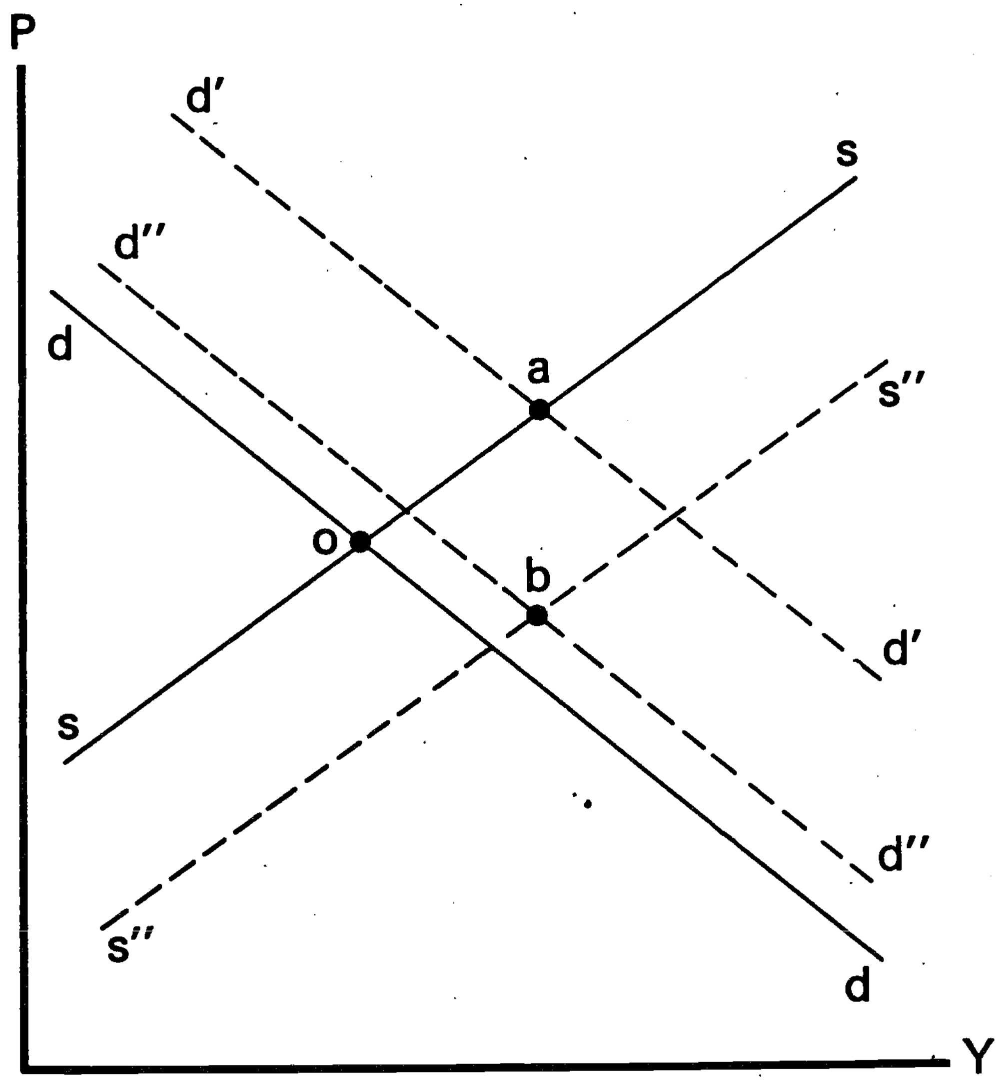

Figure 4. Government Spending in the Classical Model

the exchange rate constant, the necessary rise in the terms of trade is accomplished solely through a rise in the price of the domestic good.

Under flexible rates, by contrast, the exchange rate does most of the adjusting. As in the Keynesian model, an increase in government spending leads to an appreciation because of the increase in the demand for money. The appreciation causes both the aggregate demand and supply curves to shift down (relative to the fixed exchange rate equilibrium at point a).

Consider the case where there are no wealth effects on aggregate demand or on the demand for money. The appreciation then shifts the aggregate demand and supply schedules down proportionately from point a to point b).[47] The appreciation has no net effect on output, so point b must be directly below point a. Thus, with perfect wage flexibility, perfect capital mobility and the absence of wealth effects, fiscal policy has identical effects on output in the two exchange rate systems. Output does change in both systems, but by the same amount. The price of domestic output, however, increases less under flexible rates; in fact, the appreciation of the domestic currency may be large enough to induce a fall in the domestic price (as illustrated by point b). Because of the appreciation, the general price level unambiguously falls under flexible rates. As to the absolute variation in prices in the two regimes, it isn't possible to determine whether the price of domestic output varies more under fixed or flexible rates without further restrictions on the parameters. The same is true of the variation in the general price level.

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[47] The d"d" schedule can even shift down below its original position at dd depending upon the relative importance of income and price effects on expenditure, as well as other factors.

This analysis changes somewhat when real wealth effects are present. An appreciation of the domestic currency raises real wealth because the general price level falls, so output rises further under flexible rates than under fixed rates. The analysis changes more substantially, however, if domestic and foreign goods are perfect substitutes. Government spending raises output by changing the terms of trade between domestic and foreign goods; if those terms of trade are fixed by perfect substitutability, then government spending can have no effect on output.

To summarize the effects of monetary and fiscal policies, both are modified substantially by the flexibility of wages. In the Mundell-Fleming model monetary policy is more powerful in raising output under flexible rates and fiscal policy less powerful. In the classical model, any differences between output behavior in the two regimes depend upon wealth effects which are of secondary importance in the Mundell-Fleming model. If there are no wealth effects in the classical model, then monetary policy is equally powerless in each regime, while fiscal policy is as effective in a flexible regime as in a fixed regime.

Some of the new classical models bridge the gap between the wage assumptions of the monetary approach and Keynesian models by explicitly modeling the wage contracting process. In this new literature the distinction between the short and long runs becomes blurred because of the central role played by expectations. It is to this literature that we now turn.

5. The role of policy in the new classical macroeconomics

With many questions about stabilization policy still unresolved because of continuing controversies about asset substitutability, wage and price flexibility and other issues, economists were confronted in the 1970's with a new challenge associated with rational expectations and the new classical macroeconomics. A range of new propositions were put forward that redefine and severely limit the scope for an effective stabilization policy. Many of the basic insights of the earlier literature survive intact when rational expectations are introduced, but specific results about stabilization policy continue to hold only when disturbances in the economy, information flows and expectations take specific forms which were never adequately spelled out before.

The new classical macroeconomics has been developed mostly in the context of a closed economy in studies such as those of Lucas (1972, 1973), Sargent and Wallace (1975), and Barro (1976). The key propositions about stabilization policy can be summarized as follows: (1) Anticipated changes in the money supply have no real effects. Unanticipated changes do affect output, but random variations of the money supply merely raise the variability of output. (2) Monetary policy rules are ineffective in stabilizing output. McCallum and Whitaker (1979) have extended these propositions to include changes in government spending. For surveys of this literature, which is too broad to be fully treated here, the reader is referred to Shiller (1978), Buiter (1980), and McCallum (1980).

This section will review some of the basic propositions of the new classical macroeconomics within the context of an open economy model. The same model will be used in the following section to investigate the choice between exchange rate regimes and insulation. Open economy versions of the new classical macroeconomics have been derived from their closed economy counterparts, but there are some important differences in the open economy versions which we will describe later.[48]

Before introducing a specific model, it is useful to point out several common characteristics found in many of the open economy models:

(1) Expectations are rational in the specific sense that the public knows the underlying economic model and forms expectations on the basis of that model.[49] The open economy studies concerned with stabilization policy, however, differ from their closed economy counterparts in their assumptions about what information is available when expectations are formed.

(2) In the stabilization literature of the 1960's and earlier, economic policy was commonly modeled in terms of discrete policy initiatives formulated on an ad hoc basis. In the new classical literature, policy usually takes the form of rules tying current policy instruments to past or current economic disturbances. These rules form part of the model, and the private sector is usually assumed to know them or at least be able to make inferences about them.

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[48]Among studies dealing directly with open economy stabilization policy under rational expectations are Eaton and Turnovsky (1982), Henderson (1982), Marion (1982), and Turnovsky (1980b, 1981). Other studies such as Flood (1979) and Flood and Marion (1981) use similar models to examine the choice between exchange rate regimes. Further references are given below.

[49]Black (1973) was one of the first to employ rational expectations in an open economy context. Later influential studies include Mussa (1976), Dornbusch (1976), Kouri (1976), the latter two employing non-stochastic models with perfect foresight.

(3) Supply is responsive to unanticipated changes in prices, which drive the economy away from its "natural rate of unemployment" or its full information classical equilibrium. In the closed economy literature, the supply function is often explained in terms of a confusion between relative and absolute prices, as in the "island model" of Lucas (1973). As Flood (1979) has pointed out, however, this rationale is not appropriate for an open economy where contemporaneous international trading and intranational trading are permitted. Instead most studies base the supply function on a contract lag of the type specified by Gray (1976) and Fischer (1977c) for a closed economy.[50] In the open economy models, supply can also respond to anticipated changes in prices, as we will see below.

(4) Apart from the contract lag, almost all versions of the model exhibit classical neutrality. There are no wealth effects in the aggregate demand function, for example, and the supply function is homogeneous of degree zero in all prices. An anticipated monetary disturbance, therefore, has no real effects, and an unanticipated disturbance has real effects only during the

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[50]Recently Lucas (1981) has suggested that the two rationales for the supply function may turn out to be similar:

> "(n)one of these (contracting) models offers an explanation as to why people should choose to bind themselves to contracts which seem to be in no one's self-interest, and my conjecture is that when reasons for this are found they will reduce to the kind of informational difficulties already stressed in my 1972 article, for example."

This passage is quoted in Canzoneri, Henderson and Rogoff (1981). Flood and Hodrick (1982) provide an alternative to the wage contract model which explains inventory as well as production behavior in an open economy.

contract period.[51]

(5) Most of these models assume perfect substitutability between domestic and foreign securities. Notable exceptions are Eaton and Turnovsky (1982) and Henderson (1982). Many models also assume perfect substitutability between domestic and foreign goods, although this assumption is not necessary for most of the results.

5.1. A model of an open economy under rational expectations

In order to illustrate some of these characteristics and to discuss some of the more important results, we now introduce a model of a small open economy under flexible rates. The model, which is a simplified, stochastic version of the model used above, consists of three equations: aggregate demand and supply equations for the domestic good and an equation describing money market equilibrium.[52] All variables (except interest rates) are expressed in logarithms using small letters as follows: $j = \log J$, where J is

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[51]If expenditure were a function of wealth, monetary policy would be nonneutral in the short run if it changed the real value of wealth, as in the money-bond model introduced earlier. See Canzoneri (1980) for a discussion of wealth effects in stochastic models. Another source of nonneutrality is the Tobin effect of anticipated inflation which changes the real return on money balances. Fischer (1979) discusses this and other sources of nonneutrality. All statements about the effects of anticipated money below must be qualified if such nonneutralities are present.

[52]The main simplification is that wealth effects have been suppressed (as noted above). The new aggregate supply function with its contract specification, of course, is more complicated than the supply function used above. The model is written in logarithmic form as is most of the stochastic literature.

the corresponding level variable:

$$y_t = c(p_t - {}_{t-1}Ep_t) + \frac{c_1}{(1-a)}\ {}_{t-1}E(p_t - i_t) + c_0 \ , \tag{5.1}$$

$$y_t = (1-c')\ l_t^d = -c(w_t - p_t) + c\ \ln(1-c') \ , \tag{5.2}$$

$$l_t^s = n(w_t - i_t) + n_0 \ , \tag{5.3}$$

$$w_t' = \frac{{}_{t-1}E(p_t + nc'\ i_t)}{1 + nc'} + \frac{\ln\ (1-c') - n_0 c'}{1 + nc'} \ , \tag{5.4}$$

$$w_t = w_t' \ , \tag{5.5}$$

where $c = (1-c')/c'$,

$c_0 = (1-c')[n\ \ln(1-c') + n_0]/(1 + nc')$,

$c_1 = (1-c')\ n\ (1-a)/(1 + nc')$,

$$y_t = g_p(p_t^f + x_t - p_t) - g_r[r_t - ({}_tEi_{t+1} - i_t)] + g_y y_t^f + g_0 \ , \tag{5.6}$$

$$m_t - i_t = (p_t + y_t - i_t) - k_1 r_t \ , \tag{5.7}$$

$$r_t = r_t^f + {}_tEx_{t+1} - x_t \ . \tag{5.8}$$

Equation (5.1) describes supply behavior, which is based on a contract lag of one period. As explained in the last section, the supply equation takes a more complicated form than in a closed economy because there are two prices involved in supply decisions, the price of domestic output (p_t) and the general price level (i_t), the latter a weighted average of domestic and foreign prices,

$$i_t = a\ p_t + (1-a)\ (p_t^f + x_t) \ , \tag{5.9}$$

where p_t^f is the price of the foreign good while x_t is the domestic currency price of foreign currency. Output is responsive to the nominal wage relative to the price of domestic output, but the nominal wage is fixed in period t-1 in the light of expectations prevailing at that time.[53]

The supply equation (5.1) is derived from a Cobb-Douglas production function (5.2), from a labor demand equation based on the production function which is sensitive to the <u>producer</u>'s real wage, $w_t - p_t$, and from a labor supply equation (5.3) which is sensitive to <u>labor</u>'s real wage, $w_t - i_t$. The contract wage, w'_t, is based on expectations of labor demand and supply formed at t-1, as in equation (5.4). If there is no wage indexation, the actual wage is equal to this contract wage, as in (5.5). With wages based on last period's expectations, output is a function of <u>unexpected</u> changes in the domestic price. In an open economy, however, output is also responsive to <u>anticipated</u> changes in the terms of trade, ${}_{t-1}E(p_t - i_t) = (1 - a)_{t-1}E(p_t - p^f_t - x_t)$, for the same reason that output is a function of the terms of trade in the classical economy without contract lags described in the previous section.

This contracting approach to the aggregate supply function has been criticized by Barro (1977) who offers an alternative description of labor market behavior which gives Pareto optimal outcomes. Barro develops a model where wages are set in contracts but employment is made contingent upon shocks perceived after wages are set. Such contracts dominate the simple ones considered here, but bear little resemblance to actual contracts, as Fischer (1977a) observed in his comment on Barro's paper. The indexation of wages to prices is a common feature of labor contracts in some countries, but such

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[53] ${}_{t-1}EJ_t$ denotes the expectation of J_t formed on the basis of information available at time t-1.

schemes correct only imperfectly for the contract lags. We discuss indexation in detail in the next section.

Equation (5.6) describes aggregate demand for the domestic good as a function of the relative prices of foreign and domestic goods, the real interest rate, and foreign output (y_t^f). A rise in the foreign price relative to the domestic price (a fall in the terms of trade) increases aggregate demand, as does a rise in foreign output, while a rise in the real interest rate reduces aggregate demand. In the case of perfect substitution between domestic and foreign goods, g_p becomes infinite in size, and this aggregate demand equation reduces to the familiar purchasing power parity relationship.

There are three financial assets in the model as before, but domestic and foreign bonds are perfect substitutes in equation (5.8). The demand for money (5.7) is expressed as a function of real income and the interest rate, but not real wealth; to further simplify the model, moreover, the income elasticity is set equal to one.[54]

In equations (5.6) and (5.8) expectations of changes in the general price level and the exchange rate are based on information available in period t, including knowledge of the current exchange rate and price levels at home and abroad. This expectations assumption is different from that in most of the closed economy literature, where expectations are based on knowledge of last period's price level. This difference is particularly important in determining the effectiveness of policy rules, so we will discuss it in detail below.

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[54] If this elasticity is not equal to one, a change in the general price level, and therefore the exchange rate, has an effect on the net demand for money proportional to one minus this elasticity.

We begin by examining simple changes in the money supply which are alternatively unanticipated and anticipated by the general public. This will allow us to illustrate the crucial role played by expectations in determining the effectiveness of policy. The analysis draws most directly on a study by Turnovsky (1981), although other studies cited above are also relevant. Thereafter, we consider the role of policy rules which tie current policy to private sector disturbances.

5.2. Changes in the money supply

To examine several different types of changes in the money supply, we describe the money supply below as the sum of deterministic and stochastic terms:

$$m_t = m_0 + v_t \ , \quad v_t = \alpha v_{t-1} + u_t^m \ .$$

The stochastic term has an autoregressive component, αv_{t-1}, in addition to the innovation in period t, u_t^m. If the innovation is temporary, $\alpha = 0$; if it is permanent, $\alpha = 1$. Substituting this expression for the money supply into equation (5.7), we can solve the three equation system for current values of x_t, p_t, y_t as functions of the money supply process.[55]

$$x_t - \bar{x} = m_0 + \frac{\alpha v_{t-1}}{A_2} + \frac{A_1(1+k_1)u_t^m}{A_2 A_0} \ , \tag{5.10}$$

$$p_t - \bar{p} = m_0 + \frac{\alpha v_{t-1}}{A_2} + \frac{(g_p + g_r a)(1+k_1)}{A_2 A_0} u_t^m \ , \tag{5.11}$$

[55]The system can be solved by recursive substitution or by the method of undetermined coefficients (see Lucas, 1972). To obtain a stable solution, we must assume the absence of speculative bubbles. Shiller (1978) discusses this assumption.

$$y_t - \bar{y} = \frac{c(g_p + g_r a)(1+k_1)}{A_2 A_0} u_t^m . \tag{5.12}$$

where $A_1 = c + g_p + g_r a > 0$, $A_2 = 1 + k_1(1-\alpha) > 0$, and $A_0 = ck_1 + (g_p + g_r a)(1 + k_1 + c) > 0$, while $\bar{x}$, $\bar{p}$, and $\bar{y}$ are constants which are functions of the non-stochastic terms in equations (5.1 - 5.8).

These expressions are used to interpret three different types of changes in the money supply as follows:

(1) <u>Unanticipated, temporary increase in the money supply</u> ($u_t^m > 0$, $\alpha = 0$).

The immediate response to this type of change in the money supply is very similar to that discussed in the non-stochastic models with fixed nominal wages. The temporary expansion of the money supply induces a depreciation of the domestic currency. The depreciation is large enough to cause a fall in the terms of trade even though the price of domestic output rises. Therefore, the demand for the domestic good increases. With wages fixed during the contract period, the rise in the domestic price lowers the producer's real wage, so aggregate supply and output also rise. Thus during the contract period at least, the change in the money supply has an expansionary effect on the economy. A temporary disturbance, however, has no effect on the economy beyond the current period; in the absence of further disturbances, the exchange rate, the domestic price and output return to their stationary values. For this reason, the rational expectation at t of any future value of a variable is the stationary value of that variable. The solution of the model is simple, a feature that is especially attractive if several countries are to be analyzed at once. If there were no contract lag, or if information were complete at the time of the contract, then the monetary disturbance would have no effect on output even in the current period.

(2) Unanticipated, permanent increase in the money supply ($u_t^m > 0$, $\alpha = 1$).

If the innovation is expected to be permanent, its effects in the current period differ markedly from its subsequent effects. In the current period, the economy responds much as it would to a temporary innovation. The domestic currency depreciates, while both domestic output and price rise.[56] (It can be shown that output rises somewhat more in the current period if the change in the money supply is permanent rather than temporary.) Since the information lag associated with the contracting process persists for only one period, the system reaches equilibrium in period t+1. The effects of the innovation in that period are identical to those of any (other) anticipated change in the money supply. They are discussed immediately below.

(3) Anticipated increase in the money supply

Fully anticipated changes in the money supply leave output unchanged while increasing the domestic price and the exchange rate proportionately. Without further complicating the model introduced above, we can illustrate the effects of an anticipated increase in the money supply by focusing on v_{t-1} in equations (5.10-5.12); it represents the continuing effect of an earlier money supply innovation (which we assume to be permanent by setting $\alpha = 1$). Both x_t and p_t rise in proportion to v_{t-1}, demonstrating the homogeneity of the system in the absence of contract lags. Because the change in the money supply was

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[56]Turnovsky (1981) has an interesting discussion of exchange rate overshooting in response to this disturbance. Overshooting is by no means necessary in this model, since output is endogenous. Whether overshooting occurs depends upon a condition involving price elasticities very similar to that presented by Dornbusch (1976), even though the nominal rigidities responsible for the overshooting are quite different in the two models.

anticipated at t-1, it affects current wages, which are based on last period's expectations, so the only source of nominal rigidity in this system is removed. As a result, there are no effects on output in period t or beyond.[57] This result can also be interpreted in terms of the supply function (5.1) alone. Because the change in the money supply is anticipated, there is no unanticipated change in the domestic price to affect output, and the first term in (5.1) is zero. In addition, the second term in (5.1), which can be rewritten $c_1 \; {}_{t-1}E(p_t - x_t - p_t^f)$, is unaffected by the disturbance, because any anticipated monetary expansion leaves the anticipated terms of trade unaffected. Thus we obtain the same result as in a closed economy despite a more complicated supply function. If there were real disturbances, however, supply would be affected through anticipated changes in the terms of trade.[58]

The preceding analysis has illustrated the significant differences between the effects of anticipated and unanticipated changes in the money supply. When changes in the money supply are anticipated, we are essentially back in the classical world of section 4 where changes in the money supply have no real effects. (Recall that the particular classical world described in this model is one where there are no real wealth effects on aggregate demand.) Unanticipated changes, however, do have real effects, although only

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[57]The announcement of an increase in the money supply does have an effect on output in the period of the announcement, although not in future periods. See Turnovsky (1981).

[58]Government spending, therefore, can have real effects even if it is anticipated since (as shown in section 4) it changes the anticipated terms of trade between domestic and foreign goods. See Marion (1982) and Turnovsky (1980b). The effectiveness of government spending rules is discussed below.

during the contract period. But notice that such changes have no stabilization role thus far, since they are unrelated to those exogenous disturbances that stabilization policy is designed to control. In fact, as Sargent and Wallace (1975) have pointed out, these unanticipated changes in the money supply introduce unwanted noise into the system, raising the variance of output.

5.3. Policy rules

Stabilization policy is normally aimed at countering the effects of disturbances originating elsewhere in the economy or abroad. The question addressed in this section is whether known rules by which policy reacts to these disturbances can in fact counter them.

In the illustrative model introduced above, which is typical of most such studies of the open economy, policy rules do have an impact. To show how, we first modify the three equation model introduced above by adding disturbances to the aggregate demand and money demand expressions as follows:

$$y_t = g_p(p_t^f + x_t - p_t) - g_r[r_t - ({}_tEi_{t+1} - i_t)] + g_y y_t^f + g_0 + u_t^d \qquad (5.13)$$

$$m_t - i_t = p_t + y_t - i_t - k_1 r_t + u_t^n . \qquad (5.14)$$

These disturbances represent random elements in private behavior, with a rise in u_t^d (u_t^n) reflecting a rise in demand for the domestic good (money).[59]

What policy rule would be appropriate in this economy? Policy could respond currently to current disturbances, since the disturbances are part of

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[59]The disturbances have a mean of zero, are serially uncorrelated and uncorrelated with each other. We also could have considered a supply disturbance, but these two disturbances are sufficient to illustrate the effects of a policy rule.

the information set used in determining expectations. In that case, the disturbances could be perfectly offset. But suppose that only lagged responses are feasible. Then it is still possible, as Turnovsky (1980a) has shown in the context of a closed economy, for a policy rule to modify the effects of current disturbances.[60]

Suppose that the rule is of the form:

$$m_t = n_1 u^n_{t-1} + n_2 u^d_{t-1} + m_0 ; \tag{5.15}$$

that is, the current money supply responds to lagged disturbances. In that case, output can be written as a function of the disturbances:

$$y_t - \bar{y} = \frac{-c(g_p + g_r a)}{A_0} [1 - \frac{k_1 n_1}{1+k_1}] u^n_t + \frac{ck_1}{A_0}[1 + \frac{(g_p + g_r a)n_2}{1+k_1}] u^d_t . \tag{5.16}$$

Notice that the parameters of the policy rule, n_1 and n_2, appear in the coefficients of both disturbances.

Consider the response to money demand disturbances as reflected in n_1. If the authorities choose $n_1 = (1 + k_1)/k_1$, then output is stabilized completely. The reason has to do with private expectations of future policy actions. The public is assumed to know the policy rule and to know all current information including the disturbances. So the public correctly anticipates the future movement of the money supply induced by today's disturbance: $m_{t+1} = m_0 + n_1 u^n_t$. It knows that the domestic currency will depreciate tomorrow, and the expectation of that depreciation raises the current interest rate, thus restoring equilibrium to the money market without any change in output.

In a similar way, we can compute the value of n_2 which will keep output

[60]For a similar point, see Weiss (1980).

constant in the presence of the aggregate demand disturbance, u_t^d. Keeping output constant, however, might be inappropriate. Barro (1976) has argued that policy rules should be aimed at stabilizing output relative to its value in a full information classical economy (i.e., one without contract lags) rather than stabilizing it absolutely.[61] And an aggregate demand disturbance does change output in a full information economy. If the supply function (5.1) for an economy with contract lags is replaced with a classical supply function of the form:

$$y_t^* = c_1(p_t^* - x_t^* - p_t^{f*}) + c_0 , \qquad (5.17)$$

then output in the full information economy (y_t^*) can be expressed as a function of the disturbance:[62]

$$(y_t^* - \bar{y}) = \frac{c_1}{c_1 + g_p + g_r a} u_t^d . \qquad (5.18)$$

According to Barro, an appropriate rule for monetary policy would use the value of n_2 which minimizes $(y_t - y_t^*)$. (This calculation is left to the reader.) Stabilizing output completely is appropriate only when the full information output is constant, which would be the case if c_1 were zero (i.e., labor supply were inelastic) or g_p were infinite (the terms of trade were constant).

Consider again why the monetary policy rule is effective in this open

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[61]If the only inefficiencies in the model are those associated with labor being off its (ex ante) supply curve because of the contract lag, then our norm for assessing policy should be the output which would occur if labor were <u>on</u> its supply curve as in a full information economy.

[62]Note that output is not responsive to the monetary disturbance in this full information economy, for the reasons outlined in section 4.

economy model. What would happen if we adopted the lagged dating of expectations commonly found in the closed economy (as opposed to the open economy) literature? The expected change in the exchange rate, for example, would be written ${}_{t-1}Ex_{t+1} - {}_{t-1}Ex_t$.[63] The answer is that the policy rule would become ineffective in modifying the impact of the disturbances. If the private sector cannot revise its expectations in response to current information, there is no lever by which such a policy rule can modify the output effect of a current disturbance. This is Sargent and Wallace's (1975) basic result showing the ineffectiveness of monetary policy. With lagged dating of expectations, a policy rule can be effective only if the government itself has an information advantage, and thus can respond to current disturbances even while the private sector cannot.[64]

The reason why policy is effective in one case and not in the other has to do with the relative amounts of information available to different agents in the economy. In the typical open economy model, wage earners' expectations are formed at t-1 based on information available then, while the private sector forms all other expectations based on information at period t. (The

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[63]Both assumptions about dating are subject to objections. Agents surely know the current interest rate and the current exchange rate, so expectations should be based at least partially on current information. But agents are unlikely to know other variables currently, such as the money supply and the price index for domestically produced goods. We discuss the use of partial information below.

[64]Sargent and Wallace (1975) and Barro (1976) both consider this case. Barro suggests that instead of pursuing stabilization policy in this case the government should make available any additional information it has.

government may or may not act on the basis of information at t.) If there were no contract lags, wage earners could set their wages based on current information, and a feedback rule would obviously be ineffective.[65] (We would be back in the classical world of section 4.) In the typical closed economy model, by contrast, all expectations are formed at t-1, so there is no lever for policy, whether acting through expectations or not. Asymmetries in information provide the leverage for policy rules.[66] And those asymmetries do not have to include superior knowledge on the part of the government as long as some private agents who have superior information know the government's policy rule.

Two other strands in the literature illustrate these points further. Contracts in the labor market which extend for more than one period provide a basis for effective policy rules. Fischer (1977b) shows that with two period

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[65]Contract lags, however, are not the only source of such information asymmetries. In the model specified by Bilson (1978b), there is a difference between the information sets of asset-market and labor-market participants not because of contract lags but because asset-market participants have a greater incentive to acquire (costly) information.

[66]Turnovsky (1980b) studies government spending rules in an open economy with lagged dating (so that there are no asymmetries in information). A government spending rule based on past disturbances can affect output by changing the terms of trade as in a classical economy, an effect which is absent from a closed economy. But the rule cannot change output relative to its full information value (which changes by the same amount); according to Barro's criterion, then, government spending is ineffective even in an open economy. See Turnovsky (1980b).

contracts, for example, a policy rule tying the money supply to disturbances in period t-1 can affect output in period t. In this case the authorities exploit an information asymmetry by setting the money supply in response to disturbances which, because of contract lags, are not simultaneously reflected in wages (or at least in some of the wages, since there are staggered contracts).[67] As in the earlier case, the information asymmetry is due to a contract lag, but neither the government nor the private sector need have information beyond that available in period t-1.

Canzoneri, Henderson, and Rogoff (1981) have a one period contract lag, but adopt assumptions about information different from either the open or closed economy models. (Their model is of a closed economy, but the same point can be made in an open economy model.) They assume that some agents know the current interest rate in addition to lagged values of the price level and output.[68] Knowledge of the current interest rate allows agents to predict the current price level more accurately than would be possible with lagged information only. The study shows very clearly that the scope for policy rules depends on the existence of an asymmetry in information between wage-earners, who set their wages in contracts based on information available in

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[67]Variations on this same theme are found in Phelps and Taylor (1977) and Taylor (1980).

[68]This is the same information assumption adopted by Poole (1970) in his well-known study of interest rate and money supply rules. The Canzoneri, Henderson and Rogoff study shows that many of Poole's results continue to hold when expectations are rational. Henderson (1982) extends Poole's analysis to an open economy where the government knows the current value of the interest rate and exchange rate.

period t-1, and other agents, who know the current interest rate. These other agents might consist of the government alone, the private sector alone (in its non-wage decisions) or both.

It is quite plausible to assume that most agents in the economy make use of current information on financial variables, probably more plausible than to assume that they use all current information or only lagged information. What is more controversial in this and other studies are the assumptions about labor market behavior—that wage earners set their wages based on expectations at t-1 (or at t-j in Fischer's model of multi-period contracts) with firms free to determine output on the basis of those wages. Until more research is done about labor contracts, these assumptions are likely to remain controversial. But so also are the assumptions underlying other versions of the supply function in models where policy is ineffective.

It is not surprising that assumptions about information are central to the discussion of policy ineffectiveness. In all versions of the new classical economics, supply functions are based on some form of imperfect information about prices. But with the effectiveness of policy rules depending so crucially on specific assumptions about information flows, it is difficult to draw any firm conclusions about stabilization policy until we are confident about the validity of those specific assumptions.

Apart from details about information flows, we need to know more about the ways that agents use information to form expectations. There is a large middle ground between the omniscience built into many versions of rational expectations, where agents have perfect knowledge of the economy, and the ignorance reflected in earlier expectations hypotheses. That middle ground needs to be more fully explored. It would be particularly useful to know how agents revise their expectations during the transition period following the adoption of a new policy. Indeed, McCallum (1980, p. 724) has described the new classical propositions as being relevant only to "stochastic steady states."

Further research clearly remains to be done in defining the scope for an effective stabilizaton policy--research on labor contracting and the behavior of firms, the gathering and efficient use of information, and the formation of expectations. Whatever the limitations of the current literature, however, it has had a profound effect on economists' views of macroeconomic policy. It has shown how crucial it is to distinguish between anticipated and unanticipated policies. The effectiveness of monetary policy, for example, is very much dependent upon whether or not the particular initiative is foreseen by the private sector. No description of a policy is complete without precise statements about what the private sector knows and when it knows it.

6. Exchange-rate regimes

In this section we shift focus to another topic of central interest to stabilization policy. Instead of asking whether monetary or fiscal policy can help to stabilize output, we ask if fixed or flexible exchange rates can help to achieve this objective. We have already addressed this question briefly in discussing non-stochastic models but have reserved most of the discussion for this section where expectations can be treated more formally. In most of the models discussed in this section expectations are rational and supply is determined by a stochastic supply function of the same general form as (5.1).

As in the discussion of policy rules, the economy is assumed to be buffetted by real and financial disturbances, but now we include some disturbances that originate abroad. Flexible exchange rates are thought by some to insulate the economy from foreign disturbances, particularly if the disturbances are monetary in nature. We show that insulation is achieved only in special cases, although exchange rate flexibility does generally dampen the effects of foreign monetary disturbances.

One prominent feature of modern economies, especially those in Europe, is the indexation of wages to prices. Indexation helps to adjust wages to unforeseen shocks, but the adjustment takes a rigid form that can keep real wages constant even in the case of shocks that normally require adjustments in real wages. We show how indexation prevents the exchange rate from altering output and how it thus affects the relative advantages of fixed and flexible rates.

The section concludes with a brief discussion of intervention rules for managed floating and of exchange rate arrangements in a multi-country setting.

6.1. Domestic disturbances

Mundell's propositions about the relative effectiveness of stabilization policies under fixed and flexible rates can be readily transformed into statements about the effects of domestic monetary and aggregate demand disturbances. In the Mundell-Fleming model, fixed rates are preferable to flexible rates if domestic monetary disturbances are important, since such disturbances have no effect on output under fixed rates, but merely result in a change in foreign exchange reserves. This ranking of regimes is reversed when domestic aggregate demand disturbances are important. The present section shows that in rational expectations models of the type discussed above, with wages temporarily fixed due to contract lags, both propositions continue to hold as long as the disturbances are unanticipated. If wage indexation is introduced, however, then the exchange rate ceases to have any effect on real variables. For that reason, there is no difference in the response of output to these disturbances under fixed and flexible rates.

To illustrate each of these points, we employ the stochastic model of the last section but with two changes to the supply function. First, we now allow wages to be indexed to the general price level:

$$w_t = w_t' + b(i_t - {}_{t-1}Ei_t) \ . \tag{6.1}$$

The actual wage, w_t, may differ from the contract wage, w_t', if the indexation parameter, b, is different from zero; this indexation parameter is assumed to vary between zero (no indexation) and one (full indexation).[69] Second, to simplify the analysis we assume that the (ex ante) labor supply function is inelastic, so that the supply of output is insensitive to anticipated changes in the terms of trade ($c_1 = 0$ in equation 5.1).[70] We make this assumption so that full information output will be unaffected by the disturbances considered below; we are then left with a simple criterion for judging exchange rate regimes involving the variance of output alone. The aggregate supply equation takes the following form:

$$y_t = c(p_t - {}_{t-1}Ep_t) - cb(i_t - {}_{t-1}Ei_t) + c_0 \ . \tag{6.2}$$

In the absence of indexation, only errors in predicting domestic prices affect aggregate supply, while with indexation errors in predicting the general price

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[69] For studies of behavior with wage indexation, see Gray (1976), Fischer (1977c), and Modigliani and Padoa-Schioppa (1978). This analysis of domestic disturbances follows Marston (1982b), although Sachs (1980) and Flood and Marion (1982) present similar results in other models. Some features of the study by Flood and Marion are discussed below.

[70] The ex ante labor supply function is inelastic ($n = 0$), but once the labor contract is signed the amount of labor supplied is determined by the demand for labor.

level also matter. With full wage indexation, an unanticipated change in the general price level can lead to a proportional adjustment of the domestic price with no change in output.

The equations of the model, now consisting of (5.13), (5.14), and (6.2), determine three variables: domestic output, the price of that output, and either the exchange rate or the money supply, depending on the exchange rate regime. If we assume that all foreign variables are constant, then we can express the three variables as functions of the domestic disturbances only. To facilitate comparison between the two exchange rate regimes, the aggregate demand and supply equations are first solved for y_t and p_t as functions of x_t and of the demand disturbance, u_t^d. The resulting expressions, equations (6.3) and (6.4) below, describe aggregate demand and supply behavior under both exchange rate regimes.[71]

$$y_t - \bar{y} = \frac{c(1-ab)}{D_1} u_t^d + \frac{(g_p + g_r a)\ c(1-b)}{D_1} (x_t - \bar{x}) \ , \tag{6.3}$$

$$p_t - \bar{p} = \frac{u_t^d}{D_1} + \frac{\big(g_p + g_r a + cb(1-a)\big)}{D_1} (x_t - \bar{x}) \ , \tag{6.4}$$

$$x_t - \bar{x} = - \frac{\big(1 + c(1-ab)\big)}{D} u_t^d - \frac{D_1}{D} u_t^n \ , \tag{6.5}$$

where $D_1 = g_p + g_r a + c(1-ab) > 0,$

$D = (1 + k_1)D_1 + c(1-b)(g_p + g_r a - 1) > 0 \ .$

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[71] All expectations in the model are assumed to be formed rationally, and the disturbances are unanticipated and serially uncorrelated. As was shown in the last section, the rational expectation at t of p_{t+1} or x_{t+1} is therefore the stationary value of that variable (here denoted by $\bar{p}$ and $\bar{x}$, respectively).

Under fixed rates, x_t is kept equal to $\overline{x}$, with the money supply being determined recursively by (5.14). Under flexible rates, x_t can be expressed as in equation (6.5) as a function of both domestic disturbances, u_t^d and u_t^n, by solving all three equations (5.13), (5.14) and (6.2) for the reduced form.

We begin by examining the effects of the disturbances in the case where there is no wage indexation in the domestic economy, then we consider the effects of indexation. When there is no wage indexation, the effects of both disturbances correspond closely to those reported by Mundell (1963). A monetary disturbance, representing an increase in the money supply or decrease in money demand ($u_t^n < 0$), has no effect on output under fixed exchange rates; it results simply in an offsetting capital flow. With a flexible rate, in contrast, a monetary expansion leads to a depreciation of the domestic currency and to an increase in output as well as in the domestic price.[72] Similarly, as in Mundell's study an aggregate demand disturbance leads to a greater change in output under fixed rates. An increase in aggregate demand raises both domestic output and the domestic price. Under flexible rates, the increase in the transactions demand for money leads to an appreciation of the domestic currency which dampens the overall increase in aggregate demand.[73]

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[72]The monetary disturbance affects output and the domestic price only through the exchange rate, as equations (6.3) and (6.4) indicate.

[73]Under flexible exchange rates, the direct (positive) impact of u_t^d on y_t in equation (6.3) is dampened by the fall in x_t (which reduces y_t). In contrast to Mundell's study, however, output nonetheless increases even under flexible rates, because the appreciation leads to a rise in the domestic interest rate, thus allowing output to increase despite a constant money supply. (In the notation of section 3, the coefficient L_X is not equal to zero since the exchange rate affects the demand for money through expectations.)

Thus there is less output variation as well as less price variation under flexible rates. The similarity with Mundell's results should not be surprising since the labor contract fixes wages even if only temporarily.

In economies where wage indexation is important, however, these familiar results can break down. To understand why, notice that the effect of the exchange rate on domestic output is dependent on the degree of indexation in the domestic economy. As equation (6.3) indicates, the effect is proportional to $c(1-b)$, so that full indexation ($b = 1$) prevents the exchange rate from affecting domestic output at all. It allows the domestic wage and price to adjust currently to changes in the exchange rate. Therefore, the difference in output variation _between_ the two regimes must be proportional to $c(1-b)$. And with full indexation, each disturbance must have an _identical_ effect on output in the two regimes.

In the case of a monetary disturbance under flexible rates, full indexation restores the classical result that changes in the money supply affect prices but not output; thus there is no output variation in either regime. In the case of an aggregate demand disturbance under flexible rates, the classical (full information) equilibrium is _not_ generally restored since indexation cannot substitute for full wage flexibility.[74] But full indexation still results in output varying to the same extent under flexible rates and fixed rates. With such indexation, therefore, the choice between regimes must

[74]With $c_1 = 0$, the aggregate demand disturbance has no effect on full information output, but raises current output as indicated by (6.3). Even in the general case where $c_1 > 0$, there is no particular reason for the two measures of output to coincide.

be made not on the basis of output behavior but on other grounds such as price behavior.

For a non-indexed or partially indexed economy, the original Mundell results can be generalized in several respects, as a recent study by Henderson (1982) shows. Other types of disturbances can be considered, namely aggregate supply disturbances and financial disturbances involving shifts between domestic and foreign securities (at least if these securities are imperfect substitutes). Secondly, we can compare a "rates constant" policy, where the interest rate and exchange rate are held fixed, with an "aggregates constant" policy, where the domestic money and bond supplies are held fixed. The results cited above generalize as follows: When disturbances originate in the goods market, whether in the aggregate demand or supply equations, then an aggregates constant policy is preferable, because it permits adjustments in the interest rate and exchange rate that tend to dampen the output effects of the disturbances. When disturbances originate in the financial markets, a rates constant policy is preferable, because this policy confines the disturbances to the financial markets. The Henderson study will be discussed at greater length below in connection with optimal foreign exchange intervention.

One study which departs significantly from the Mundell framework is that of Fischer (1976); there is no capital mobility and output is independent of prices (and hence the exchange rate regime), being affected only by supply disturbances. To choose between regimes, Fischer adopts a criterion based on real consumption, where consumption is defined as $C_t = P_t Y_t - B_t$, nominal output less the trade balance (in levels). The ranking of regimes established above is reversed, with flexible rates being preferred when there are monetary disturbances and fixed rates when there are goods market disturbances.[75] Monetary disturbances affect real consumption under fixed rates, but not under flexible rates since the exchange rate adjusts to ensure that $B_t = 0$. Supply disturbances affect real consumption in both regimes (since Y_t changes) but by less under fixed rates, because the balance of payments plays a shock absorber role in that regime. As Fischer shows, however, these results may be overturned if output responds to price innovations, even if capital remains immobile.

6.2. Foreign disturbances and insulation

We turn now to foreign disturbances. Flexible rates are widely thought to insulate an economy from foreign disturbances, probably because of the insulation achieved in models without capital mobility. The analysis below shows that insulation applies only in special cases, and that in general flexible rates do not even insulate the economy from foreign monetary disturbances. This is the first of two central points that will emerge from the analysis. The second concerns the tendency in the literature to define foreign disturbances in terms of individual foreign variables such as foreign prices or interest rates. As Flood (1979) has emphasized, this can be highly misleading. Foreign disturbances almost always affect the domestic economy through a variety of channels. A foreign monetary disturbance, in particular, may raise the foreign price, lower the foreign interest rate and raise foreign output, with the combined effects of all these changes being very different from their individual effects. To analyze foreign disturbances, therefore, it is necessary to trace these disturbances through the foreign economy.

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[75] Frenkel and Aizenman (1981) use a similar model to analyze managed floating.

These points can be illustrated with a simple model of a foreign economy subject to monetary disturbances. The model consists of three equations paralleling those of the domestic model.[76]

$$y_t^f = c^f(1 - b^f)\,(p_t^f - {}_{t-1}Ep_t^f) + c_0^f \,, \tag{6.6}$$

$$y_t^f = -g_r^f\left(r_t^f - ({}_tEp_{t+1}^f - p_t^f)\right) + g_0^f \,, \tag{6.7}$$

$$m_t^f = p_t^f + y_t^f - k_1 r_t^f + k_0 + u_t^{nf} \,. \tag{6.8}$$

The main difference is that only one good is involved, so there are no relative prices entering the foreign model. Aggregate supply, therefore, is a function of the price of the foreign good alone; output responds to unexpected changes in that price as long as there is less than complete indexation (b^f is less than one). Note that the monetary disturbance is defined as a money demand innovation but could be interpreted equally well as a (negative) money supply innovation.

The three equations can be solved for p_t^f, y_t^f, and r_t^f as functions of the foreign monetary disturbance, u_t^{nf}:

$$p_t^f - \bar{p}^f = -u_t^{nf}/F_1 \,, \tag{6.9}$$

$$y_t^f - \bar{y}^f = -c^f(1-b^f)\,u_t^{nf}/F_1 \,, \tag{6.10}$$

$$r_t^f - \bar{r}^f = \left(1 + c^f(1-b^f)/g_r^f\right)\,u_t^{nf}/F_1 \,, \tag{6.11}$$

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[76]The model is described more fully in Marston (1982b). This is an example of what Flood (1979) terms an extended small country analysis; the two country model is recursive, so foreign disturbances can be studied first in the foreign model, then their effects can be traced through the domestic model.

where $F_1 = 1 + k_1 + c^f(1-b^f) + k_1 \, c^f(1-b^f)/g_r^f > 0$.

All three variables are affected by both foreign disturbances, although foreign output remains constant if there is full indexation abroad ($b^f = 1$).

Even with this simple model there are three channels through which a foreign monetary disturbance affects the domestic country: (a) the price channel, with the foreign price directly affecting domestic aggregate demand (and domestic aggregate supply as well if wages are indexed); (b) the output or income channel, also directly affecting aggregate demand; (c) the interest rate channel, affecting the real interest rate in the aggregate demand function and the nominal interest rate in the money equation.

Without formally solving the domestic model, we can summarize the main effects of a foreign monetary disturbance under flexible rates, where the disturbance represents a decrease in money demand or increase in money supply ($u_t^n < 0$). Although it originates as a monetary disturbance, it becomes both a real and nominal disturbance from the point of view of the domestic country. The real disturbance is represented by the change in foreign output and affects the domestic economy much as would a domestic aggregate demand disturbance. It <u>raises</u> demand for the domestic good, the increase being proportional to g_y in the domestic aggregate demand equation (5.13). The nominal disturbance is represented by the combined effect of a higher foreign price and an appreciating exchange rate (which is in turn influenced by the foreign interest rate as well as the foreign price and output). It <u>reduces</u> demand for the domestic good, because the appreciation is always large enough to ensure that the domestic currency price of the foreign good falls. The net result of a higher foreign output and an appreciating exchange rate can be either a rise or fall in domestic output.

With disturbances affecting the economy in so many ways, insulation is achieved only in special cases. Even if there is full wage indexation in the domestic country, for example, a flexible exchange rate does not generally insulate that country from a foreign monetary disturbance. Wage indexation can shield domestic output from an appreciating exchange rate, but it cannot prevent foreign income from directly raising aggregate demand, much as would a domestic aggregate demand disturbance.

Similarly, if there is perfect substitutability between domestic and foreign goods, a flexible rate does not insulate the economy from a foreign monetary disturbance. When the law of one price holds, the aggregate supply equation is modified as follows:

$$y_t = c(1 - b)(p_t - {}_{t-1}E\, p_t) + c_0 , \tag{6.2$'$}$$

where $p_t = p_t^f + x_t$. As is evident from this equation, unexpected changes in the foreign price level lead to changes in domestic output and insulation is again not achieved.

In order for output to be insulated from this disturbance, the law of one price must be combined with full wage indexation in the domestic economy. Indexation shuts off the one remaining channel for foreign influence, unexpected changes in the foreign price. As these examples suggest, insulation is by no means a general feature of flexible rates.[77]

A study by Flood and Marion (1982) raises two further points about

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[77]Marston (1982b) shows that insulation can also be achieved if the foreign country is fully indexed. For another example of insulation, see Saidi (1980), who employs an aggregate supply function based on an intertemporal substitution effect rather than a contract lag to analyze the effects of foreign disturbances.

insulation and the choice between regimes. Exchange rate regimes have traditionally been compared under the assumption that behavioral parameters remain the same even when the regime changes. Flood and Marion argue, however, that the extent of wage indexation should adjust endogenously to the exchange rate regime. The appropriate comparison between exchange rate regimes, therefore, is one where the indexation parameter is at its optimal level (according to an output criterion) in each regime. The same point can be raised about other behavioral parameters such as the degree of asset substitutability. The second point they make is equally interesting: insulation may be an undesirable objective of exchange rate policy; it may be preferable to allow foreign disturbances to enter an economy if this helps to minimize the effects of other disturbances. The law of one price prevails in their model, so that full wage indexation provides insulation from foreign disturbances. They show, however, that under flexible rates it is better to have partial than full wage indexation, even though it prevents insulation from a foreign monetary disturbance, because partial indexation allows the exchange rate to dampen the output effects of a domestic supply disturbance.

6.3. Optimal foreign exchange intervention

Since neither fixed nor flexible rates stabilize output except in special cases, it is natural to ask if some limited form of exchange intervention, "managed floating," might be best. Intervention might follow a rule such as $m_t - \overline{m} = k(x_t - \overline{x})$, whereby the money supply is varied in response to current changes in the exchange rate. The polar cases of fixed and flexible rates correspond to infinite and zero values, respectively, of the intervention parameter, k.

Managed floating appears to be an attractive alternative to either fixed or flexible rates. This is the message of Boyer (1978), who examines optimal intervention in a small open economy. He shows that in the presence of domestic monetary and aggregate demand disturbances, a limited form of foreign exchange intervention is called for, with the degree of intervention determined by the relative importance of the two disturbances. Only in extreme cases are fixed or flexible rates warranted. If monetary disturbances alone affect the economy, then fixed rates are optimal. If aggregate demand disturbances alone affect the economy, then flexible rates are optimal, at least when money demand is independent of the exchange rate. If money demand is positively related to the exchange rate, as with regressive expectations, then the authorities should "lean with the wind," exaggerating exchange rate movements to neutralize the aggregate demand disturbances. The results are analagous to those of Poole (1970) for optimal monetary policy in a closed economy.

The Boyer paper does not analyze the case where expectations are rational. Nor does it explain why private agents fail to utilize the same information that the authorities use in their managed intervention--the information provided by exchange rate movements. Yet we know from the earlier discussion how important information asymmetries are in determining the effectiveness of policy rules. Henderson (1982) analyzes intervention in a model with rational expectations, where assumptions about information are carefully set out.[78] Foreign exchange intervention is based on the

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[78]Roper and Turnovsky (1980) also analyze managed floating rules under rational expectations (as well as other expectations hypotheses). They have an interesting discussion of how "leaning with the wind" may put a country at odds with its neighbors to the extent that there are implicit international rules limiting intervention operations to dampen exchange rate movements. For a discussion of guidelines for managed floating, see Ethier and Bloomfield (1975).

authorities' knowledge of the current exchange rate and other financial variables, but private agents base wages on information available in period t-1. Henderson justifies this asymmetry by citing the relatively greater costs associated with renegotiating the nominal wage compared with adopting policy responses. His results are similar to those of Boyer and other studies, except that a wider range of disturbances is considered. He finds that fixed rates are called for if all disturbances are financial and that "leaning with the wind" is called for if there are either aggregate demand or aggregate supply disturbances. He also points out that a more complex financial policy, involving two policy instruments, would be necessary if the authorities had more than one objective or if the coefficients of the model were not known with certainty (as in Brainard, 1967).

Other recent studies have investigated exchange market intervention in a three-country or multiple-country setting. In such a setting, an analog of fixed exchange rates is an exchange-rate union which fixes exchange rates between two or more countries that float relative to the rest of the world. (European experiments with such unions, beginning with the Snake in 1972 and following with the European Monetary System in 1979, have heightened interest in the subject.) Corden (1972) discusses the different forms such a union can take, including the simplest "pseudo-exchange-rate union" involving no explicit integration of national economic policies beyond the commitment to fix bilateral exchange rates. A number of studies have investigated the desirability of such unions, including the classic studies of Mundell (1961) and McKinnon (1963).[79] Recently, Aoki (1982), Bhandari (1982) and Marston (1982a) have applied stochastic models similar to that outlined above to the

[79]Tower and Willett (1975) provide a survey of this literature.

union question. Marston, for example, shows how wage indexation, trade patterns, and the sources of economic disturbances influence the case for a union.

One alternative to an exchange rate union in the multiple-country setting is a basket rule tying a currency to a weighted average of exchange rates. Branson and Katseli-Papaefstratiou (1980), Flanders and Helpman (1979), and Lipschitz and Sundararajan (1980) have investigated alternative weighting schemes for the baskets. Branson and Katseli-Papaefstratiou, for example, show how weights based on market power in import and export markets can minimize the effects of exchange rate fluctuations on the terms of trade. Canzoneri (1982) analyzes basket rules within a macroeconomic model similar to that outlined above, showing that basket pegging is generally superior to exchange-rate unions between subsets of countries. These studies point toward a fruitful area for future research which will go beyond the two country setting which previously dominated research on exchange market intervention.

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