12 Effects of Open Market Operations and Foreign Exchange Market Operations under Flexible Exchange Rates

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During the period of pegged exchange rates under the Bretton Woods Agreement, attention was directed to the problems of capital and reserve flows in the literature of international monetary economics. One relevant question was whether an individual country can conduct an independent monetary policy under fixed exchange rates. After the collapse of this system in the early seventies, attention was diverted to the determination of exchange rates and the workings of the flexible exchange-rate system. At least in theory, it seems that we finally have independent monetary policies.

This chapter examines one of the topics in this still developing field, namely the relative effects of the two alternative instruments, open market operations (OMO) and foreign exchange market operations (FXO), in a small open economy. This topic is of great importance to policymakers who are faced with various policy targets and have two alternative instruments. For example, when the objective is to stabilize exchange rates in the short run, they have to decide which instrument to use. To do this, they need a theory and empirical evidence that supports the use of one instrument or the other for the purpose at hand.

The issue of the relative use of domestic and foreign assets in the conduct of monetary policy under flexible exchange rates was first raised by Jürg Niehans (1976). In discussing the problems of the international monetary mechanism after the collapse of the Bretton Woods system, he conjectured that an OMO would have more influence on domestic demand and a FXO on foreign exchange rates, although the two operations affect domestic demand and foreign exchange rates in the same direction. If this conjecture were correct, he argues, then Mundell's assignment

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principle could be used and the policy implication is clear. It says that an OMO should be used for domestic stabilization and a FXO for foreign exchange-rate stabilization. However, Niehans did not elaborate his argument or give any empirical evidence to support his conjecture. He just stopped at raising the question.

There have been largely two main strands of literature on international monetary economics in recent years. One is the monetary approach (MA), and the other is the portfolio balance approach (PBA). They are both "asset market approaches," in the sense that the balance-of-payments or exchange-rate fluctuations are caused basically by asset disequilibrium. However, there are some major differences.

In MA, it is implicitly (e.g. most of the articles in Frenkel and Johnson 1978) or explicitly (e.g. Frenkel and Rodriguez 1975) assumed that the asset holdings can be classified under two categories: money and non-money assets. Under such an assumption, one needs to look at only one of the two assets, money in this case. In this sense, MA may be regarded as a special case of PBA. In a portfolio balance model with three assets, money, domestic assets, and foreign assets, if the latter two are perfect substitutes, one ends up with a MA model. And this is the usual justification of MA. MA proponents believe that interest parity holds given an appropriate risk premium, and therefore domestic assets and foreign assets can be regarded as perfect substitutes. In this case, there is no need to distinguish between OMOs and FXOs, because any operation that changes money supply by an equal amount is identical. This is the result of most MA models (e.g. Girton and Roper 1977; Dornbusch 1976a, b; Bilson 1978) or portfolio balance models in MA spirit, i.e. with two assets (e.g. Frenkel and Rodriguez 1975; Kouri 1976).[1]

But in portfolio balance models (e.g. Henderson 1976; Girton and Henderson 1977), there usually are three assets, money, domestic assets and foreign assets, which are strictly gross substitutes. Since domestic and foreign assets are not perfect substitutes, the interest parity condition does not hold and each asset demand depends on the rate of return from each asset holding, i.e. domestic interest rate and foreign interest rate adjusted for forward premium, and asset prices. Operations on different assets are expected to have different effects on macroeconomic variables, because they imply different changes in asset composition and therefore in domestic and foreign interest rates adjusted for forward premiums. It is not surprising that the first attempt to distinguish the effects of OMOs and FXOs used a portfolio balance framework.

So far, there have been very few studies of this subject that compare in

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1. Some portfolio balance models, constructed in MA spirit, use only two assets and reach the same general conclusions as in a typical MA model. For example, Frenkel and Rodriguez (1975) use money and real capital (domestic and foreign equities are assumed to be perfect substitutes), and Kouri (1976) has money and foreign assets.

a systematic way the effects of OMO and FXO. None of them are either satisfactory or complete.[2]

The specific questions that are asked in this study are: (1) What are the dynamic effects (i.e. not only the impact effects, but also the short-run and long-run effects) of OMO and FXO on major macroeconomic variables such as interest rate, exchange rate, price level, and real income in a small open economy under flexible exchange rates? Are they identical? If different, how? (2) What are the policy implications? Is it possible to have an assignment principle which tells us which policy instrument to use for the purpose at hand?

The objective of this chapter is to provide theoretical answers to these questions. Specifically, the objectives are (1) to develop a satisfactory theoretical framework which overcomes some common problems in existing models, and in which the dynamic analysis of OMOs and FXOs can be conducted systematically, and (2) to provide a dynamic theory about the effects of OMOs and FXOs on major macroeconomic variables.

The existing models of small open economies under flexible exchange rates are critically discussed in section 12.1. In section 12.2, a macroeconomic model in which OMOs and FXOs can be discussed in a nontrivial way is constructed. In section 12.3, a nonmathematical analysis of OMOs and FXOs is conducted using the model developed in section 12.2. In section 12.4, the results of the analysis are summarized and the policy implications are discussed.

12.1 Problems in Existing Open Macromodels

In this section, some common problems in the existing models of open economies under flexible exchange rates are discussed with a view to avoiding these problems in developing a model in the following section.

12.1.1 Purchasing Power Parity

In the typical MA model, purchasing power parity (PPP) serves the crucial role of representing the relative price of two monies by an exchange rate. MA models are usually concerned with the long-run equilibrium with the notable exception of Dornbusch (1976a, b), and the PPP is a plausible long-run hypothesis. In many cases, however (e.g. the papers in Frenkel and Johnson 1978; Barro 1978), the PPP is assumed to hold even in the short run. Although the PPP assumption is very convenient in that it makes any model much simpler than otherwise, there seem to be

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2. For example, both Henderson (1976) and Girton and Henderson (1977) deal with this subject directly, but because they limit their analyses to the impact effects and ignore the real sector reactions and the short-run dynamics, they are not really satisfactory or complete. There is another study by Henderson (1979), which considers short-run dynamics and real sector reactions, but it is about a FXO only and does not compare OMOs and FXOs.

some problems in using it, especially in the determination of exchange rates in the short run.[3]

In contrast, in portfolio balance literature, the PPP is completely ignored (e.g. Girton and Henderson 1977) or reserved for the long run as in Dornbusch (1975). For short-run analyses, it is usually assumed that exchange-rate determination is completely dominated by asset markets and that goods market arbitrage is ineffective.

In a paper which was otherwise written in the vein of MA, Dornbusch (1976a) takes this position and allows short-run deviations from PPP, which holds in the long run when all the asset markets and the goods market are in equilibrium. In this chapter I will follow Dornbusch in doing without the PPP in the short run, because I believe the evidence for short-run validity of PPP is rather weak so far and there is an important role for the short-run deviations from PPP to perform in the model.

12.1.2   Real Sector

In the asset market approach in general, the price level, which is determined in the real sector, is assumed to adjust very slowly, if at all, so that it can be ignored for the purpose of a short-run analysis. Although this assumption is usually adopted without much persuasive theoretical argument, the facts seem to point in this direction, and realistic results that resemble actual movements of exchange rates in the short run are obtained by using this assumption. However, the emphasis on the short-run asset markets appears to have resulted in neglecting the linkage with the real sector until recently.

In MA literature full employment is generally assumed (e.g. Barro 1978), which can be justified by limiting the analysis to the long run, or real income is included as an exogenous variable. Consequently the possibility of interaction between the asset and real sector is precluded. A satisfactory treatment of the real sector in MA literature can be found in Bilson (1978). In introducing rational expectations in MA, Bilson used a reduced-form variant of a Lucas-Barro type of short-run Phillips curve relation. His transitory income consists of three elements, a first-order autoregressive term, a term that represents a short-run output response to an unexpected money shock, and a term for exogenous real income shock. Although this treatment of the real sector certainly makes the rational expectations model easier to solve and test than it would be otherwise, we know that, by treating the real sector this way, we are missing many of the interesting and revealing structural aspects of the

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3. See Frenkel (1976) for the use of the PPP in both the short-run and the long-run determination of exchange rates. See Roll (1978) for a critical view on the use of the PPP in the short run.

short-run behavior of macrovariables such as consumption, investment, and international trade. Frenkel and Rodriguez (1975) provide a rigorous theory about the dynamics of the interactions between capital stock, investment, and the balance of payments. A fairly good treatment of the real sector can also be found in Dornbusch (1976b). However, his model's real output is strictly demand-determined, and consequently he misses the aspect of Lucas-type aggregate supply responses.

12.1.3   Expectations

When general attention shifted from the fixed exchange-rate regime to the flexible one, the forward exchange rate naturally emerged as the critical variable. The forward premium or discount, which is the expected rate of depreciation or appreciation adjusted for risks, is part of the returns from holding foreign assets, and therefore an opportunity cost of holding other assets. It is a crucial variable in any asset market approach, regardless of whether domestic and foreign assets are perfect substitutes.

For example, in Dornbusch (1976b) an increase in the money supply tends to reduce the interest rate because the price level is assumed fixed in the short run ("short-run liquidity effect"). Then, because of the interest parity condition, the foreign interest rate adjusted for the forward premium must fall. Because the foreign interest rate is assumed to be fixed by foreign central banks, it is the forward premium that must adjust downward. Given the adaptive expectations mechanism in which the forward premium is proportional to the difference between the current and the long-run exchange rates, the current rate must overshoot the long-run rate, which has been revised following the money shock, to have the forward premium fall. Dornbusch later considers a perfect foresight path, which he calls a rational expectations path, by imposing the condition that the expectations about future exchange rates derived by using the adaptive expectations mechanism are always correct.

Although Dornbusch's contribution is significant and a step in the right direction, there is a problem regarding the price expectations. Dornbusch (and most writers) ignores the possibility of changes in price expectations during the adjustment period after a shock. When the PPP is abandoned in the short run as in Dornbusch, we no longer have the automatic link between the forward exchange rate and the expected rate of inflation as in MA models. When the whole adjustment process takes place with great speed, we might not need to specify a separate expectations mechanism for the expected rate of inflation, assuming the inflationary expectations stay constant during the adjustment period. However, when the process takes considerable time, as some empirical studies suggest it does, inflationary expectations are likely to change during the adjustment period, and a separate formula must be specified for the inflationary ex-

pectations.[4] Furthermore, when Dornbusch implicitly assumes that the private sector immediately realizes the new long-run level of exchange rates after the money shock, it is hard to understand why the same information should not cause the same private sector to do the same thing about the long-run price level.

Dornbusch, like all other writers, ignores this possibility altogether and implicitly assumes a constant expected rate of inflation. In the model to be developed in the following section, inflationary expectations are explicitly specified. This enables us to distinguish between the real and the nominal interest rate, which becomes very important when there is investment in the real sector which depends on the real interest rate.

12.1.4   Long-Run Neutrality

The long-run neutrality of money is intuitively appealing, because it is consistent with such well-established long-run hypotheses as the PPP. And such long-run results can serve as relatively simple reference time paths in dynamic analysis. In general, the sufficient conditions for long-run neutrality with respect to a change in a nominal variable are: (1) The model is homogenous of degree 0 in all nominal variables. (2) The nominal variable that is being changed is the only exogenous nominal variable. In MA, the usual specification of the asset sector, which allows only one exogenous nominal variable, money, guarantees the long-run neutrality of money. In MA, money is the only nominal variable and therefore a doubling of money would result in the doubling of the price level, which leaves real variables unchanged in the long run. However, the PBA models in general are not concerned with a long-run analysis and do not exhibit long-run neutrality of money except for those with only two assets and only one nominal variable (e.g. Frenkel and Rodriguez 1975). Consider a portfolio balance model which has three assets—money, domestic bonds with fixed nominal value, and foreign assets. There are three nominal variables—money, nominally fixed domestic bonds, and the price level. The first two variables are exogenous, and the third is endogenous. Therefore, when the stock of money is doubled, the doubling of price level would not leave the real variables, for example real interest rates, unchanged. The real value of domestic bond holdings will be reduced to one-half, and this will obviously affect the interest rate. The model is therefore not long-run-neutral with respect to changes in money stock.

It is possible to make a portfolio balance model long-run-neutral with respect to changes in money by assuming that all the domestic assets are real claims. However, this does not automatically guarantee a long-run neutrality with respect to OMOs or FXOs because these operations

4. For example, Barro's (1978) empirical study suggests that it takes more than two years for the effects of a monetary shock to abate completely.

involve changes in one of the other assets as well as in money. If we want to retain the long-run virtues of MA such as the long-run PPP in discussing the effects of OMOs and FXOs, we need the long-run neutrality of the model with respect to OMOs and FXOs as well.

One way to avoid this problem is to assume that the government is fully "internalized" by the private sector; i.e. the private sector regards the government as nothing more than its agent and therefore government transactions on assets do not constitute changes in the perceived composition of the asset holdings by the private sector. With this assumption, OMOs and FXOs are identical to simple changes in the money stock by unilateral transfer payments in their effect on macrovariables. The model is then long-run-neutral with respect to any kind of changes in money. This position was recently taken by Stockman (1979).

Despite its obvious advantage in making a model simpler and despite its intuitive appeal, this "internalized" government assumption seems to be inconsistent with the common observation about the private sector. It is unrealistic to expect the private sector of a small open economy to be completely indifferent to government purchases and sales of assets. Therefore such an assumption will not be adopted in this study. Instead, in the following section a model which exhibits asymptotic neutrality with respect to OMOs and FXOs will be developed.

12.2   The Basic Model

In this section a model of a small open economy under flexible exchange rates is developed.[5] In doing so, an attempt is made to reduce the shortcomings of the existing models as discussed in the preceding section. Also, efforts are made to simplify the model as much as possible at various stages for the sake of tractability and practicality.

12.2.1   The Building Blocks

It is assumed that the "public"[6] holds three assets—domestic money (M), domestic nonmoney assets (B_p), and foreign bonds (F_p)—which are

5. The advantage of a small-country assumption is obvious when one is concerned with domestic monetary policy alone, ceteris paribus. This advantage is analogous to that of a partial equilibrium analysis over a general equilibrium analysis.

6. The term "public" is used here instead of "domestic residents" because the wealth constraint here is for all those whose holdings of domestic money are included in the money stock, some of whom are presumably foreigners or foreign residents. If we want to make OMOs and FXOs affect money stock by the full amounts of the operations regardless of whether the transactions are with domestic or foreign residents, there must be corresponding changes in other asset holdings. In this sense, the relevant wealth constraint should include asset holdings by those foreign residents and foreigners who hold domestic assets or money. In some studies, transactions with foreigners affect the money supply, but not other asset holdings by "domestic residents," which seems to be erroneous and a clear violation of the wealth constraint, regardless of how it is defined.

strictly gross substitutes. The last two are interest-bearing with the interest rates of i and i^*, respectively.

The domestic economy is small in the sense that it is a price taker in the international markets of goods and assets. Foreign interest rates are assumed to be kept at a constant level by foreign monetary authorities.

Assume that domestic nonmoney assets are all equities, i.e. claims to real capital. Also, assume that capital goods do not depreciate.

The domestic economy produces an internationally traded single output according to a neoclassical production function. Because the domestic economy is assumed to be a price taker, the prices of its product and foreign products on the international market are not affected by the domestic economy. The output can be used for either consumption or investment. Only the private sector is engaged in the production and investment activities. The private sector invests and increases its capital stock according to a nontrivial investment function with increasing marginal cost.

The role of government is limited to that of a simple supplier of money. It is assumed that the government increases the money stock at a constant rate continuously in the steady state, by printing and spending. The government is not "internalized" by the private sector, and therefore government transactions on assets with the private sector do imply changes in the private sector's asset composition. The government does not save and increase its capital stock.

Consider an economy in which everything grows at a constant rate that is given by the exogenous growth rate of the labor force g_l, in accordance with the neoclassical growth model. It is well known that in a neoclassical steady state, real income, wealth, real money balance, and capital stock grow at the rate g_l, which is equal to the marginal product of capital, assuming that the economy is in the Golden Rule situation.

12.2.2   Asset Sector

There are four basic equations for the asset sector:

$$(12.1) \qquad (M/P)_t^d = m(r_t, \pi_t^e, \bar{i}^* + \epsilon_j, y_t/w_t)w_t$$
$$m_1 < 0, \ m_2 < 0, \ m_3 < 0, \ m_4 > 0,$$

$$(12.2) \qquad (B_p)_t^d = (P_k)_t(K_p)_t = (\rho_t/r_t)(K_p)_t$$
$$= b(r_t, \pi_t^e, \bar{i}^* + \epsilon_t, y_t/w_t)w_t = (P_k)_t(K - K_g)$$
$$b_1 > 0, \ b_2 > 0, \ b_3 < 0, \ b_4 < 0,$$

$$(12.3) \qquad (eF_p/P)_t^d = f(r_t, \pi_t^e, \bar{i}^* + \epsilon_t, y_t/w_t)w_t$$
$$f_1 < 0, \ f_2 > 0, \ f_3 > 0, \ f_4 < 0,$$

$$(12.4) \qquad m + b + f = 1,$$

where
M = nominal stock of money,
P = price of domestic output,
w = real value of financial wealth in terms of consumption goods,
B_p = nominal value of private equity holdings,
B_g = nominal value of government equity holdings,
K_p = real value of private equity holdings in units of capital goods,
P_k = price of capital goods in terms of consumption goods,
K_g = real value of government equity holdings in units of capital goods,
K = real value of the total capital stock in the economy,
F_p = value of private holdings of foreign bonds in foreign currency units,
F_g = value of government holdings of foreign bonds in foreign currency units,
r = domestic real interest rate,
π^e = expected rate of domestic inflation,
$\bar{i}^*$ = foreign nominal rate of interest, which is assumed constant,
y = real output = real income,
ϵ = forward premium on future exchange rate,
ρ = marginal product of capital,
e = foreign exchange rate = number of domestic currency units per unit of foreign currency,
$m = \dfrac{(M/P)}{w}$ = share of real money balance in the total real wealth,
$b = \dfrac{P_k \cdot K_p}{w}$ = share of domestic bond holdings in the total real wealth,
$f = \dfrac{(eF_p/P)}{w}$ = share of foreign assets in the total wealth.

Equations (12.1), (12.2), and (12.3) are asset demand equations and (12.4) is the wealth constraint. Because of the wealth constraint equation (12.4), we have the relation between elasticities

(12.5) $m \cdot m_i + b \cdot b_i + f \cdot f_i = 0,$

where $m_i, b_i,$ and f_i are the elasticities of asset demands with respect to the variables in parentheses in equations (12.1), (12.2), and (12.3). Equation (12.5) makes one of the three asset demand equations linearly dependent on the other two.

In the asset demand equations, the nominal interest rate i is divided into the real interest rate r and the expected rate of interest π^e. The

distinction between r and π^e is very important in discussing investment, and π^e is likely to change when the economy is subjected to a shock. It seems that when r and π^e change in opposite directions leaving i constant, K_p^d presumably changes, suggesting different coefficients for r and π^e. However, assuming an identical coefficient for both r and π^e would not seem to change the results much.

In the money demand equation, it is assumed that the relevant price variable is the price of domestic output. Of course, we can use a weighted sum of the prices of domestic output and imports as the relevant price level, but this does not seem to change the results significantly.

In equation (12.2), P_k is defined as ρ/r such that in the long-run steady-state equilibrium, $\bar{P}_k$, which is the price of capital goods, in terms of consumption goods, is equal to unity; i.e. using an overbar to denote a steady-state value, $\bar{P}_k = 1$ and therefore $\bar{\rho} = \bar{r}$.

The term y/w is the transactions demand term. The real income y is divided by wealth, w, because m presumably would not increase when y and w both increase proportionately. When y increases alone, m would increase. This specification implies unit elasticity of money demand with respect to permanent income, because a change in permanent income implies proportionate changes in y and w, leaving y/w unchanged.

Before going any further, let us investigate the long-run properties of the asset sector, especially long-run neutrality. In the steady state, real values of assets grow at the rate g_l in the absence of disturbances. This is because the relative shares are constant, while the total value of assets grows at the rate g_l. Assume at this point that the money stock is increased at a constant rate by a continuous process of printing and random distribution by the government, not by continuous open market purchases and foreign exchange purchases. With the assumption that all the domestic bonds are equities, the model is long-run-neutral with respect to changes in either the level or growth rate of the money supply, because it is the only nominal exogenous variable in the model. For example, if the money supply is doubled without accompanying any other changes, it will be exactly offset by a doubling of price level in the long run without affecting the real variables such as capital stock. The model is long-run-neutral also with respect to FXOs because the steady-state level of foreign asset holdings can be restored through accumulation of current account balances.

However, the model does not seem to be long-run-neutral with respect to disturbances in domestic asset holdings. For example, an open market purchase of domestic assets raises P_k through a decline in r. Investment by the private sector continues until $P_k = 1$, given the type of investment function used here. This investment by the private sector over and above the steady-state level will eventually restore its holdings of domestic assets to the steady-state level, making the total stock of capital in the

economy K, which is equal to $K_p + K_g$, lie above the steady-state path. As long as we do not assume a fixed capital-labor ratio, this implies a drop in the marginal product of capital, and therefore a drop in the interest rate. This drop in the real rate of interest would change the steady-state paths of the real money balance and foreign assets, as well as the real output.

However, in a neoclassical steady state in which asset holdings grow at a constant rate, including domestic capital, the effect of this one-time level shock on the steady-state path of the economy's capital stock by a one-time purchase of capital by the government would decline in terms of percentage deviations from the original steady-state path. In other words, the level shock would decline over time in log scale. In this sense, we have an asymptotic long-run neutrality with respect to OMO in the model.[7] This neutrality will never be an exact one, but if we consider that the magnitude of an OMO would probably be very small compared to the total capital stock in the economy, such neutrality would make more sense.

In the short-run dynamic analysis in the following section, we will conduct our analysis as if we had an exact long-run neutrality. The fact that what we actually have is not an exact long-run neutrality, but instead an asymptotic one does not change the results qualitatively.

12.2.3 Real Sector

There are three basic equations in the real sector:

(12.6) $$y_t^d = C(w_t - \bar{w}_t, y_t) + I(P_{kt}, t) + X(e_t P_t^*/P_t, y_t, \bar{y}_t^*)^8$$
$$C_1 > 0, \ C_2 > 0, \ I_1 > 0, \ X_1 > 0, \ X_2 < 0, \ X_3 > 0,$$

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7. The assumption that the government increases the money stock at a constant rate by printing and transfer payments in the steady-state is crucial here. If it were assumed that the money supply is increased by continuous open market purchases and foreign exchange market purchases, we might not get this asymptotic long-run neutrality, depending on the specific assumptions about the situation.

8. Some readers might wonder about the absence of any variable that is associated with the inflationary finance in the steady state, because it was assumed that the government increases the money supply at a constant rate in the steady state by printing and transfer payments. However, this absence can be justified in the following way.

The disposable income can be expressed as

$$y_t^{dis} = y_t + \tau_t = y_t + \frac{g_M \cdot M_t}{P_t},$$

where τ is the transfer payments financed by printing money, ignoring taxes and government spending, and g_M the growth rate of nominal money.

This should be equal to the expenditure, i.e.

$$y_t^{dis} = C_t + I_t + \frac{e_t}{P_t} \Delta F_{p,t} + \frac{\Delta M_t^d}{P_t},$$

where the last three terms represent additions to each asset holding.

We know that in the steady-state equilibrium,

(12.7) $y_t^s = g(P_t/\tilde{P}_t)\bar{y}_t^s, \qquad g' > 0,$

(12.8) $y_t^d = y_t^s,$

where C = real consumption,
         I = real investment,
         X = value of net exports in domestic output = exports
              − imports,
         $\tilde{P}_t$ = expected price level in time t as expected in time
              $t - 1$,
         y_t^d = aggregate demand for real output,
         y_t^s = aggregate supply of real output,
         $\bar{y}_t^s$ = planned output for time t with price expectation of P_t
              which is assumed to be equal to $\bar{y}_t$, the long-run
              steady-state output level,
         P_t^* = foreign price level = price of imports in foreign cur-
              rency units,
         $\bar{y}_t^*$ = foreign steady-state level of real income at time t,
         $\bar{w}_t$ = steady-state level of real wealth that would otherwise
              have prevailed at time t,
         e_t = exchange rate.

Consumption is a function of the deviation of the real wealth from its steady-state path and the real income which grows at the rate g_I. It is assumed that C is unit-elastic with respect to the permanent income in the steady state, so that C grows at the same rate as real income in the steady state.

It is essential in building a macroeconomic model to have a nontrivial investment function. The investment part of equation (12.6) is derived as follows. Recall that the economy produces a single type of output which can be used for either consumption or investment. Also, assume that capital does not depreciate. Let us distinguish investment from capital formation. The former can be regarded as the input requirement for the latter in terms of consumption goods. Assume that the marginal cost of capital formation above the steady-state level $g_I \bar{K}_t$ is an increasing function of the input requirement, i.e.

$$\frac{1}{P_t} g_M M_t^s = \frac{1}{P_t} \Delta M_t^d,$$

i.e. government cannot force the private sector to hold a real balance larger than desired, and

$$\frac{e_t}{P_t} \Delta_{p,t} = X_t.$$

Therefore, by equating the income with the expenditure, we get

$$y_t = C_t + I_t + X_t,$$

which is equation (12.6).

$$\frac{\Delta K_t}{\Delta t} - g_t \bar{K}_t = k(I_t - \bar{I}_t), \qquad k' > 0, \; k'' < 0, \; k'(0) = 1 \, ,$$

where $\bar{I}$ is the steady-state level of investment.

Profit maximization implies that the marginal cost of capital formation k' is equal to the price of capital in terms of consumption of goods P_k. Then the level of capital formation over and above the steady-state level becomes a function of P_k, and

$$I_t - \bar{I}_t = k^{-1} \left(\frac{\Delta K_t}{\Delta t} - g_t \bar{K}_t \right)$$

$$= h(P_k), \qquad h' > 0, \; h(1) = 0 \, ;$$

i.e. investment over and above the steady-state level is a positive function of the price of capital in terms of consumption goods.

Recall that the steady-state price of capital in terms of consumption goods was assumed to be equal to unity. This implies a horizontal long-run stock supply curve in a (P_k, K) diagram. In this diagram, the steady-state growth of capital stock would be represented by continuous outward shifts of the stock demand curve for the capital stock.

Now, because only the private sector invests, the resulting investment function would actually look like

$$(12.9) \qquad I_t = \frac{\Delta K_{pt}}{\Delta t} = I(P_{kt} - 1) + \bar{g}_k \bar{K}_{pt} \, ,$$

where $\bar{g}_t$ is the long-run steady-state growth rate of private capital stock and $\bar{K}_{pt}$ the steady-state level of private capital stock at time t. Investment is a positive function of the deviation of P_k from unity plus the long-run growth of the capital stock. And it can be readily seen from equation (12.9) that I grows at the same rate as capital stock g_k. This investment function specifies investment as an adjustment to the stock disequilibrium.

Net exports are a function of the terms of trade and real income. Income elasticities of net exports with respect to domestic and foreign incomes are assumed to be identical. However, there is a specific role for net exports to play in the model. Because foreigners are not assumed to hold domestic money and vice versa, the only way to alter domestic holdings of foreign bonds is to accumulate current account balances over time. The current account balance in terms of domestic output is

$$(12.10) \qquad CA_t = (e_t/P_t) \frac{\Delta F_{pt} + \Delta F_{gt}}{\Delta t} = X_t$$

$$+ i^* (F_{p,t-1} + F_{g,t-1})(e_t/P_t) \, ;$$

i.e. it is the sum of the trade account balance (net exports) and service account balance.

If we assume that the domestic steady-state real interest rate is equal to that of the rest of the world, i.e. $\bar{r} = \bar{r}^* = g_l$, and that the government lets its foreign bond holdings increase by the interest income and any capital gains,[9] it can be shown that, in the steady state, the service account surplus is just enough to meet the steady-state growth requirement of demand for foreign assets, i.e. $\bar{i}^*\bar{F}(\bar{e}/\bar{P}) = \Delta(\overline{eF/P})^d$, and therefore $\bar{X}$, the steady-state level of net exports, is equal to 0.[10] These assumptions and the resulting implications for X not only simplify the model but also are intuitively plausible. Therefore we adopt this assumption here. The sufficient condition for X to be on its steady-state path, i.e. $\bar{X} = 0$ in equation (12.6), is that the purchasing power ratio is equal to the steady-state value (purchasing power parity), which is a constant, and that the domestic and foreign real incomes are on their steady-state paths.

Equation (12.7) is an aggregate supply function in the spirit of Lucas-type rational expectations.[11] According to this type of aggregate supply function, the supply reacts (deviates from its steady-state path in this model) to price changes only if the changes are unexpected. This specification seems to be superior to the usual specification in MA that assumes real output is constant at the full-employment level or that in which output is strictly demand-determined as in Dornbusch (1976b), simply because it seems to be a more accurate description of the real world.

12.2.4   Expectations

In this model, we have two expectations, one for the forward exchange rate and the other for the expected rate of inflation.

$$\epsilon_t = E(e_{t+1}) - e_t{}^{12},$$

$$\pi_t^e = E(P_{t+1}) - P_t.$$

9. The question is what the government does with the interest income from asset holdings. If the government spends its foreign interest income on foreign goods, the steady-state trade balance will be a negative constant in real terms, which will not change the substance of the model; we can simply replace the zero with a constant for the steady-state trade account balance.

10. By definition, $\bar{i}^* = \bar{r}^* + \bar{\pi}^{e*}$. The steady-state growth rate of the domestic value of foreign assets in terms of domestic output is equal to g_l, which is equal to $\bar{r}$ in the Golden Rule situation; i.e.

$$\overline{(eF_p/P)}^d = g_l = \bar{r} = \dot{\bar{e}} - \dot{\bar{P}} + \dot{\bar{F}}_p^d = -\dot{\bar{\pi}}^* + \dot{\bar{F}}_p^d,$$

because $\dot{\bar{e}} = \dot{\bar{\pi}} - \dot{\bar{\pi}}^*$, where an overdot denotes the percentage growth rate. From this we get $\dot{\bar{F}}_p^d = \bar{r} + \bar{\pi}^* = \bar{r}^* + \bar{\pi}^* = \bar{i}^*$. Assuming that the government lets its foreign asset holdings grow by the interest payments, i.e. $\dot{\bar{F}}_g^d = \bar{i}^*$, and substituting these into (12.10), we get $\bar{X} = 0$.

11. See R. E. Lucas (1973) for an explanation of this type of supply function.

12. Forward premium is actually the expected rate of depreciation plus risk premium. However, following Stockman (1978), the risk premium is assumed to be a constant and is ignored here. This contrasts with Dooly and Isard (1979), where the risk premium is crucial in the determination of asset composition between domestic and foreign assets.

This is different from existing models, which usually have expectation mechanisms for only forward exchange rates (e.g. Dornbusch 1976a, b). But as discussed previously, when the adjustment period is sufficiently long, as some empirical studies show, π^e is likely to be revised temporarily during the period of adjustment.[13]

An adaptive expectations mechanism is adopted here which has been widely used in open macroeconomic models by Dornbusch and others. The forward premium is given by

$$(12.11) \qquad \epsilon_t = \frac{-\theta}{\bar{e}_t}(e_t - \bar{e}_t) + \bar{\pi}^e - \bar{\pi}^{e*},$$

where overbars denote steady-state values of variables and the asterisk denotes foreign variables. According to this type of specification, the private sector knows what the new long-run steady-state paths will be as soon as a government action takes place. The private sector revises its expectations according to the discrepancy between the actual and the new steady-state value which would have prevailed otherwise at the time, on the presumption that the value will eventually return to its steady-state path but not immediately. It is usually assumed that the revision is a constant fraction of the discrepancy between the actual and the steady-state value, and therefore the resulting expectation is not necessarily correct.

Equation (12.11) is similar to the equation used in Dornbusch (1976b). It is a version modified for use in the present model in which domestic and foreign price levels continue to rise instead of being stagnant as in Dornbusch. In the steady state, the real demand for money grows at the rate g_l, and $\bar{\pi}_t' = g_M - g_l$, where $\bar{g}_M$ is the steady-state growth rate of nominal money supply. And the same is true for the rest of the world. Because PPP holds in the long run in this model, the exchange rate depreciates at the constant rate of $\bar{\pi}^e - \bar{\pi}^{e*}$ in the steady state.

The adaptive expectations mechanism like equation (12.11) gives the well-publicized result of overshooting (e.g. Dornbusch 1976a, b). When the forward premium must change in response to asset market disturbances, (12.11) implies a change in the exchange rate that is larger than the shifts in the long-run steady-state exchange-rate path.

By extending the same expectations mechanism as in equation (12.11) to expectations about future inflations, the expected rate of inflation between this period and the next would be

$$(12.12) \qquad \pi_t^e = -\frac{\lambda}{\bar{P}_t}(P_t - \bar{P}_t) + \bar{\pi}^{e14},$$

13. See, for example, Barro (1978).
14. The apparent inconsistency between equation (11.12), in which the current price level seems to be known to everybody, and equation (11.7), in which producers do not seem to observe it, can be resolved by assuming a discrepancy in the information available to

where $\bar{P}_t$ is the steady-state price level that would have prevailed otherwise according to the new steady-state time path of P.

12.2.5   Summary of the Model

We have nine basic equations in the model.

(12.1)
$$(M/P)_t^d = m(r_t, \pi_t^e, \bar{i}^* + \epsilon_t, y_t/w_t)w_t$$
$$m_1 < 0, \ m_2 < 0, \ m_3 < 0, \ m_4 > 0,$$

(12.2)
$$(B_p)_t^d = (P_k)_t(K_p)_t = (\rho_t/r_t)(K_p)_t$$
$$= b(r_t, \pi_t^e, \bar{i}^* + \epsilon_t, y_t/w_t)w_t$$
$$= (P_k)_t(K - K_g)$$
$$b_1 > 0, b_2 > 0, \ b_3 < 0, \ b_4 < 0,$$

(12.3)
$$(eF_p/P)_t^d = f(r_t, \pi_t^e, \bar{i}^* + \epsilon_t, y_t/w_t)w_t$$
$$f_1 < 0, f_2 > 0, f_3 > 0, f_4 < 0,$$

(12.4)
$$m + b + f = 1,$$

(12.6)
$$y_t^d = C(w_t - \bar{w}_t, y_t) + I(P_{k,t}, t)$$
$$+ X(e_t P_t^*/P_t, y_t, \bar{y}_t^*)$$
$$C_1 > 0, \ C_2 > 0, \ I_1 > 0,$$
$$X_1 > 0, \ X_2 < 0, \ X_3 > 0,$$

(12.7)
$$y_t^s = g(P_t/\bar{P}_t)\bar{y}_t^s, \qquad g' > 0,$$

(12.8)
$$y_t^d = y_t^s,$$

(12.11)
$$\epsilon_t = -\frac{\theta}{\bar{e}_t}(e_t - \bar{e}_t) + \bar{\pi}^e - \bar{\pi}^{e*},$$

(12.12)
$$\pi_t^e = -\frac{\lambda}{\bar{P}_t}(P_t - \bar{P}_t) + \bar{\pi}^e.$$

Note that one of equations (12.1), (12.2), and (12.3) is linearly dependent on the other two, and we really have eight independent equations. We can eliminate ϵ_t and π_t^e by using expectations (12.11) and (12.12). And because of equation (12.8), in the end we only have one independent equation in the real sector. We end up with four independent equations

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producers and that available to the participants in the financial market. In this paper, producers are assumed to have expectations only about the current price level, based on the past values of the prices of their output and other relevant variables. Any price higher than this expectation is interpreted as a genuine increase in the relative price and the production is increased. However, the people in the financial market, who determine the nominal interest rate, are assumed to have a better information set, which includes the current price level as well as those pieces of information available to producers.

and four unknowns—r, P, y, and e—which we can solve for the unknowns.[15]

12.2.6   Steady-State Properties

In the steady state, every asset grows at a constant rate; i.e.

$$\dot{K}_p = \overline{(\dot{M/P})} = \overline{(e\dot{F}_p/P)} = \dot{w} = g_l,$$

where the overdot denotes the growth rate of a variable. Also, real output and its components grow at the same rate; i.e.

$$\dot{y} = \dot{C} = \dot{I} = g_l.$$

The steady-state rate of inflation is determined by the relative growth of money supply and real money demand, which is identical to the expected rate of inflation; i.e.

$$\overline{\pi} = \overline{\pi}^e = \overline{g}_M - \overline{(\dot{M/P})}^d = \overline{g}_M - g_l.$$

The long-run PPP is assumed to hold, which is consistent with the steady-state specification of X; i.e.

$$\overline{(eP^*/P)} = \alpha, \qquad X = X(\alpha, \overline{y}, \overline{y}^*) = 0,$$

where the overbar denotes a long-run steady-state PPP ratio, and $\overline{y}$ and $\overline{y}^*$ are the steady-state levels of domestic and foreign real income.

Therefore the steady-state level of the forward premium, ignoring the risk premium, is equal to the difference between the domestic and foreign steady-state rate of inflation; i.e.

$$\overline{\epsilon} = \overline{\pi} - \overline{\pi}^*,$$

where $\overline{\pi}^* = \overline{g}_M^* - g_l^*$ ($\overline{g}_M^*$ is the fixed growth rate of foreign money stock, and g_l^* is the natural growth rate of foreign labor).

12.3   Effects of OMO and FXO

In this section, using a diagram and without using mathematics, a simple analysis of OMOs and FXOs is conducted.[16] In discussing dynamics, it will be assumed that the dynamics are stable.

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15. Using appropriate functional forms, the model can be solved for the levels of the four endogenous variables—r, P, y, and e. There could be problems in doing this, but it can be done by assuming linear asset demand functions and a linear aggregate demand function. However, the level solutions are not important in the present context, because we are interested mainly in the short-run dynamics. For present purposes, it is sufficient to know that there exists a set of level solutions for the steady state. See Henderson (1979) for the level solutions using linear functions.

16. For mathematical analysis of the short-run dynamics, see Lee (1980). It is omitted here because of its length. This section is a nonmathematical summary of the analysis.

12.3.1 Definitions of OMOs and FXOs

An OMO is defined as a once-and-for-all exchange of domestic money for domestic bonds between the government and the private sector. This implies a permanent parallel shift in the time path of ln M, because the government is assumed to continue increasing the money supply at a constant rate after the one time level shock in money stock by an OMO. The analysis of OMOs will be concentrated on open market purchases, because the results for open market sales can be obtained simply by reversing the signs.

An FXO is similarly defined as a once-and-for-all exchange of domestic money for foreign assets between the government and the private sector.[17] It implies a permanent parallel shift in the time path of ln M and a temporary deviation of F_p from its steady-state path. Here also, the analysis of an FXO is concentrated on the foreign exchange market purchase, because the results for foreign exchange market sales can be obtained simply by reversing the signs.

In terms of notations, an OMO is represented by

$$\Delta B_g = -\Delta B_p = \Delta M$$

and an FXO by

$$(e + \Delta e)\Delta F_g = -(e + \Delta e)\Delta F_p = \Delta M.$$

12.3.2 Long-Run Effects

Long-run effects of an OMO are easy to see given the asymptotic long-run neutrality discussed previously. The condition for the long-run steady-state equilibrium is that all the real variables M/P, $P_k K_p$, eF_p/P, y, C, and I grow at the constant rate g_l. After an OMO, which is a permanent level shock in M, proportional shifts in the time paths of the endogenous nominal variables p and e are consistent with all the real variables on their original steady-state paths, given the asymptotic long-run neutrality. The long-run effects of an FXO are identical to the above results for an OMO, except that the neutrality is an exact, not an asymptotic one.

Therefore we have a typical MA result here for the long-run effects. As in an MA model, regardless of the asset on which the government operates to increase the money supply, the results are identical in the long run. That is, money is neutral regardless of the method of changing it in the long run.

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17. This specification of FXO may seem too restrictive because there can be other types of FXO, such as exchange of domestic money for foreign monies, etc. However, in this model it is the only type of FXO that is allowed because foreign bonds are the only type of foreign assets held by the private sector. This seems to be the most representative case of FXO.
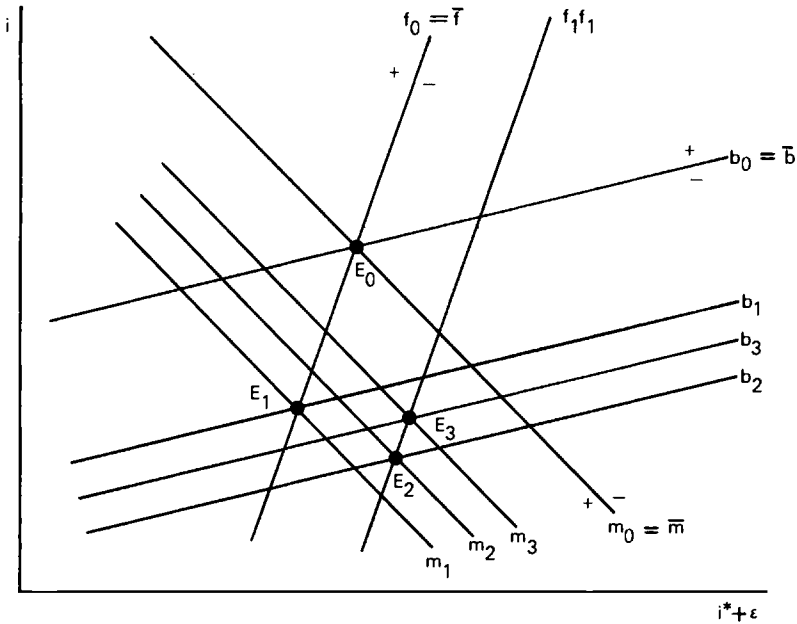
Fig. 12.1

12.3.3   Open Market Operation

Given the historic level of wealth, and assuming that demands for domestic and foreign assets are more elastic with respect to their own returns, and that the partial derivatives for r and π^e are identical, the whole asset market (equations (12.1), (12.2), (12.3)) can be represented in a single diagram as in figure 12.1.[18] Each curve represents the combination of i ($= r + \pi^e$) and $i^* + \epsilon$ that will hold the shares of assets, money (m), domestic assets (b), and foreign assets (f) at constant levels. Curve m is negatively sloped because when i rises, it must be compensated for by lower values of $i^* + \epsilon$ to keep m from declining. Both b and f are positively sloped because when i rises, it must be compensated for by an increase in $i^* + \epsilon$ to keep b and f from increasing and decreasing, respectively. Curve f is steeper than curve b, because it is assumed that an asset demand is more elastic with respect to its own returns than to returns from other assets. Also, it is clear that one of the three is redundant; i.e. we need only two curves to get equilibrium values of i and ϵ. And because i^* is assumed to be fixed, it is ϵ that adjusts when $i^* + \epsilon$ must adjust.

An open market purchase of domestic assets with money shifts b and m downward to b_1 and m_1 in figure 12.1 because it implies a reduction in b

18. A diagram similar to this was first used by Girton and Henderson (1977).

and an increase in m, i.e. an excess supply of money and an excess demand for domestic assets at old levels of i and ϵ. As shown in figure 12.1, this will unambiguously reduce i, but it is ambiguous whether ϵ will increase or decrease, because excess supply of domestic bonds implies upward pressure on ϵ while excess demand for money implies the opposite. However, if we assume that f stays constant, b_1 and m_1 must intersect on the f curve and therefore ϵ must fall unambiguously.

With adaptive expectations like (12.11), a decline in ϵ means more than a proportionate increase in e, because the new long-run rate has increased in proportion to the increase in the money stock. This is the well-publicized result of overshooting.

Usually in portfolio balance literature (e.g. Girton and Henderson 1977), the analysis ends here, making it an impact analysis. Obviously there is more to it than this impact analysis, especially when we consider the relation with the real sector.

First, there is an effect of the change in e on asset demands because of a higher exchange rate (e) implies a higher value of a given stock of foreign assets, which in turn implies a higher wealth level, triggering a wealth effect on asset demands. This revaluation effects raises f, creating an excess supply situation and shifting the f curve downward to f_1 in figure 12.1. However, the increase in wealth in this case involves an actual decrease in m and b, because f increases through revaluation, implying a strengthening of the excess demand for domestic assets and a reduction in excess supply of money. The reduction in the transactions demand term y/w that results from the revaluation effect would further strengthen the excess demand for domestic assets and the excess supply of money. Therefore the net effect of this wealth increase on the excess supply of money is not certain. In figure 12.1, this wealth effect on money and domestic assets is shown by the movement of the m curve from m_1 to m_2 (assuming that the effect through the transactions term is relatively small), and that of the b curve from b_1 to b_2. It might seem possible that ϵ could even increase if the downward shift of the f curve were large enough, but it is impossible because it was the reduction in ϵ that caused e to increase and the f curve to shift downward in the first place. The net result of this revaluation effect is that it dampens the effect of an OMO on ϵ and e, but never reverses the sign.[19]

Second, there are interactions with the real sector:

i) An increase in wealth will increase consumption directly through a conventional wealth effect.

ii) A decrease in the real interest rate, which means higher P_k ($= \rho/r$), increases investment.

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19. This revaluation effect hinges upon the relative increase in e and p. The above analysis depends on the implicit assumption that the price level does not change. When the price level is allowed to change, it is possible that the value of foreign asset holdings (eF/P) might even fall if the percentage increase in P is larger than that in e.

iii) A depreciated exchange rate, given a constant price level, implies an improvement in the trade balance, i.e. an increase in X, through a change in the terms of trade.

iv) Now (i), (ii), and (iii) above imply higher demand for real output, as can be seen from equation (12.6). This in turn implies a higher price level, as can be seen from equations (12.6) and (12.7).

v) These increases in output and the price level affect asset demands, and a new chain of reactions described in (i), (ii), (iii), and (iv) follows. Increases in the price level and output reduce the original excess supply of money by reducing the real increase in the money supply through increase in P, and by increasing the transactions demand through the increase in real income. They reduce the original excess demand for domestic assets through the increase in the transactions demand for money, which implies a reduction in demand for domestic assets. As for foreign assets, the net effect is not clear because a price increase tends to reduce the value of foreign asset holdings in terms of domestic consumption while the increase in the transactions demand for money tends to reduce the demand for foreign assets. In terms of figure 12.1, all these imply a further reduction in the impact effects of an OMO on ϵ (and therefore on e) and i, by upward shifts of b and m curves to b_3 and m_3, assuming that the f curve does not shift. If the income effect is large enough, i.e. if the shift of the m curve is large enough, it is possible that an open market purchase will cause appreciation as Henderson conjectured.

These real sector reactions will be further strengthened because the increase in the price level will raise π^e, reducing r for a given decline in i and therefore increasing investment and aggregate demand further, as can be seen from equation (12.12). This would be true even if a more general form of rational expectations mechanism were assumed instead of the adaptive expectations.

Over time, the whole system moves toward the new long-run equilibrium steady state, as shown in figure 12.2. First, the price level continues to approach the new long-run path after the initial level shock in the nominal stock of money is gone and the money supply resumes its normal growth rate $\bar{g}_M$.[20] As long as there remain deviations in asset holdings from their steady-state paths, there will be residual effects on aggregate demand through r and ϵ (and therefore through I and X) that are lower than the long-run steady-state levels. It is even possible for the real output and price level to overshoot their new long-run paths in approaching them, as depicted in figures 12.2b and 12.2f.[21] Eventually,

20. At the time of OMO, $M = g + \mu$, where μ represents the once-and-for-all level shock.

21. This is because when price level and real output approach their new long-run paths for the first time after a shock, depending on the speed of investment the capital stock may still be below its long-run path and require more investment, therefore requiring a level of consumption lower than, and a level of net exports higher than, the respective steady-state levels.
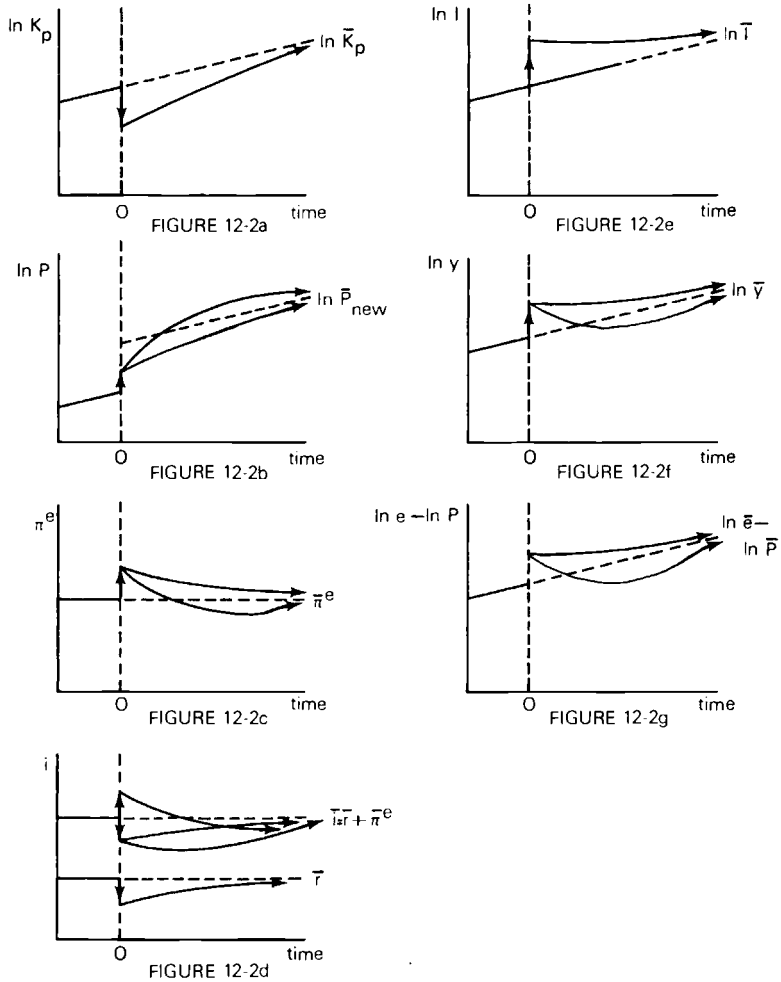
FIGURE 12-2a

FIGURE 12-2b

FIGURE 12-2c

FIGURE 12-2d

FIGURE 12-2e

FIGURE 12-2f

FIGURE 12-2g

Fig. 12.2   Dynamic effects of an OMP.

however, when asset markets return to the long-run steady state, r (approximately) and ϵ will return to the original long-run steady-state values.

The time paths of π^e corresponding to those of the price level are shown in figure 12.2c. Given any rational or adaptive expectations mechanism such as equation (12.12), there will be a temporary deviation of π^e from its long-run steady-state level, which is given by the steady-

state growth rate of the nominal money supply $\bar{g}_M$ minus the steady-state growth rate of the real demand for money g_l.

As long as there is a deviation from the long-run steady-state path in domestic asset holdings and therefore $P_k \neq 1$, there will be a flow adjustment in the form of investment. Given the asymptotic long-run neutrality with respect to OMO discussed in the previous section, the real interest rate r will approach its old long-run level over time, as K_p approaches its long-run steady-state level. This is depicted in figure 12.2d. And given an investment function such as equation (12.9), investment will gradually decrease over time until it reaches the steady-state level, as depicted in figure 12.2e.

Under the simplifying assumption that the partial derivatives of r and π^e in asset demand equations are identical, the nominal interest rate must fall after an open market purchase. Given that the real interest rate approaches its long-run level monotonically and π^e follows the time path shown in figure 12.2c, paths a and b in figure 12.2d are possible for the nominal interest rate. However, if we drop the assumption that the partial derivatives with respect to r and π^e are identical, the nominal interest rate will not necessarily decline after an open market purchase. It is possible that the increase in π^e will be large enough to offset the decline in r, such that i will increase after an open market purchase as depicted by path c in figure 12.2d.

The time path of K_p implied by the above analysis is shown in figure 12.2a. The actual domestic asset holdings of the private sector approach the long-run steady-state path over time. As discussed earlier, the effect of OMO on r will eventually be washed out (in the sense that r approaches its long-run level asymptotically), because the one-time increase in K $(= K_p + K_g)$ diminishes as a proportion of the total K, as K grows over time.

The effects of an open market purchase on the foreign asset market are not clear-cut. However, it is obvious that when the long-run PPP holds and e/P is restored to its original level in the long run, F_p must be restored to its long-run path. In other words, if the current account turns to surplus first, increasing F_p for a while, it must be followed by a period of deficit or lower-than-normal surplus to restore F_p to its long-run path. And the opposite is true if F_p first decreases.

Given the net export function implicit in equation (12.6),

$$(12.13) \qquad X = X(eP^*/P, y),$$

it is ambiguous whether X would increase or decrease after an open market purchase. Given the initial overshooting of e and the undershooting of P, the terms of trade (eP^*/P) should initially increase and would be

followed by a monotonic decrease as they approach the long-run path, implying a continuous but declining pressure toward trade surplus. However, there is an offsetting pressure from the increase in y, making the net effect on the trade account ambiguous. The time path of X might be one with an initial increase and a subsequent monotonic decrease followed by a period of negative X, keeping the foreign bond holdings on the long-run path in the long run.[22]

Given the dynamic time paths of I, C, and X as discussed above, the real income y would follow the time path shown in figure 12.2f.

12.3.4   Foreign Exchange Market Operation

Using the same diagram as in figure 12.1, we can analyze the effect of a FXO in asset markets. Consider a foreign exchange market purchase, in which the central bank purchases foreign assets with domestic money. This means an excess demand for foreign assets at the old levels of r and ϵ, shifting the f curve upward to f_1, and an excess supply of money, shifting m downward to m_1 in figure 12.3. These lower ϵ unambiguously and probably i too, assuming b stays constant. Note that in this case the effect on i is smaller and that on ϵ is larger than in the case of an OMO of the same size.

Now a chain reaction similar to the case of OMO follows, but with different relative magnitudes for different variables. First, a decline in ϵ would imply an increase in e (an overshooting given the adaptive expectation in equation (12.11)). This increases the value of the remaining foreign asset holdings of the private sector and causes a revaluation effect. In the present context, this means downward shifts of f and b curves to f_2 and b_2 in figure 12.3 and an upward shift of the m curve to m_2, which results in dampening the original impact effect on ϵ. Again, this revaluation effect hinges on the relative strength of rises in ϵ and P.

In the real sector, the increase in P_k, due to lower r and higher e, tends to increase investment and net exports, resulting in a higher aggregate demand for the real output. Now the price level and output increase. Whether the increase in output and the price level caused by a foreign exchange market purchase is larger or smaller than that caused by an open market purchase of the same size depends partly on the relative strengths of the effects of P_k and e on investment and net exports, because a FXO works mainly through its effect on e and an OMO through its effect on P_k. It might seem that the effect of a FXO on the real sector is smaller than that of an OMO of the same magnitude because there is an offsetting pressure on X resulting from the increase in y. However, it is

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22. Sometimes it is argued that an increase in the money supply would deteriorate the trade balance because of the resulting increase in real income which raises import demands. In the present context, this means that the income effect dominates the substitution effect, i.e. improvement in the terms of trade.
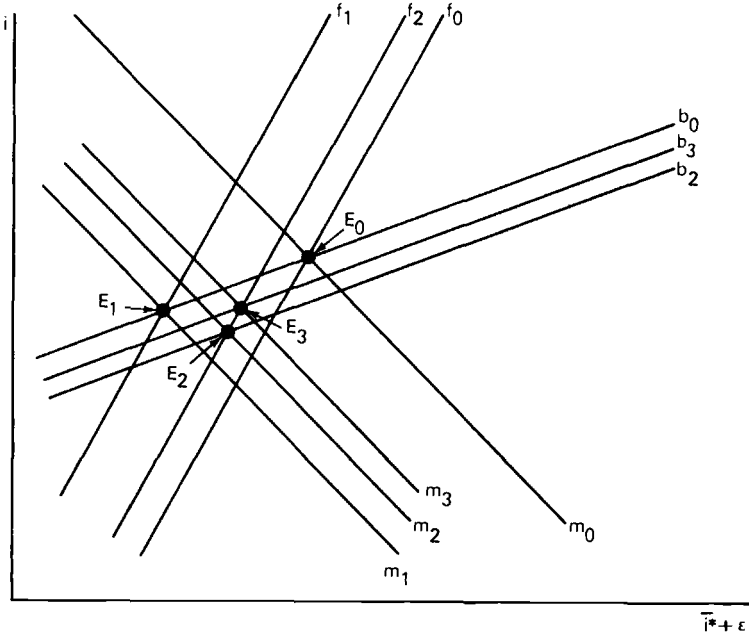
Fig. 12.3

still possible that the terms of trade effect dominates the income effect so that a FXO is more effective than an OMO in influencing the real sector. Also important is the relative speed of the reactions to OMOs and FXOs in this regard. These are basically empirical questions because there is no a priori reason to believe one or the other.

Whatever the sizes of the initial increases in output and the price level are, they will reduce the excess supply of money through a reduction in the real money supply and through increases in the transactions demand for money, and probably create an excess supply of domestic bonds by the negative transactions demand. The latter makes it possible for i to even increase, because this means an upward shift of the b curve, contrary to what is generally believed. However, even in this case, r is likely to decline because π^e would be adjusted upward. When r does increase, we must assume that the increase in X dominates the resulting decline in investment in order to have an increase in real output and price level in the first place. In that case, it is less likely that a FXO is more effective than an OMO in influencing the real sector.

The effect of increases in output and price level on the foreign asset market is ambiguous because the former reduces the demand for foreign assets by increasing the transactions demand for money and the latter reduces the value of foreign asset holdings in terms of domestic output.

Over time, all the variables would adjust in a way that is similar to the case of an OMO in general, except that this time the main disturbance is in the foreign asset market and in e rather than in the domestic asset market and in P_k. Although it is ambiguous whether the effect on output and the price level is larger or smaller than the case of an OMO of the same magnitude, the long-run effect must be the same; i.e. they must be on the same long-run path eventually.

Now, let us investigate the implied time paths of individual components of the aggregate demand. As for the trade balance, a larger drop in ϵ implies a larger increase in e than the case of an OMO of the same size. Again, given the overshooting e and undershooting P, the temporary change in the terms of trade in favor of the domestic country is guaranteed, as shown in figure 12.4e. If the negative effect of an increase in y on X is sufficiently strong, it is possible that the net effect on X by a foreign exchange market purchase will be negative, making the dynamics unstable, because y could still increase through increases in C and I. However, this is unlikely, because the wealth effect on C, through the revaluation effect, and the fall in r are likely to be relatively small (r could even rise).

It is also possible to have something like the well-publicized J curve, in a different context. If, due to rigid contracts, it takes a considerable length of time to change the effective terms of trade, it is possible for X to be negative for a while after a foreign exchange market purchase, dominated by the income effect until the effect of the change in the terms of trade materializes.

In the normal case in which the effect of a change in the terms of trade outweighs that of an increase in real income, the time paths of X and F_p are as shown in figures 12.4f and 12.4a.

As for the I and K_p, because the reduction in the real interest rate would be small and could even be positive when the increase in the transactions demand for money is strong enough, the effects on I and K_p are likely to be negligible. In any case, r could take one of the time paths depicted in figure 12.4g. The important thing here is that a period of above (below) the steady-state real interest rate must be followed by a period of below (above) the steady-state rate to make the capital stock (K_p) return to the long-run path.

12.3.5   OMO versus FXO

One way to compare the relative strengths of an OMO and a FXO in influencing the economy is to combine an OMO with a FXO of the opposite direction. Consider an open market purchase combined with foreign exchange market sales of the same magnitude, which is equivalent to the purchase of domestic assets with foreign assets leaving the
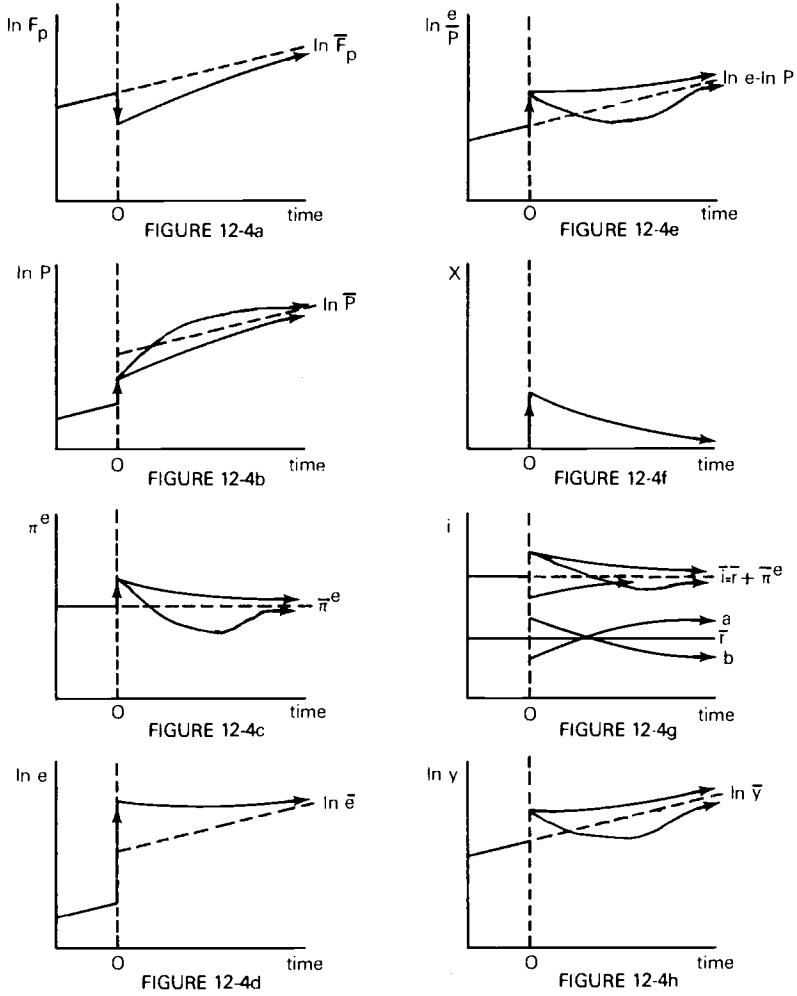
Fig. 12.4   Dynamic effects of a FXP.

money supply constant. This implies an excess demand situation for domestic assets, shifting the b curve in figure 12.5 downward, and an excess supply situation for foreign assets, shifting the f curve downward also. Assuming that the m curve does not shift, this would lower i and raise ϵ, which implies a fall in given e. Lowering i increases investment
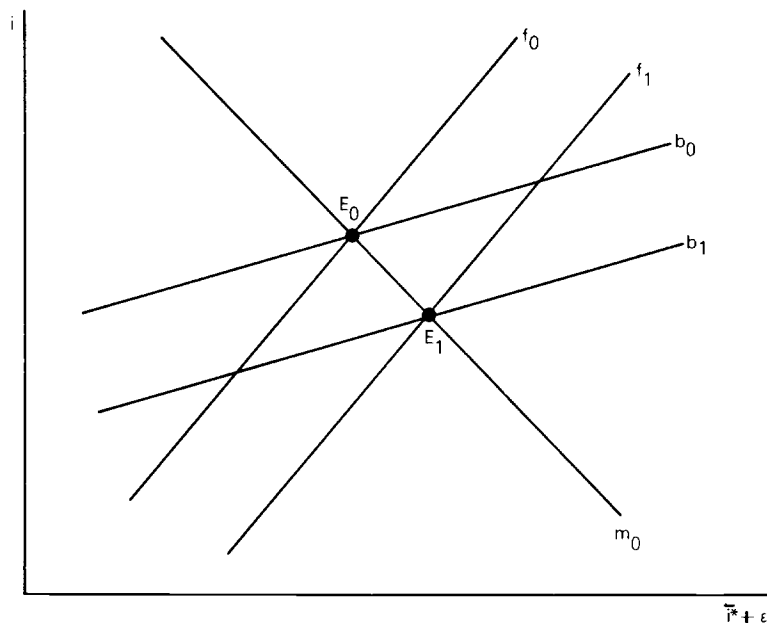
Fig. 12.5

and lowering e decreases net exports, making the net effect on aggregate demand ambiguous. As mentioned above, the net effect depends on the relative strength and speed of the effects of an increase in I and a decrease in X. If the response of investment is faster and stronger than that of net exports, then aggregate demand would increase; i.e. an OMO is more effective than a FXO in affecting the real sector in this case.

12.4   Conclusion and Policy Implications

In this chapter, effects of the two alternative instruments in the conduct of monetary policy, OMOs and FXOs, were discussed using a portfolio balance framework with a real sector in the context of a small open economy, for the short run and the long run.

i) Regardless of the short-run effects, both OMO and FXO have (asymptotically) identical long-run effects under the steady-state assumption. In the long run, all the variables except the price level and the exchange rate return to their original steady-state paths. The long-run PPP holds, and the changes in the exchange rate and the price level, which are proportional to the monetary shock, take care of all the disturbances in the long run.

ii) In the short run, it is true that an OMO exercises greater influence on the interest rate than a FXO of identical size and a FXO exercises

greater influence on the exchange rate than an OMO. Therefore the short-run response to an OMO in the real sector occurs mainly through changes in investment, while that to a FXO occurs through changes in the trade balance.

iii) The relative strengths of effects of OMO and FXO on output and price in the short run are ambiguous. If the response of the trade balance to changes in the terms of trade is relatively slower and weaker than that of investment to interest-rate changes, we might be able to say that the immediate short-run effect of an OMO is stronger than a FXO. Or, if the foreign sector is relatively large and responsive, we might be able to say the opposite. All these are basically empirical questions, because there is no a priori reason to believe one thing or the other.

iv) Given our inability to resolve the question posed in (iii) without satisfactory empirical evidence,[23] the choice between OMOs and FXOs is at present a choice between short-run investment and short-run trade balance, as conjectured by Niehans.

v) When we assume a stationary state in which long-run stock values are constant rather than growing at a constant rate, the asymptotic long-run neutrality with respect to an OMO disappears. In this case, an OMO leaves a permanent mark on the capital stock, the relative importance of which does not diminish over time, and therefore on the real interest rate and real income as long as the public does not fully "internalize" the government. A FXO poses no such problem, because foreign assets can be replenished by the private sector at constant prices. Although the short-run relative effects of an OMO and a FXO may be ambiguous, the long-run relative effects are obviously different. An OMO, which is equivalent to a financing of domestic investments by the central bank, raises the capital stock permanently, while a FXO, which is equivalent to a financing of foreign investment, does not leave any permanent mark on the domestic economy under the small-country assumption.

Acknowledgments

23. See Darby (1980), for example, for an international study of balance of payments and exchange rates. Also see Lee (1980) for some preliminary empirical evidence regarding the hypotheses derived here.

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