International Finance Discussion Papers

Number 142

June 1979

THE DYNAMIC EFFECTS OF EXCHANGE MARKET INTERVENTION POLICY: TWO EXTREME VIEWS AND A SYNTHESIS

by

Dale W. Henderson

The Dynamic Effects of Exchange Market Intervention Policy: Two Extreme Views and a Synthesis

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I. Introduction

Under a regime of managed floating, one policy instrument available to the authorities is exchange market intervention policy, purchases or sales of assets denominated in foreign currency in exchange for assets denominated in home currency. Since, in general, an economy does not reach its new long-run equilibrium immediately following an exchange market intervention, a complete analysis of the effects of this policy must include a description of the path followed by the economy as it adjusts to its new long-run equilibrium. This paper is a study of the dynamic effects of a particular type of intervention policy, a purchase of foreign money with home money.[1/]

Recent studies of exchange rate dynamics contain two extreme views about why an economy does not reach its new long-run equilibrium immediately following a shock. One extreme view is based on the assumption that changes in real wealth affect spending decisions and asset demands.[2/] Under this assumption the intervention policy considered here gives rise to an incentive for residents of the home country to accumulate assets and for foreigners to decumulate assets. This incentive leads to an asset transfer which occurs slowly over time at a rate which is equal in magnitude to the home trade

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* This is a revised version of a paper presented at the conference on "The Economics of Flexible Exchange Rates" at the Institute for Advanced Studies, Vienna, Austria, March 29-31, 1978. It will appear in the proceedings of the conference which will be published as a supplement to Kredit und Kapital in the fall of 1979. Discussions with Ralph Bryant, Rudiger Dornbusch, Lance Girton, Gene Grossman, and Bennett McCallum have resulted in improvements in the paper. Betty Daniel, Barry Eichengreen, Peter Isard, Richard Meese, Walter Salant, Jürgen Siebke, Carl Van Duyne, and Janet Yellen made helpful comments on earlier drafts. No one but the author is responsible for the remaining shortcomings of the paper. This paper represents the views of the author and should not be interpreted as reflecting the views of the Federal Reserve System or other members of its staff.

account surplus. During the slow buildup of assets by home residents through the trade account surplus, the short-run equilibrium position of the economy continues to change because of wealth effects on spending decisions and asset demands. The economy cannot come to rest at its new long-run equilibrium until there is no longer an incentive for asset transfers to take place so that the trade account is once again in balance.

The other extreme view is based on the assumption that prices adjust slowly when there is an excess demand for goods.[3/] Under this assumption the intervention policy considered here gives rise to an excess demand for the home good over "normal" supply. This excess demand must ultimately be removed by a rise in the price of the home good which occurs slowly over time. While the price of the home good is rising, the short-run equilibrium position of the economy continues to change since increases in the price of the home good affect spending decisions and asset demands. The economy cannot come to rest at its new long-run equilibrium until the adjustment of the price of the home good is complete.

The effects of intervention policy are explored using three specialized versions of the model of a single open economy which is now in general use.[4/] Each of the first two versions embodies one of the extreme views about why the economy adjusts slowly to its new long-run equilibrium. In the first version, changes in wealth affect the spending decisions and asset demands of home residents, but the home wage rate and the price of the home good are perfectly flexible so that output is always at its full employment level. In the second version, the wage rate and the price of the home good adjust slowly when there is an excess demand for the home good, but there are no wealth effects. The third version is a synthesis of the first two which incorporates both wealth effects and slow wage and price adjustment.

Since attention is to be focused on the adjustment path of the economy after an exchange market intervention under alternative assumptions about what affects this path, the three versions of the model have been constructed so that the long-run effects of exchange market intervention are particularly simple. In the long run the exchange market intervention causes all nominal variables to increase by the same proportion as the supply of home money increases and leaves all real variables unchanged.

The effects of intervention policy are investigated under the assumption that in forming their exchange rate expectations consumers have long-run perfect foresight.[5/] Under this regime the stationary equilibrium value of the exchange rate is known to consumers, and they expect that the exchange rate will move from its current value toward that stationary equilibrium rate. Expectations are correct in the long run, but they may be incorrect while the system is adjusting toward its stationary equilibrium.

The analysis begins with a description of the building blocks for the three versions of the model in Section II. A consideration of the effects of exchange market intervention when only asset transfers accomplished through a trade surplus affect the adjustment path of the economy is contained in Section III. Then, in Section IV, the case in which only slow adjustment of the price of the home good influences the path of the economy is discussed. Both the trade surplus and slow price adjustment affect the path of the economy in the version of the model explored in Section V. Section VI contains some concluding remarks.

II. The Building Blocks for the Three Versions of the Model

Home Consumers

Consumers in the home economy make four basic decisions: a saving decision, an expenditure-allocation decision, a wealth-allocation decision, and a labor market decision. In the description of how consumers make these decisions it is assumed that all real variables are obtained by deflating nominal variables by a price index (P_I):

$$P_I = k_1 P + k_2 E, \qquad k_1, k_2 > 0, \; k_1 + k_2 = 1, \qquad (1)$$

where P is the home currency price of the single home good, and E is the home currency price of foreign currency. The foreign authorities keep the foreign currency price of the single foreign good, which is different from the home good, constant at one unit of foreign currency.[6/]

Consumers' real saving ($\frac{S}{P_I}$) rises with increases in real income ($\frac{Py}{P_I}$) and falls with increases in real wealth ($\frac{A}{P_I}$):

$$\frac{S}{P_I} = s_1 \frac{Py}{P_I} - s_2 \frac{A}{P_I} + s_6, \qquad 0 < s_1 < 1, \; s_2, s_6 > 0, \qquad (2)$$

where S is nominal saving, y is output of the home good measured in physical units, and A is nominal wealth.

Consumers allocate part of their real expenditure to the home good and the rest to the foreign good. Real imports ($\frac{M}{P_I}$) depend positively on real spending $(\frac{Py}{P_I} - \frac{S}{P_I})$, negatively on the ratio of the exchange rate to the price index $(\frac{E}{P_I})$, and positively on the ratio of the price of the home good to the price index $(\frac{P}{P_I})$:7/

$$\frac{M}{P_I} = m_1(\frac{Py}{P_I} - \frac{S}{P_I}) - m_3 \frac{E}{P_I} + m_4 \frac{P}{P_I}, \qquad 0 < m_1 < 1,\ m_3,\ m_4 > 0, \tag{3}$$

where M is nominal imports.

They allocate their real wealth between home money and foreign money. Their demand for real holdings of home money $(\frac{Q^d}{P_I})$ depends positively on real income and real wealth and negatively on the expected rate of depreciation of the home currency (e):8/

$$\frac{Q^d}{P_I} = q_1 \frac{Py}{P_I} + q_2 \frac{A}{P_I} - q_5 e + q_6, \qquad q_1,\ q_2,\ q_5,\ q_6 > 0, \tag{4}$$

where Q^d is consumers' demand for nominal holdings of home money. It is assumed that foreign consumers do not hold domestic money. Therefore, home consumers' nominal wealth in terms of home currency is equal to the total supply of domestic money (Q) plus the product of the exchange rate and home consumers' holdings of foreign money measured in foreign currency (F):

$$A = Q + EF. \tag{5}$$

Consumers also make a labor market decision. Two alternative forms of labor market behavior by consumers are considered. In the first version of the model explored below it is assumed that consumers supply a fixed amount of labor services ($\tilde{N}$) no matter what the real wage.[9/] In this version the nominal wage (W) is determined in a competitive labor market. In the other two versions explored below it is assumed that at a point in time consumers supply whatever amount of labor firms want at the prevailing nominal wage. In these versions consumers set the percentage rate of change of the nominal wage. They attempt to raise (lower) the real wage by increasing (decreasing) the nominal wage when labor demand (N^d) exceeds (falls short of) a fixed "normal" supply ($\tilde{N}$):[10/]

$$\frac{\dot{W}}{W} = u(N^d - \tilde{N}), \qquad u > 0. \tag{6}$$

Home Firms

Firms in the home economy produce output using only labor and a production function with a fixed labor-output ratio (n). In the version in which the supply of labor is inelastic, the supply of output is inelastic at the full employment level:

$$y = \bar{y} = \frac{1}{n}\tilde{N}. \tag{7}$$

Firms take the price of output as given and bid the nominal wage up or down to the point at which profits are zero:

$$W = \frac{1}{n}P. \tag{8}$$

In the versions in which labor is supplied perfectly elastically at a point in time, firms produce enough output to satisfy aggregate demand, and labor demand is given by

$$N^d = ny. \tag{9}$$

Competition among firms assures that the price of the domestic good is set so that it just covers costs at the prevailing nominal wage:

$$P = Wn, \tag{10}$$

so the percentage rate of change in the price of the domestic good is equal to the percentage rate of change in nominal wages:

$$\frac{\dot{P}}{P} = \frac{\dot{W}}{W}. \tag{11}$$

Home Authorities

The home authorities determine the nominal supply of home money. They undertake exchange market intervention by purchasing foreign money from home residents with home money subject to

$$dQ + EdF = 0, \tag{12}$$

or in percentage terms

$$q\hat{Q} + f\hat{F} = 0, \tag{13}$$

where a hat over a variable indicates a percentage change in the variable and where q is the fraction of wealth held in domestic money and f is the fraction of wealth held in foreign money.

Foreigners

Consumers in the foreign country have a real demand for the home good $(\frac{X}{P_I})$ which depends positively on the ratio of the exchange rate to the price index and negatively on the ratio of the price of the home good to the price index:

$$\frac{X}{P_I} = x_3 \frac{E}{P_I} - x_4 \frac{P}{P_I}, \qquad x_3, x_4 > 0, \qquad (14)$$

where X is foreign consumers' nominal demand for the home good measured in home currency. As stated above, foreign consumers do not hold home money, and the foreign authorities keep the foreign currency price of the foreign good constant at one unit of foreign currency. It is important to observe that the assumptions that foreign demand for the home good is independent of foreign wealth and that foreigners do not hold home money insure that transfers of wealth from foreigners to home residents lead to increases in demand for home goods and home money.

Expectations Formation

Home consumers are assumed to possess long-run perfect foresight. Under this assumption, consumers correctly calculate the stationary state value of E, denoted by $\bar{E}$, and expect that E will adjust toward this stationary state value at a rate which is proportional to the ratio of the gap between its stationary state value and its current value to its stationary state value:[11/]

$$e = \epsilon(1 - \frac{E}{\bar{E}}), \qquad \epsilon > 0. \qquad (15)$$

In the limiting case in which $\epsilon = 0$, consumers have static expectations.

III. The Effects of Intervention Policy When Only the Trade Surplus Affects the Adjustment Path of the Economy

The Conditions for Momentary Equilibrium

In order to focus attention on the effects of the trade surplus on the path of the economy following exchange market intervention it is assumed in the version of the model of this Section that prices and wages are perfectly flexible so that output is always at its full employment level $(\bar{y})$.12/ The position of the economy at a point in time is referred to as momentary equilibrium.

In order to lay a foundation for the discussion of the conditions for momentary equilibrium it is useful to derive an expression for the real trade balance $(\frac{T}{P_I})$ from equations (3) and (14):

$$\frac{T}{P_I} = \frac{X}{P_I} - \frac{M}{P_I} = - t_1 \frac{Py}{P_I} - t_2 \frac{A}{P_I} + t_3 \frac{E}{P_I} - t_4 \frac{P}{P_I} + t_6, \tag{16}$$

$$t_1 = m_1(1 - s_1),\ t_2 = m_1 s_2,$$

$$t_3 = x_3 + m_3,\ t_4 = x_4 + m_4,\ t_6 = m_1 s_6,$$

where T is the nominal trade surplus measured in terms of home currency.

Three conditions determine the momentary equilibrium values of the exchange rate, the price level, and the change in home consumers' holdings of foreign money $(\dot{F})$. The first condition is that the domestic goods market must clear. For the excess demand for domestic goods to equal zero, the real trade surplus must equal real saving:

$$\frac{T}{P_I} - \frac{S}{P_I} = 0. \tag{17}$$

When equations (2), (5), and (16) are substituted into equation (17) the condition for goods market equilibrium becomes

$$-g_1 \frac{P\bar{y}}{P_I} + g_2 \frac{Q + EF}{P_I} + g_3 \frac{E}{P_I} - g_4 \frac{P}{P_I} - g_6 = 0, \tag{18a}$$

$$g_1 = s_1 + m_1(1 - s_1),\ g_2 = s_2(1 - m_1),$$

$$g_3 = x_3 + m_3,\ g_4 = x_4 + m_4,\ g_6 = (1 - m_1)s_6.$$

A second condition for momentary equilibrium is that the excess demand by consumers for home money must equal zero. When equations (5) and (15) are substituted into equation (4), this condition can be written as

$$q_1 \frac{P\bar{y}}{P_I} + q_2 \frac{Q + EF}{P_I} - q_5 \varepsilon\left(1 - \frac{E}{\bar{E}}\right) + q_6 - \frac{Q}{P_I} = 0. \tag{18b}$$

The third and final condition states that the change in real domestic holdings of foreign money ($\frac{E}{P_I}\dot{F}$) must equal the trade surplus:

$$-t_1 \frac{P\bar{y}}{P_I} - t_2 \frac{Q + EF}{P_I} + t_3 \frac{E}{P_I} - t_4 \frac{P}{P_I} + t_6 - \frac{E}{P_I}\dot{F} = 0. \tag{18c}$$

The Stationary State Effects

Since knowledge of the stationary state effects of intervention policy is necessary for determining the impacts effects and the paths of the variables under long run perfect foresight, it is useful to begin by describing these stationary state effects. In a stationary state foreign money accumulation by domestic residents is zero, and the exchange rate is expected to remain unchanged:

$$\dot{F} = e = 0. \tag{19}$$

Imposing these restrictions on the three equations (18) after eliminating P_I using equation (1) yields three equations which are sufficient to determine the stationary state values of the price level ($\bar{P}$), the exchange rate ($\bar{E}$), and home consumers' holdings of foreign money ($\bar{F}$) given full employment output ($\bar{y}$) and the stationary state stock of domestic money ($\bar{Q}$). The stationary state effects of a purchase of foreign money by the authorities on $\bar{P}$, $\bar{E}$, and $\bar{F}$ can be determined by inspection. The system of equations obtained by imposing the stationary state restrictions (19) on equations (18) is homogenous of degree zero in the three nominal variables $\bar{P}$, $\bar{E}$, and $\bar{Q}$, and $\bar{Q}$ is the only exogenous nominal variable.[13/] So, if $\bar{Q}$ increases, $\bar{P}$ and $\bar{E}$ must increase by the same proportion, and $\bar{F}$ must remain unchanged:

$$\hat{P} = \hat{E} = \hat{Q}, \tag{20a}$$

$$\hat{F} = 0. \tag{20b}$$

The Impact Effects

The impact effects of a purchase of foreign money by the authorities on the exchange rate and the price of the domestic good are shown in Figure 1 which is constructed using equations (18a) and (18b) with P_I eliminated through equation (1). The G_0G_0 schedule shows the pairs of (the natural logarithms of) E and P which are compatible with equilibrium in the market for the home good. The Q_0Q_0 schedule shows the pairs of E and P which are compatible with equilibrium in the home money market.

The GG schedule has a slope which is greater than positive one as shown in Figure 1 under plausible assumptions. First, consider the effects of an increase in the price of the home good on excess demand for the home good. This price increase reduces the excess demand for the home good for three reasons: (1) the price increase raises real income thereby reducing the trade surplus and increasing saving; (2) it lowers real wealth, and this decline in real wealth raises saving by more then it improves the trade account; and (3) it lowers the ratio of the exchange rate to the price index and raises the ratio of the price of the home good to the price index, and both of these changes cause home and foreign residents to shift spending from the home good to the foreign good thereby reducing the trade surplus.

Next, consider the effects of a depreciation of the home currency (a rise in E) on the excess demand for the home good. This depreciation tends to raise excess demand for two reasons: (1) it lowers real income, and (2) it raises the ratio of the exchange rate to the price index and lowers the ratio of the price of the home good to the price index. However, the depreciation may raise or lower excess demand through its effects on real wealth.

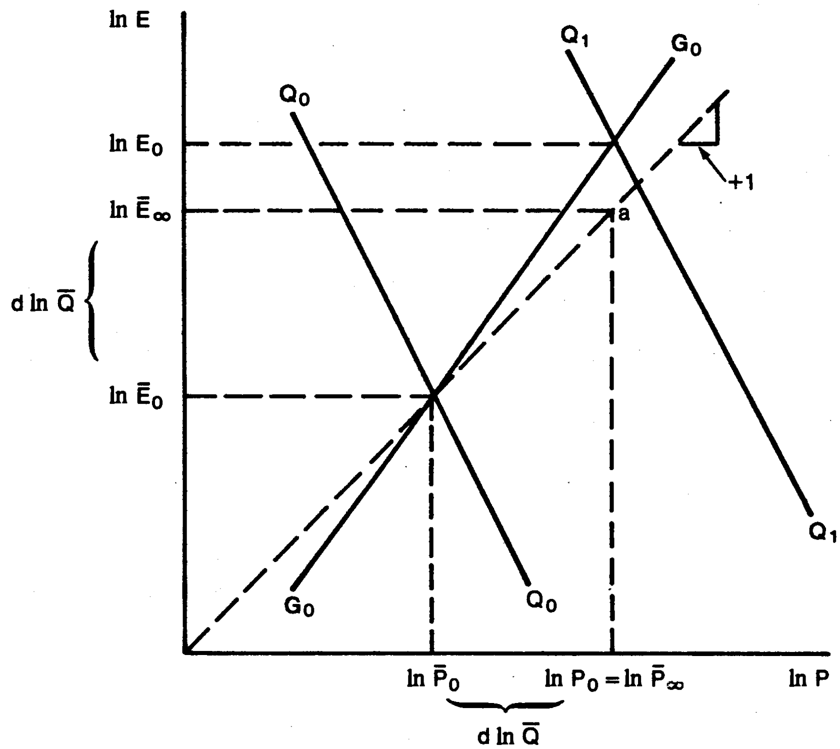


FIGURE 1

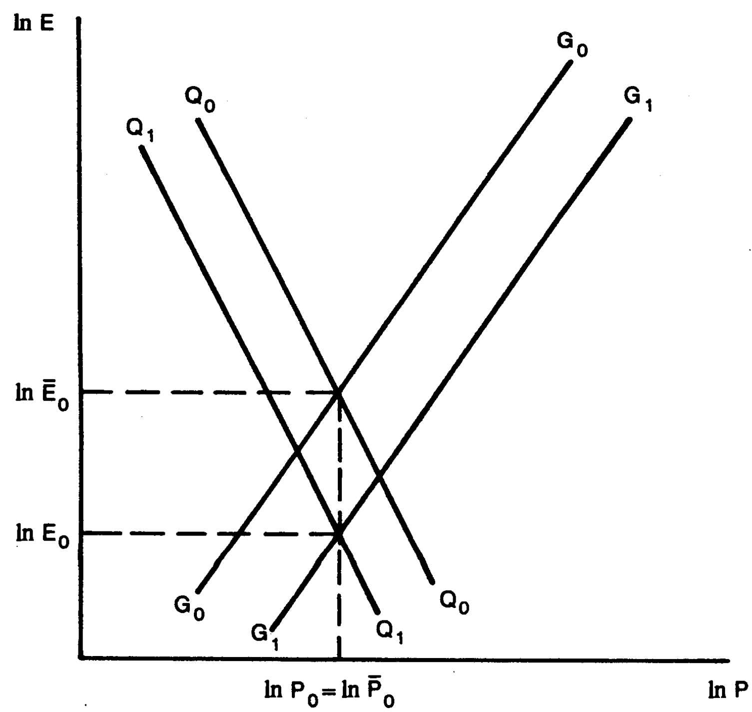


FIGURE 2

It tends to raise real wealth because it raises the home currency value of consumers' foreign money holdings, but it tends to lower real wealth because it raises the price index. The net effect of the depreciation on real wealth is positive (negative) if the ratio of foreign money holdings to total wealth (f) exceeds (falls short of) the weight on the exchange rate in the price index (k_2). It is assumed in what follows that the overall effect of a depreciation on the excess demand for goods is positive; that is, it is assumed that the effects of the decrease in real income, the increase in $\frac{E}{P_I}$, and the decrease in $\frac{P}{P_I}$ outweigh the effect of the decrease in real wealth if f is less than k_2.

The slope of the GG schedule must be positive given the assumption that a depreciation of the home currency raises the excess demand for goods. An increase in P creates an excess supply of goods, so the domestic currency must depreciate if the goods market is to remain in equilibrium. The slope of the GG schedule must exceed positive one. Increases in P and E by the same proportion leave real income, the ratio of the exchange rate to the price index, and the ratio of the price of the home good to the price index unchanged but reduce real wealth thereby giving rise to an excess supply of the home good. The increases in P and E raise the price index and therefore lower the real value of both home and foreign money, but the increase in E raises only the domestic currency value of consumers' foreign money holdings. Since equiproportionate increases in P and E give rise to an excess supply of the home good, the proportionate increase in E must be greater than the proportionate increase in P if the market for the home good is to remain in equilibrium. Note that if g_2 were zero so that real wealth did not affect the condition for goods market equilibrium, the GG schedule would have a slope of positive one. The equation of the GG schedule is derived by differentiating equation

(18a) in the neighborhood of stationary equilibrium to obtain

$$-(g + g_2\bar{A}k_1)\hat{P} + [g + g_2\bar{A}(\bar{f} - k_2)]\hat{E} + g_2\bar{A}\ \bar{q}\hat{Q} + g_2\bar{A}\ \bar{f}\hat{F} = 0, \tag{21}$$

$$g = g_1\bar{y}k_2 + g_3k_1 + g_4k_2 > 0,$$

where units are chosen such that P = E = 1 in stationary equilibrium.

The QQ schedule has a negative slope as shown in Figure 1 under plausible assumptions. First, consider the effect of an increase in the price of the home good on the excess demand for home money. This price increase raises the excess demand for home money because it raises nominal income. However, the increase in the price of the home good may raise or lower excess demand because it raises the price index. The increase in the price index reduces the supply of real balances; however, it also reduces the demand for real balances because it reduces real income and real wealth. The net effect of an increase in the price index is to raise the excess demand for home money if the sum of the real income and real wealth elasticities of demand for real balances is less than one ($q_1\bar{y} + q_2\bar{A} < \bar{Q}$). It is assumed in what follows that this condition is met so that an increase in the price index raises the excess demand for money. Under this assumption the overall effect of a increase in the price of the home good is definitely to raise the excess demand for money.

Next, consider the effect of a depreciation of the home currency on the excess demand for home money. This depreciation raises the excess demand for money for three reasons: (1) it increases nominal wealth; (2) it increases the price index; and (3) it induces money holders to expect an appreciation of the home currency.

The slope of the QQ schedule must be negative given the assumption that the sum of the real income and real wealth elasticities of demand for real balances is less than one. An increase in P creates an excess demand for money, so the domestic currency must appreciate if the money market is to remain in equilibrium. The equation of the QQ schedule is derived by differentiating (18b) in the neighborhood of stationary equilibrium and recognizing the fact that $\hat{\bar{E}} = \hat{\bar{Q}}$ to obtain

$$[(\bar{Q} - q_1\bar{y} - q_2\bar{A})k_1 + q_1\bar{y}]\hat{P} + [(\bar{Q} - q_1\bar{y} - q_2\bar{A})k_2 + q_2\bar{A}\,\bar{f} + q_5\epsilon]\hat{E}$$
$$+ (q_2\bar{A}\,\bar{q} - \bar{Q} - q_5\epsilon)\hat{\bar{Q}} + q_2\bar{A}\,\bar{f}\hat{\bar{F}} = 0. \qquad (22)$$

A purchase of foreign money by the home authorities $(\bar{q}\,\hat{\bar{Q}} + \bar{f}\hat{\bar{F}} = 0)$ shifts the QQ schedule up to Q_1Q_1. The QQ schedule must shift farther than point a along the dashed line which has a slope of positive one in Figure 1. Point a is the point which corresponds to increases in both E and P by the same proportion as the increases in $\bar{Q}$ $(\hat{E} = \hat{P} = \hat{\bar{Q}})$. Equiproportionate increases in E, P, and $\bar{Q}$ leave real balances, real income, and the expected rate of depreciation unchanged but reduce real wealth thereby giving rise to an excess supply of money. Thus, if equilibrium in the home money market were to be reestablished with equal percentage changes in E and P following an exchange market intervention which increases $\bar{Q}$, the percentage changes in E and P would have to exceed the percentage change in $\bar{Q}$. Note that if q_2 were equal to zero so that real wealth did not influence the demand for real balances, Q_1Q_1 would pass through point a.

The impact effects of an exchange market intervention are shown by the intersection of Q_1Q_1 and G_0G_0. The home currency depreciates, and the price of the home good rises. The exchange rate overshoots its stationary equilibrium level; that is, E rises initially to a value that it higher than the one associated with the new stationary equilibrium, $\bar{E}_{\infty}$, where the subscript ∞ indicates the value of a variable in the new stationary equilibrium.[14/] This result arises because changes in real wealth affect the markets for the home good and home money. If changes in wealth affect either market (g_2 or $q_2 > 0$), the exchange rate overshoots.[15/] The price of the home good may overshoot or undershoot its new stationary equilibrium level.[16/] A borderline case in which the price of the home good rises only as much as is necessary to reach its new stationary equilibrium level is shown in Figure 1. The proportionate rise in E is greater than the proportionate rise in P, so the relative price of the foreign good ("the real exchange rate") definitely rises. This result is quite important: a policy change which leaves the real exchange rate unchanged in the long run causes it to rise in the short run even though wages and prices are completely flexible. It follows from the fact that changes in real wealth affect the market for the home good. If there were no wealth effect in either market ($g_2 = q_2 = 0$), both E and P would rise by the same proportion as $\bar{Q}$ rises; the new momentary and stationary state equilibria would be at point a.

The Adjustment Process

In order to lay a foundation for the discussion of the adjustment process it is useful to derive two additional relationships. The changes in the exchange rate and the price of the home good which are required to clear the markets for the home good and home money when home consumers' holdings of foreign money increase are shown in Figure 2. An increase in F shifts the GG schedule down to G_1G_1. A rise in F raises the demand for the home good, so for a given value of P, E must fall if the market for the home good is to remain in equilibrium. An increase in F also shifts the QQ schedule down to Q_1Q_1. A rise in F raises the demand for home money, so for a given value of P, E must fall if the home money market is to remain in equilibrium. The new equilibrium values of E and P are given by the intersection of Q_1Q_1 and G_1G_1. The home currency definitely appreciates.[17/] The price of the home good may rise or fall; a borderline case in which P remains unchanged is shown in Figure 2.[18/]

The adjustment process for the system following the exchange market intervention is shown in Figure 3. The downward-sloping GQ_0GQ_0 schedule shows the pairs of the exchange rate and home consumers' holdings of foreign money which are compatible with equilibrium in both the market for the home good and the market for home money before the exchange market intervention. It has just been established that increases in F cause E to fall.

The $\dot{F}_0\dot{F}_0$ schedule shows the pairs of the exchange rate and home consumers' holdings of foreign money which are compatible both with equilibrium in the market for the home good and with zero foreign money accumulation before the exchange market intervention. It can be shown that (1) the $\dot{F}\dot{F}$ schedule is upward-sloping, and (2) to the left of (the right of) the $\dot{F}\dot{F}$ schedule, foreign money accumulation is positive (negative).[19/]

Just before the exchange market intervention the home economy is at point b in Figure 3 with foreign money holdings of $\bar{F}_0$ and with an exchange rate of $\bar{E}_0$. The stationary equilibrium which the economy approaches following the exchange market intervention is at point c. It has been shown that an

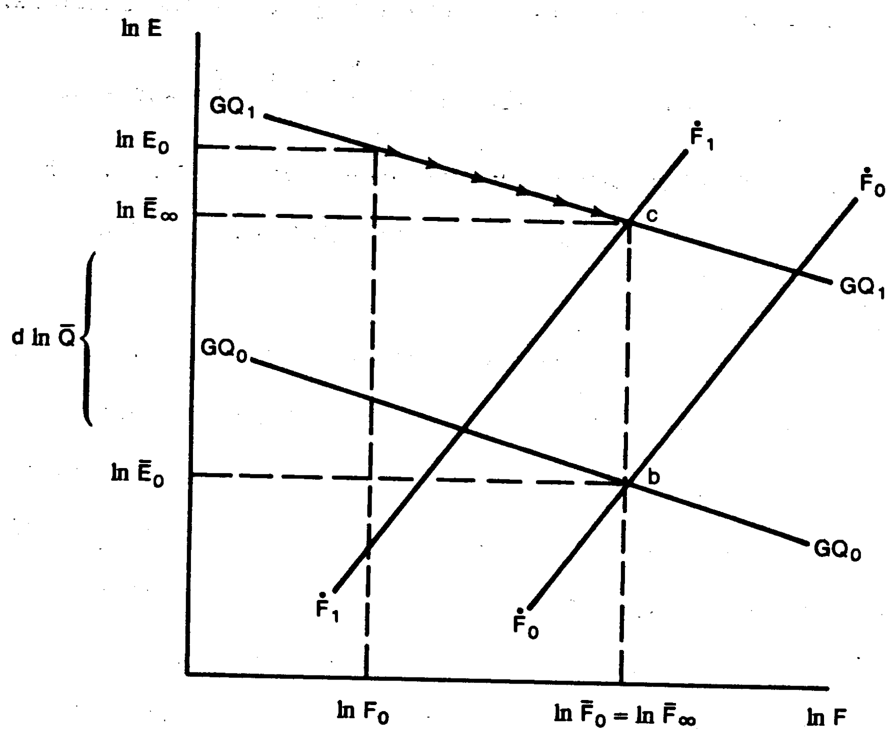


FIGURE 3

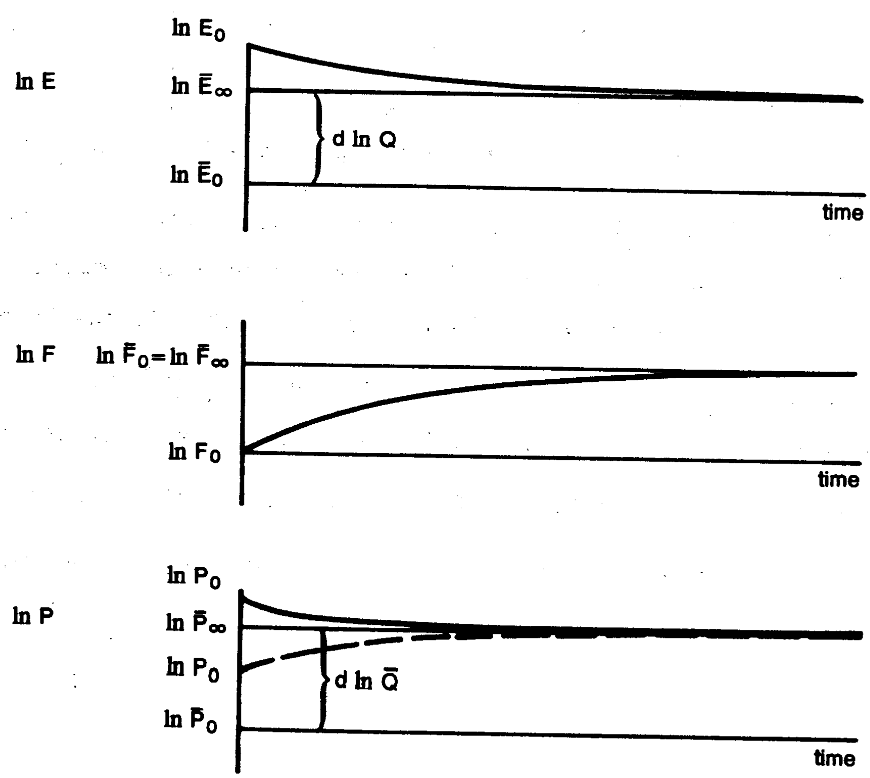


FIGURE 4

exchange market intervention which increases $\bar{Q}$ raises the stationary state exchange rate by the same proportion $(\frac{\bar{E}_\infty - \bar{E}_0}{\bar{E}_0} = \hat{\bar{E}} = \hat{\bar{Q}})$ and leaves consumers' stationary state foreign money holdings unchanged $(\bar{F}_\infty = \bar{F}_0)$. Thus, the exchange market intervention must cause the GQGQ and $\dot{F}\dot{F}$ schedules to shift upward to GQ_1GQ_1 and $\dot{F}_1\dot{F}_1$.

The economy approaches the new stationary equilibrium over time. The exchange market intervention initially reduces home residents' holdings of foreign money from $\bar{F}_0$ to F_0. Given home residents' holdings of foreign money, the exchange rate must be the one which is compatible with equilibrium in the home goods and home money markets. Thus, at the moment of the exchange market intervention, the exchange rate jumps up from $\bar{E}_0$ to E_0, the value of the exchange rate on the GQ_1GQ_1 schedule which corresponds to F_0. Since the pair (E_0, F_0) lies to the left of the $\dot{F}_1\dot{F}_1$ schedule, the trade surplus is positive, and home residents begin accumulating foreign money. The economy moves along GQ_1GQ_1 until the new stationary equilibrium pair $(\bar{E}_\infty, \bar{F}_\infty)$ is reached. After its initial depreciation the home currency appreciates steadily from E_0 to $\bar{E}_\infty$.

The time paths of E and F and two alternative time paths for P are shown in Figure 4. The time paths of E and F have already been discussed, but the two possible paths of P require a little further comment. It has been shown that P may initially overshoot or undershoot its stationary equilibrium value. It can be shown that if P initially overshoots (undershoots), increases in F cause decreases (increases) in P.[20/] Since F is always rising while the economy is adjusting, P steadily approaches its new stationary equilibrium value from either above or below.

IV. The Effects of Intervention Policy When Only Slow Price Adjustment Affects the Adjustment Path of the Economy

The Conditions for Momentary Equilibrium

In order to focus attention on the effects of slow price adjustment on the path of the economy following exchange market intervention, it is assumed that the price level adjusts slowly and that output is variable.[21/] It is also assumed that neither saving nor the demand for home money depend on real wealth so that $s_2 = q_2 = 0$. This assumption implies that changes in real wealth do not affect either the excess demand for goods ($g_2 = 0$) or the trade surplus ($t_2 = 0$). For convenience the position of the economy at a point in time is still referred to as momentary equilibrium even though the labor market is not in full equilibrium.

Under the assumptions stated above four conditions determine the momentary equilibrium values of the exchange rate, output, the rate of inflation, and the change in home consumers' holdings of foreign money:

$$-g_1 \frac{Py}{P_I} + g_3 \frac{E}{P_I} - g_4 \frac{P}{P_I} - g_6 = 0, \tag{23a}$$

$$q_1 \frac{Py}{P_I} - q_2 \varepsilon (1 - \frac{E}{\bar{E}}) + q_6 - \frac{Q}{P_I} = 0, \tag{23b}$$

$$u(ny - \tilde{N}) - \frac{\dot{P}}{P} = 0, \tag{23c}$$

$$-t_1 \frac{Py}{P_I} + t_3 \frac{E}{P_I} - t_4 \frac{P}{P_I} + t_6 - \frac{E}{P_I} \dot{F} = 0. \tag{23d}$$

Equation (23c) which determines the rate of inflation of the price of the home good is obtained by substituting equations (9) and (11) into equation (6).

The Stationary State Effects

As before it is useful to begin the analysis of the effects of intervention policy by describing the stationary state effects. In a stationary state the rate of inflation is zero, and the exchange rate is expected to remain unchanged:

$$\frac{\dot{P}}{P} = e = 0. \tag{24}$$

Imposing these restrictions on the four equations (23) after eliminating P_I using equation (1) yields four equations which are sufficient to determine the stationary state equilibrium values $\bar{y}$, $\bar{P}$, $\bar{E}$, and $\bar{\dot{F}}$ given $\bar{Q}$. These four equations actually describe a pseudo stationary state equilibrium since wealth continues to change because $\bar{\dot{F}}$ is not equal to zero, but in what follows the equilibrium is referred to as a stationary state for convenience. The four equations which describe stationary state equilibrium are homogenous of degree zero in the three nominal variables $\bar{P}$, $\bar{E}$, and $\bar{Q}$, and $\bar{Q}$ is the only exogenous nominal variable. So, if $\bar{Q}$ increases, $\bar{P}$ and $\bar{E}$ must increase by the same proportion, and $\bar{y}$ and $\bar{\dot{F}}$ must remain unchanged:

$$\hat{\bar{P}} = \hat{\bar{E}} = \hat{\bar{Q}}, \tag{25a}$$

$$\hat{\bar{y}} = \hat{\bar{\dot{F}}} = 0. \tag{25b}$$

The Impact Effects

The impact effects of a purchase of foreign money by the authorities on the exchange rate and physical output are shown in Figure 5 which is constructed using equations (23a) and (23b) with P_I eliminated through equation (1). The G_0G_0 schedule shows the pairs of the exchange rate and output which are compatible with equilibrium in the market for the home good. The Q_0Q_0 schedule shows the pairs of the exchange rate and output which are compatible with equilibrium in the home money market.

The GG schedule is upward-sloping. An increase in output creates an excess supply of goods. This excess supply must be offset by a depreciation of the home currency which raises demand if the market for the home good is to remain in equilibrium. A depreciation raises demand for two reasons: (1) it reduces real income; and (2) it raises the ratio of the exchange rate to the price index and lowers the ratio of the price of the domestic good to the price index. The equation of the GG schedule is obtained by differentiating equation (23a) in the neighborhood of stationary equilibrium to obtain

$$- g_1\bar{y}\hat{y} + g\hat{E} - g\hat{P} = 0. \tag{26}$$

The slope of the GG schedule may be greater than or less than one. The special case in which the slope of the GG schedule is exactly equal to one is shown in Figure 5.

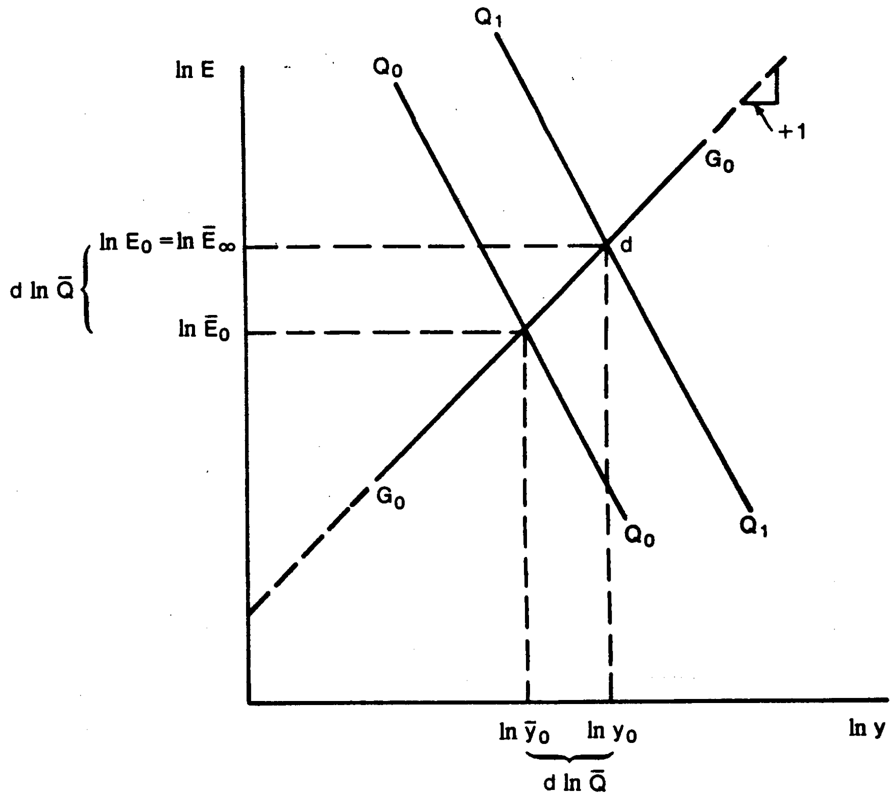


FIGURE 5

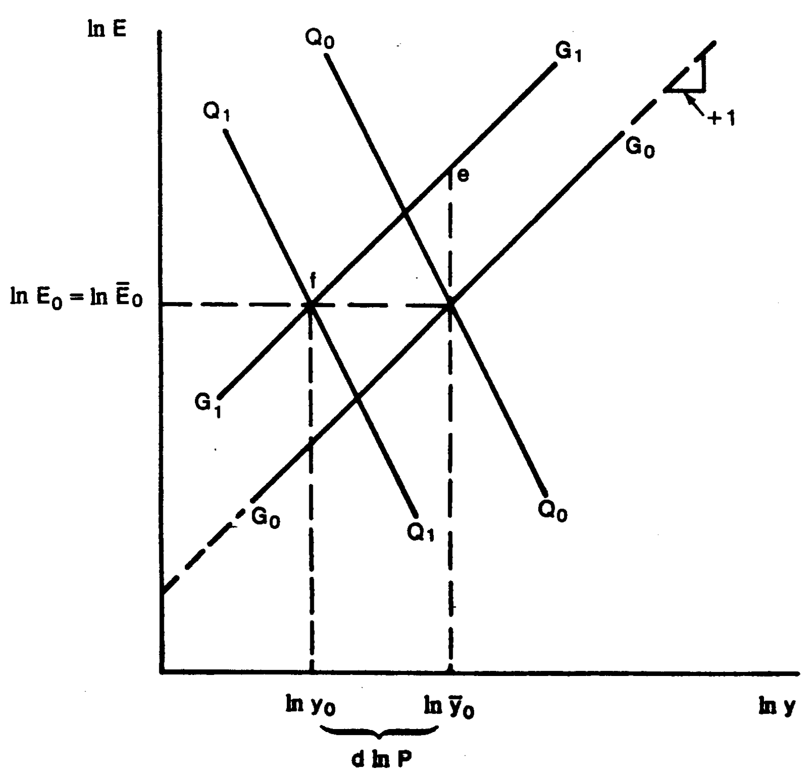


FIGURE 6

The QQ schedule is downward-sloping. An increase in output creates an excess demand for money. This excess demand must be offset by an appreciation of the home currency if the market for home money is to remain in equilibrium. An appreciation reduces excess money demand for two reasons: (1) it lowers the price index, and (2) it induces money holders to expect a depreciation of the home currency. The equation of the QQ schedule is derived by differentiating equation (24a) in the neighborhood of stationary equilibrium and taking account of the fact that $\hat{\bar{E}} = \hat{\bar{Q}}$ to obtain

$$q_1\bar{y}\hat{y} + [(\bar{Q} - q_1\bar{y})k_2 + q_5\epsilon]\hat{E} - (\bar{Q} + q_5\epsilon)\hat{\bar{Q}} + [(\bar{Q} - q_1\bar{y})k_1 + q_1\bar{y}]\hat{P} = 0. \quad (27)$$

A purchase of foreign money by the home authorities shifts the QQ schedule up to Q_1Q_1. The Q_1Q_1 schedule must intersect the dashed line which has a slope of positive one in Figure 5 at or above point d. Point d corresponds to proportionate increases in E and y equal to the proportionate increase in $\bar{Q}$ $(\hat{E} = \hat{y} = \hat{\bar{Q}})$. Equiproportionate changes in E, y, and $\bar{Q}$ leave the expected rate of depreciation unchanged and raise real balances and real income by the same percentage. If the real income elasticity of the demand for money is less than one, equal percentage increases in real balances and real income give rise to an excess supply of money. Thus, if equilibrium were to be established with equal percentage increases in E and y following an exchange market intervention which increases $\bar{Q}$, the percentage changes in E and y would have to exceed the percentage change in $\bar{Q}$. The special case in which the real income elasticity of demand for real balances is exactly equal to one so that Q_1Q_1 intersects the dashed line at point d is shown in Figure 5.

The impact effects on E and y are shown by the intersection of Q_1Q_1 and G_0G_0. The home currency depreciates, and the exchange rate may overshoot or undershoot its stationary equilibrium value.[22] Physical output rises, and the proportionate increase in output may exceed or fall short of the proportionate increase in the home money supply.[23] The special case in which $\hat{E} = \hat{\bar{E}} = \hat{\bar{Q}}$ and $\hat{y} = \hat{\bar{Q}}$ is shown in Figure 5. If the GG schedule were steeper (flatter) than one, the exchange rate would overshoot (undershoot), and the proportionate increase output would fall short of (exceed) the proportionate increase in the home money supply. If the real income elasticity of the demand for real balances were less than one, the exchange rate would overshoot and $\hat{y}$ would exceed $\hat{\bar{Q}}$. In general, the steeper the GG schedule and the lower the real income elasticity of the demand for real balances, the more likely it is that the exchange rate will overshoot; the flatter the GG schedule and the lower the real income elasticity of the demand for real balances, the more likely it is that $\hat{y}$ will exceed $\hat{\bar{Q}}$.

The Adjustment Process

In order to lay a foundation for a discussion of the adjustment process it is useful to derive two additional relationships. The changes in the exchange rate and physical output which are required in order to clear the markets for the home good and home money when the price of the home good changes are shown in Figure 6. An increase in the price of the home good shifts the GG schedule up to G_1G_1. A rise in P creates an excess supply of the home good for two reasons: (1) it raises real income; and (2) it lowers the ratio of E to P_I and raises the ratio of P to P_I. In order to offset this excess supply so that the market for the home good remains in equilibrium, the home currency must depreciate for a given value of output. G_1G_1 must intersect the vertical dashed lined at point e which corresponds to a proportionate increase in E equal to the proportionate increase in P since equiproportionate increases in P and E with y held constant leave the goods market in equilibrium. A rise in the price of the home good shifts the QQ schedule to the left to Q_1Q_1. An increase in P creates an excess demand for real balances because it lowers real balances and raises real income. In order to offset this excess demand for real balances so that the market for home money remains in equilibrium, output must fall for a given value of the exchange rate. Q_1Q_1 must intersect the horizontal dashed line at or to the left of point f which corresponds to a proportionate decrease in y equal to the proportionate increase in P. If y decreases by the same proportion as P increases, real balances and real income fall by the same proportion. If the real income elasticity of the demand for real balances is less than one, equal percentage decreases in real balances and real income give rise to an excess demand for money. Thus, when the real income elasticity of demand for real balances is less than one, the percentage decrease in y must exceed the percentage increase in P if the market for the home good is to remain in equilibrium; that is, Q_1Q_1 must cut the horizontal dashed line to the left of f. The special case in which the real income elasticity is equal to one so that Q_1Q_1 passes through point f is shown in Figure 6.

The new equilibrium values of E and y are given by the intersection of G_1G_1 and Q_1Q_1. The home currency may depreciate or appreciate.[24/] Real output must fall, and the absolute value of the proportionate decrease in y may exceed or fall short of the proportionate increase in P.[25/] In the special case shown in Figure 6 the GG schedule has a slope of one and the real income elasticity of the demand for real balances is equal to one. In this case $\hat{E} = 0$ and $\hat{y} = -\hat{P}$. If the GG schedule were steeper (flatter) than one, the home currency would appreciate (depreciate), and the absolute value of the proportionate decrease in output would be less than (exceed) the proportionate rise in the price of the home good. If the real income elasticity of the demand for real balances were less than one, the exchange rate would appreciate and the absolute value of $\hat{y}$ would exceed $\hat{P}$. In general, the steeper the GG schedule and the lower the real income elasticity of demand for real balances, the more likely it is that $\hat{E}$ will be negative; the flatter the GG schedule and the lower the real income elasticity of the demand for real balances, the more likely it is that the absolute value of $\hat{y}$ will exceed $\hat{P}$. It is important to observe that the conditions under which an increase in Q causes E to overshoot its stationary equilibrium value are exactly the same as the conditions under which an increase in P causes E to fall.[26/]

The adjustment process for the system following the exchange market intervention is shown in Figure 7. The downward-sloping GQ_0GQ_0 schedule shows the pairs of E and P which are compatible with equilibrium in both the market for the home good and the market for home money before the exchange market intervention. Although the GQGQ schedule has been drawn with a negative slope in Figure 7, it follows from the analysis above that the slope of this

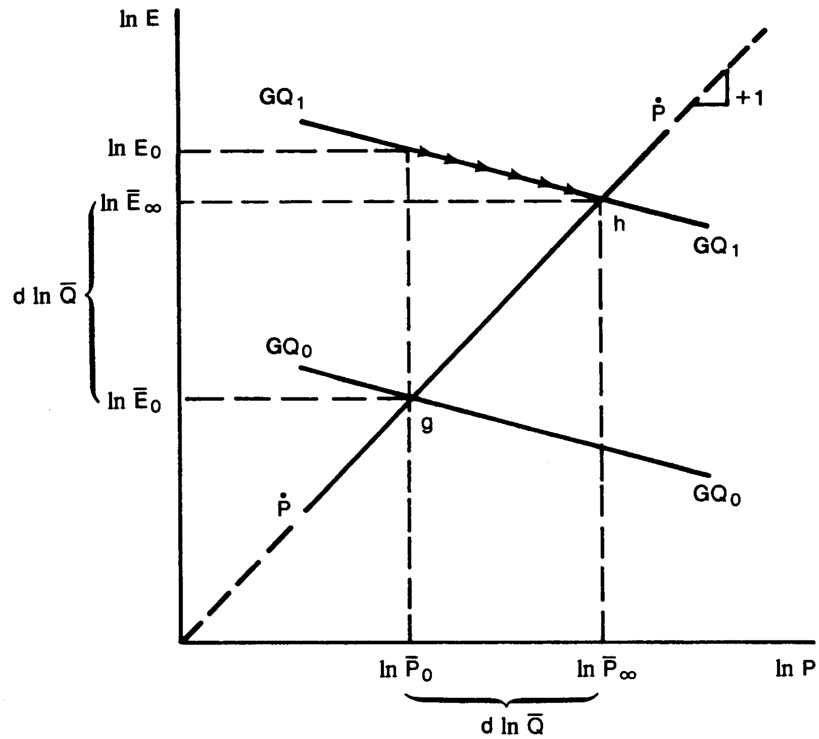


FIGURE 7

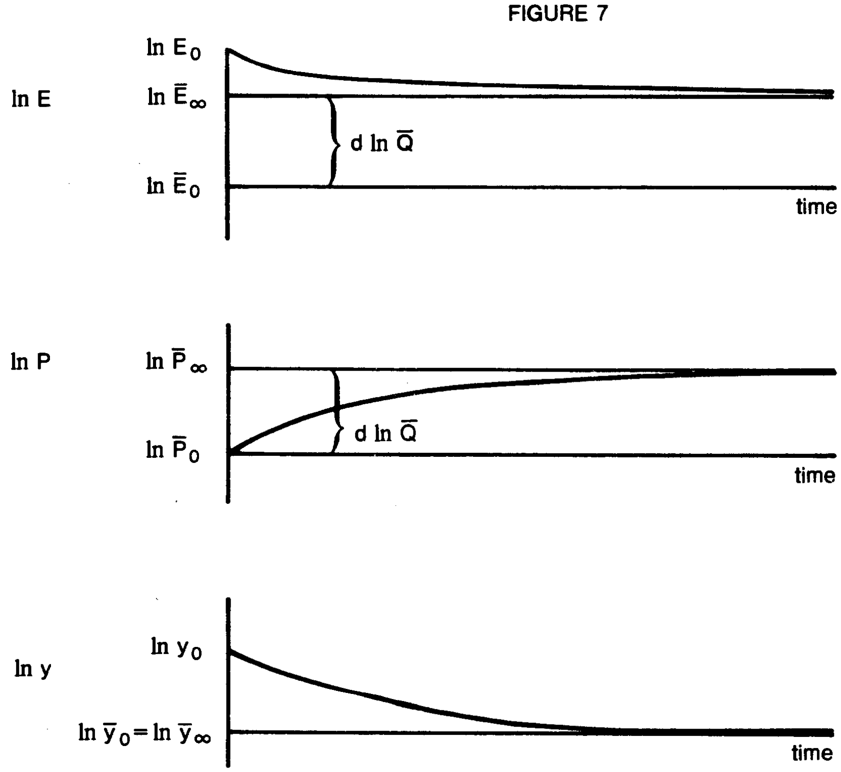


FIGURE 8

schedule may be positive. What happens when GQGQ has a positive slope is discussed at the end of this section.

The $\dot{P}\dot{P}$ schedule shows the pairs of E and P which are compatible both with equilibrium in the market for the home good and with zero inflation. It has a slope of positive one because equiproportionate changes in E and P leave the market for the home good in equilibrium at an unchanged value of physical output and, therefore, lead to no change in the rate of inflation. To the left of (the right of) the $\dot{P}\dot{P}$ schedule the rate of inflation is positive (negative). For any given value of the exchange rate a fall in the price of the home good raises the value of physical output which clears the goods market. This increase in output raises the rate of inflation because it increases the demand for labor.[27/]

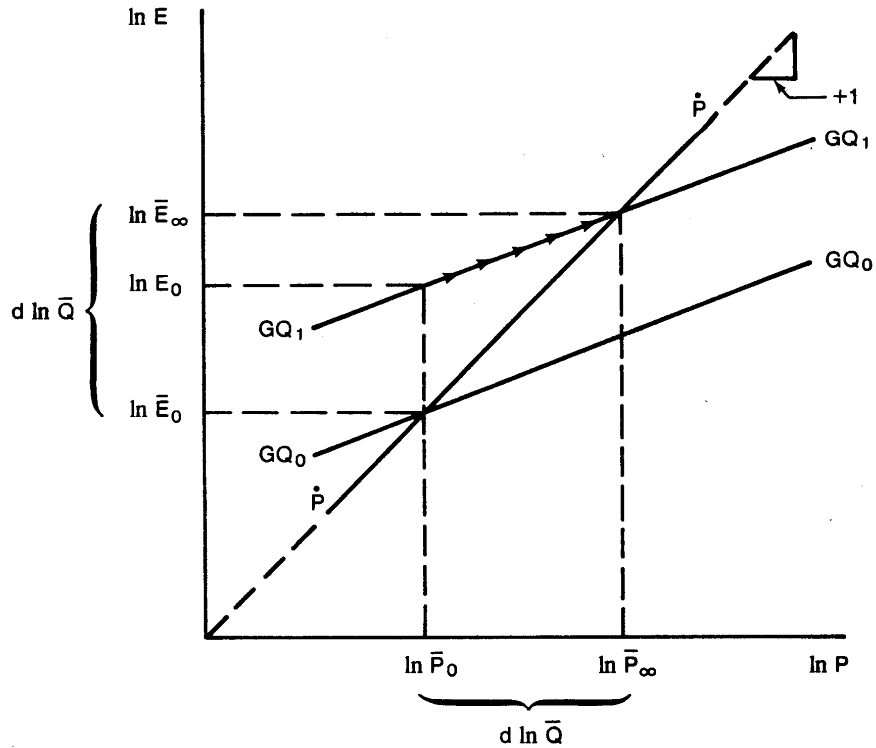
Just before the exchange market intervention the economy is at point g in Figure 7 with a price level of $\bar{P}_0$ and with the exchange rate at $\bar{E}_0$. The exchange market intervention shifts the GQGQ schedule up to GQ_1GQ_1. It has been established above that, given P, E must rise when $\bar{Q}$ rises if both the goods and money markets are to remain in equilibrium.

From the analysis of the stationary state effects of the intervention policy, it follows that the exchange market intervention must shift the GQGQ schedule in such a way that it intersects the $\dot{P}\dot{P}$ schedule, which is unaffected by the increase in $\bar{Q}$, at point h. This point represents proportionate increases in P and E equal to the proportionate increase in $\bar{Q}$. The new stationary values of P and E are represented by $\bar{P}_\infty$ and $\bar{E}_\infty$.

Given the price level, the exchange rate at any time must be that one which is compatible with equilibrium in the markets for the home good and home money. Thus at the moment of the exchange market intervention the exchange rate jumps from $\overline{E}_0$ to E_0, the value of the exchange rate on the GQ_1GQ_1 schedule which corresponds to $\overline{P}_0$. As has been established above the exchange rate overshoots its stationary equilibrium value when the GQGQ schedule is downward sloping. Since the point corresponding to the pair $(E_0, \overline{P}_0)$ lies to the left of $\dot{P}\dot{P}$, the inflation rate is positive. The economy moves downward along GQ_1GQ_1 until the new stationary equilibrium pair $(\overline{E}_\infty, \overline{P}_\infty)$ is reached. After its initial jump up, the home currency appreciates steadily from E_0 to $\overline{E}_\infty$, and the price level rises steadily from $\overline{P}_0$ to $\overline{P}_\infty$.

The time paths of the three endogenous variables are shown in Figure 8. The time paths of E and P have already been discussed. It has been demonstrated above that y increases initially. Since increases in P cause decreases in y, physical output declines steadily back to its unchanged stationary value.

If the GQGQ schedule has a positive slope as in Figure 9, the exchange rate rises but undershoots its stationary equilibrium value as a result of an exchange market intervention. Since the slope of the GQGQ schedule must be less than one, the inflation rate becomes positive. The economy moves upward along its new GQGQ schedule until the new stationary equilibrium exchange rate and price level are reached. After its initial jump up, the exchange rate continues to rise, as the price level rises. Output rises initially and then declines steadily back to its unchanged stationary value.



ln E
ln $\bar{E}_\infty$
ln E_0
ln $\bar{E}_0$
d ln $\bar{Q}$
GQ_1
GQ_0
$\dot{P}$
+1
ln $\bar{P}_0$
ln $\bar{P}_\infty$
ln P

FIGURE 9

V. The Effects of Intervention Policy When Both the Trade Surplus and Slow Price Adjustment Affect the Adjustment Path of the Economy

The Conditions for Momentary Equilibrium

When both the trade surplus and slow price adjustment affect the path of the economy, the conditions for momentary equilibrium are

$$-g_1 \frac{Py}{P_I} + g_2 \frac{Q + EF}{P_I} + g_3 \frac{E}{P_I} - g_4 \frac{P}{P_I} - g_6 = 0, \tag{28a}$$

$$q_1 \frac{Py}{P_I} + q_2 \frac{Q + EF}{P_I} - q_5 \epsilon (1 - \frac{E}{\bar{E}}) + q_6 - \frac{Q}{P_I} = 0, \tag{28b}$$

$$u(ny - \tilde{N}) - \frac{\dot{P}}{P} = 0, \tag{28c}$$

$$-t_1 \frac{Py}{P_I} - t_2 \frac{Q + EF}{P_I} + t_3 \frac{E}{P_I} - t_4 \frac{P}{P_I} + t_6 - \frac{E}{P_I} \dot{F} = 0. \tag{28d}$$

These conditions are identical to the conditions for momentary equilibrium in the version of Section IV except that the excess demand for the home good, the excess demand for home money, and the trade surplus all depend on real wealth.

The Stationary State Effects

Once again it is useful to begin the analysis of the effects of intervention policy by describing the stationary state effects. In a stationary state no variable is changing and no variable is expected to change, so

$$\dot{F} = \frac{\dot{P}}{P} = e = 0. \tag{29}$$

Imposing these restrictions on the four equations (28) after eliminating P_I using equation (1) yields four equations which are sufficient to determine $\overline{P}$, $\overline{E}$, $\overline{y}$, and $\overline{F}$ given $\overline{Q}$. The system of equations obtained by imposing the stationary state restrictions (29) on equations (28) is homogenous of degree zero in the three nominal variables $\overline{P}$, $\overline{E}$, and $\overline{Q}$, and $\overline{Q}$ is the only exogenous nominal variable. So, if $\overline{Q}$ increases, $\overline{P}$ and $\overline{E}$ must increase by the same proportion, and $\overline{y}$ and $\overline{F}$ must remain unchanged:

$$\hat{\overline{P}} = \hat{\overline{E}} = \hat{\overline{Q}}, \tag{30a}$$

$$\hat{\overline{y}} = \hat{\overline{F}} = 0. \tag{30b}$$

The Impact Effects

The impact effects of a purchase of foreign money by the authorities on the exchange rate and output are shown in Figure 10 which is constructed using equations (28a) and (28b) with P_I eliminated through equation (1). The G_0G_0 schedule shows the pairs of the exchange rate and physical output which are compatible with equilibrium in the market for the home good. The Q_0Q_0 schedule shows the pairs of E and y which are compatible with equilibrium in the market for home money.

The GG schedule is upward-sloping given the assumption of Section III that a depreciation of the home currency raises demand for the home good. An increase in output creates an excess supply of the home good, so the home currency must depreciate in order to increase demand if the market for the home good is to remain in equilibrium. The slope of the GG schedule

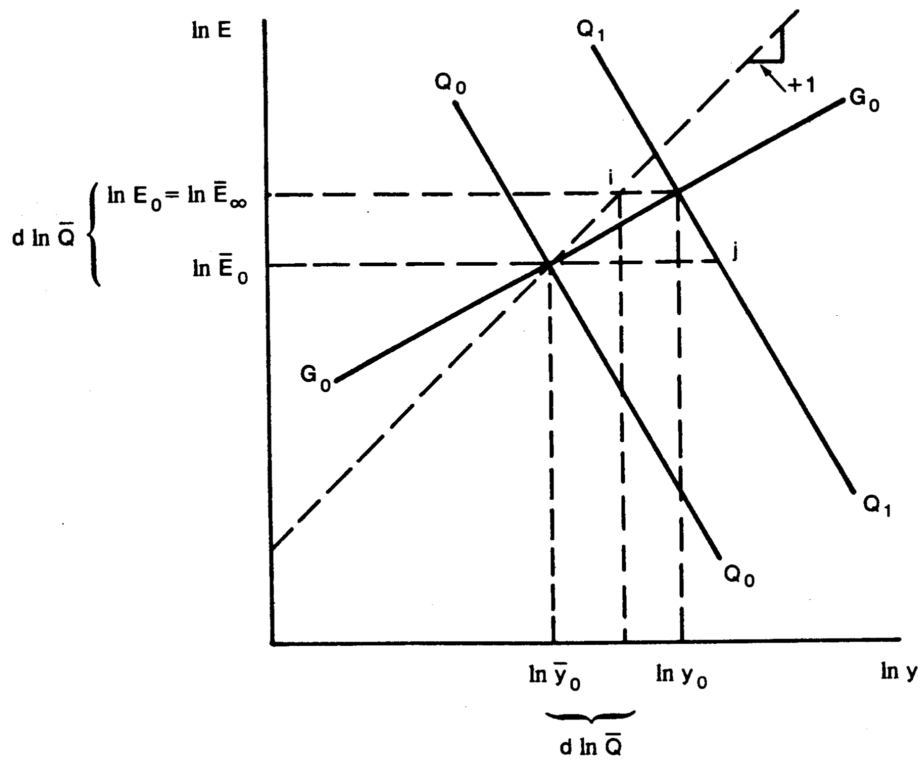

ln E
Q_1
Q_0
+1
G_0
i
$\ln E_0 = \ln \bar{\bar{E}}_\infty$
d ln $\bar{Q}$
j
ln $\bar{E}_0$
G_0
Q_1
Q_0
ln $\bar{y}_0$
ln y_0
ln y
d ln $\bar{Q}$

FIGURE 10

may be less than one as it is in Figure 10 or greater than one. An increase in the effect of changes in real wealth on excess demand for the home good (a rise in g_2) may lower or raise the slope of the GG schedule; the slope of the GG schedule is decreased (increased) when g_2 rises if f is greater than (less than) k_2 since a depreciation of the home currency raises (lowers) real wealth. The equation of the GG schedule is derived by differentiating equation (28a) in the neighborhood of stationary state equilibrium to obtain

$$-g_1\bar{y}\hat{y} + [g + g_2\bar{A}(\bar{f} - \bar{k}_2)]\hat{E} + g_2\bar{A}\,\bar{q}\,\hat{Q} + g_2\bar{A}\,\bar{f}\hat{F} - (g + g_2\bar{A}k_1)\hat{P} = 0. \qquad (31)$$

The QQ schedule is downward-sloping given the assumption of Section III that the sum of the real income and real wealth elasticities of the demand for money is less than one ($q_1\bar{y} + q_2\bar{A} < \bar{Q}$). Under this assumption a depreciation of the home currency raises the excess demand for home money. The QQ schedule has a negative slope because an increase in real output creates excess demand for home money, so the home currency must appreciate in order to reduce the demand for money if the market for home money is to remain in equilibrium. An increase in the effect of changes in real wealth on the excess demand for home money (a rise in q_2) may cause the QQ schedule to become flatter or steeper; the QQ schedule becomes flatter (steeper) when f is greater than (less than) k_2 since a depreciation of the home currency raises (lowers) real wealth. The equation of the QQ schedule is derived by differentiating (28b) in the neighborhood of stationary equilibrium and recognizing that $\hat{E} = \hat{Q}$ to obtain

$$q_1\bar{y}\hat{y} + [(\bar{Q} - q_1\bar{y} - q_2\bar{A})k_2 + q_2\bar{A}\ \bar{f} + q_5\epsilon]\hat{E}$$

$$+ (q_2\bar{A}\ \bar{q} - \bar{Q} - q_5\epsilon)\hat{Q} + q_2Af\hat{F} + [(\bar{Q} - q_1\bar{y} - q_2\bar{A})k_1 + q_1\bar{y}]\hat{P} = 0. \qquad (32)$$

A purchase of foreign money by the home authorities $(\bar{q}\ \hat{Q} + \bar{f}\hat{F} = 0)$ shifts the QQ schedule up to Q_1Q_1. The QQ schedule must shift farther than point i along the dashed line which has a slope of positive one in Figure 10. Point i is the point which corresponds to increases in E and y by the same proportion as the increase in $\bar{Q}$ $(\hat{E} = \hat{y} = \hat{Q})$. Equiproportionate increases in E, y, and $\bar{Q}$ raise real balances and real income by the same proportion. These changes raise (lower) real wealth if f is greater than (less than) k_2. However, even if these changes raise real wealth, they increase it by a smaller proportion than real balances and real income are increased since only the foreign money component of nominal wealth is increased by increases in E. Thus, equiproportionate changes in E, y, and $\bar{Q}$ give rise to a excess supply of real balances since it has been assumed that the sum of the real income and real wealth elasticities of demand for real balances is less than (or, in the extreme, equal to) one. If equilibrium in the market for home money were to be established with equal percentage changes in E and y following an exchange market intervention which raises $\bar{Q}$, the percentage increases in E and y would have to exceed the percentage change in $\bar{Q}$.

The impact effects on E and y are shown by the intersection of Q_1Q_1 and G_0G_0. Both E and y definitely increase.28/29/ E may overshoot or undershoot its stationary equilibrium level; a borderline case in which E rises only as much as is necessary to reach its new stationary equilibrium level is shown in Figure 10. Note that since Q_1Q_1 must intersect the dashed line with a slope of positive one to the right of point i, the exchange rate may overshoot even if the slope of the GG schedule is less than one. The percentage increase in y may be greater than or less than the percentage change in $\overline{Q}$. If E undershoots $\hat{y}$ definitely exceeds $\hat{\overline{Q}}$; if E overshoots $\hat{y}$ may be greater than or less than $\hat{\overline{Q}}$.

Since the only difference between this version of the model and the one of Section IV is the presence of wealth effects in the market for the home good and the market for home money, it is important to investigate how changes in these wealth effects alter the impact effects of intervention policy. An increase in g_2 causes the GG schedule to become flatter (steeper) if f is greater than (less than) k_2 and therefore makes it more likely that the exchange rate will undershoot (overshoot) and that $\hat{y}$ will be greater than (less than) $\hat{\overline{Q}}$. An increase in q_2 causes the Q_1Q_1 schedule to rotate around point j which corresponds to the old equilibrium exchange rate, $\overline{E}_0$, since the real income elasticity of the demand for real balances remains unchanged. An increase in q_2 causes the QQ schedule to become flatter (steeper) if f is greater than (less than) k_2 and therefore makes it more likely that the exchange rate will undershoot (overshoot) and that $\hat{y}$ will be less than (greater than) $\hat{\overline{Q}}$.30/

The Adjustment Process

In order to lay a foundation for a discussion of the adjustment process it is useful to derive four additional relationships. The changes in the exchange rate and real output which are required in order to clear the market for the home good and home money when the price of the home good changes are shown in Figure 11. An increase in P shifts the GG schedule to the left to G_1G_1. A rise in P decreases excess demand for the home good, so, for a given value of E, y must fall if the goods market is to remain in equilibrium. A rise in P also shifts the QQ schedule to the left to Q_1Q_1. A rise in P creates an excess demand for home money, so, for a given value of E, y must fall if the money market is to remain in equilibrium. The new equilibrium values of E and y are given by the intersection of G_1G_1 and Q_1Q_1.[31] E may rise or fall; the borderline case in which E remains unchanged is shown in Figure 11. y definitely falls. The larger g_2, the more GG shifts to the left; the larger q_2, the less QQ shifts to the left. Therefore, the larger g_2 and q_2, the more likely it is that E will rise. E is more likely to rise when P rises in the version of this Section than in that of Section IV in which $g_2 = q_2 = 0$.

The changes in the exchange rate and real output which are required to clear the markets for the home good and home money when home residents' holdings of foreign money change are shown in Figure 12. An increase in F shifts the GG schedule down to G_1G_1. A rise in F raises the demand for

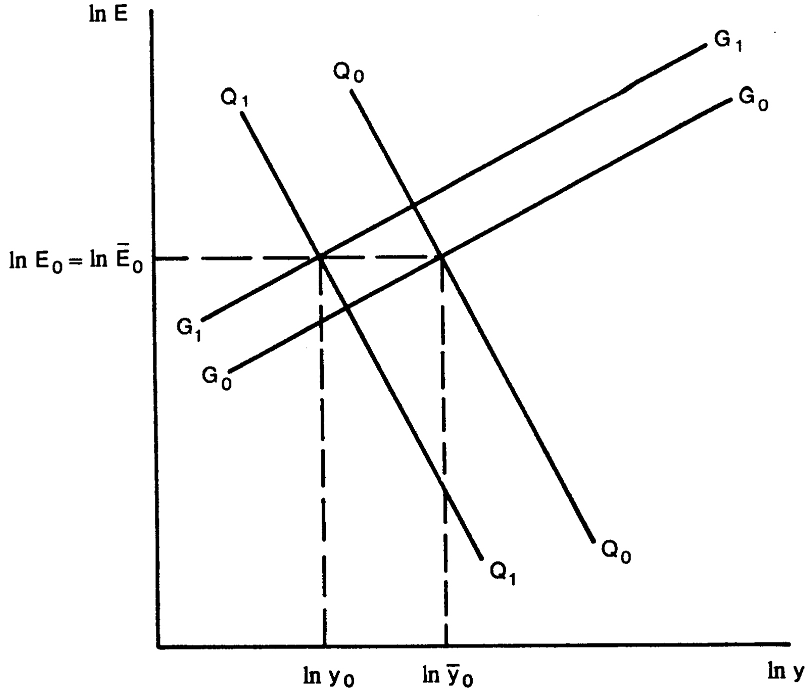


FIGURE 11

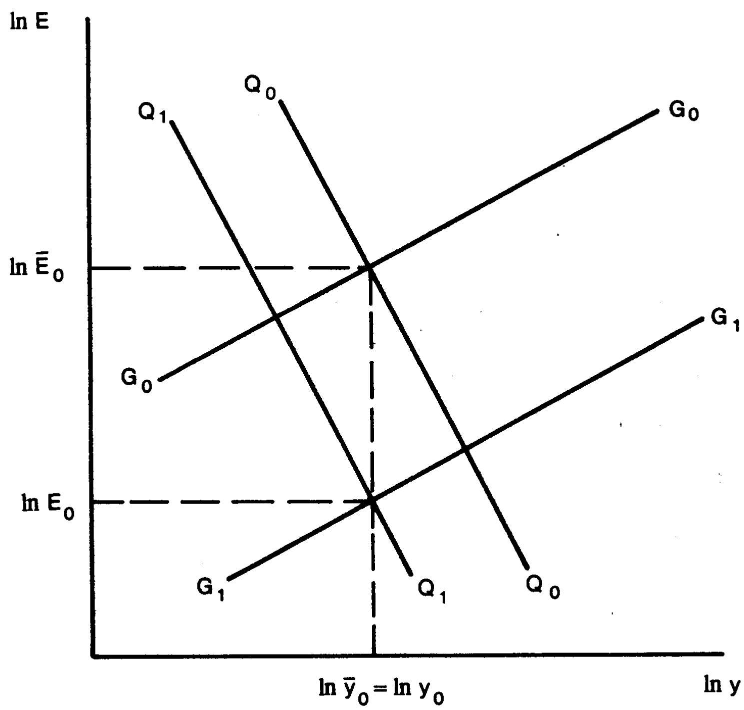


FIGURE 12

the home good, so, for a given value of y, E must fall if the market for the home good is to remain in equilibrium. An increase in F also shifts the QQ schedule down to Q_1Q_1. A rise in F creates an excess demand for home money, so, for a given value of y, E must fall if the market for home money is to remain in equilibrium. The new equilibrium values of E and y are given by the intersection of G_1G_1 and Q_1Q_1.[32/] E definitely falls. y may rise or fall; a borderline case in which y remains unchanged is shown in Figure 12. The larger are g_2 and q_2, the larger the appreciation in the home currency since both the GG and QQ schedules shift down farther.

The adjustment process for the system following the exchange market intervention is described by the two differential equations (28c) and (28d) which are reproduced here for convenience:

$$\frac{\dot{P}}{P} = u(ny - \tilde{N}), \tag{28c}$$

$$\frac{E}{P_I}\dot{F} = - t_1 \frac{Py}{P_I} - t_2 \frac{Q + EF}{P_I} + t_3 \frac{E}{P_I} - t_4 \frac{E}{P_I} + t_6. \tag{28d}$$

Linearizing these equations in the neighborhood of stationary equilibrium after eliminating P_I through (1) yields:

$$\dot{P} = un\bar{y}\hat{y}, \tag{33a}$$

$$\dot{F} = -t_1\bar{y}\hat{y} + [t - t_2\bar{A}(\bar{f} - k_2)]\hat{E} - [t - t_2\bar{A}k_1]\hat{P} - t_2\bar{A}\ \bar{f}\hat{F}. \tag{33b}$$

It has been shown above that $\hat{E}$ and $\hat{y}$ depend on $\hat{P}$ and $\hat{F}$.[33] Substituting for $\hat{E}$ and $\hat{y}$ using these relationships transforms equations (33) into

$$\dot{P} = B_{11}\hat{P} + B_{12}\hat{F}, \tag{34a}$$

$$\dot{F} = B_{21}\hat{P} + B_{22}\hat{F}, \tag{34b}$$

$$B_{11} = \frac{1}{\Delta_3} un\bar{y}[(g_1\bar{y}k_2 + C_1)C_2 - q_2\bar{A}\,\bar{q} + g_2\bar{A}k_1C_3 - \bar{A}\,\bar{q}\,\bar{y}k_2C_4] < 0,$$

$$B_{12} = \frac{1}{\Delta_3} un\bar{y}[-g_2C_5 + \bar{y}k_2C_4 + q_2C_1]\bar{A}\,\bar{f} \gtrless 0,$$

$$B_{21} = \frac{1}{\Delta_3}[s_1C_1C_2 - \bar{A}\,\bar{q}C_1C_6 - m_1s_2k_1\bar{A}C_3]\bar{y} \gtrless 0,$$

$$B_{22} = \frac{1}{\Delta_3}[C_1C_6 + m_1s_2C_5]\bar{A}\,\bar{f}\,\bar{y} < 0,$$

$$\Delta_3 = -g_1\bar{y}C_5 - \bar{A}\,\bar{y}(\bar{f} - k_2)C_4 - q_1\bar{y}C_1 < 0,$$

$$C_1 = g_3k_1 + g_4k_2 = t_3k_1 + t_4k_2,$$

$$C_2 = \bar{Q} + q_5\varepsilon,$$

$$C_3 = \bar{Q}\,\bar{f} + q_5\varepsilon,$$

$$C_4 = g_1q_2 + g_2q_1,$$

$$C_5 = \bar{Q}k_2 + q_5\varepsilon,$$

$$C_6 = s_1q_2 + s_2q_1.$$

The adjustment process is definitely stable since the trace of the matrix of coefficients of the pair of differential equations (34) is negative,[34/]

$$B_{11} + B_{22} < 0, \tag{35}$$

and the determinant is positive,[35/]

$$B_{11}B_{22} - B_{12}B_{21} = -\frac{1}{\Delta_3}un\bar{y}\,\bar{A}\,\bar{f}(s_2C_1 + m_1s_2\bar{y}k_2)(\bar{Q} + q_5\varepsilon) > 0. \tag{36}$$

Given that two out of the four coefficients in the dynamic system have ambiguous signs, it is not surprising that it is not possible to make unambiguous statements about the path followed by the system to stationary equilibrium. The adjustment path may be non-cyclical or cyclical. Each of these possibilities can be illustrated with a special case of system (34).

First, a case in which the adjustment path is non-cyclical is considered. If s_1 is large enough, B_{12} and B_{21} are both negative. Under this assumption the adjustment paths for P and F can be analyzed using the phase diagram shown in Figure 13. The $\dot{P}\dot{P}$ schedule shows the pairs of P and F which are consistent with zero inflation. It must be downward sloping since B_{11} and B_{12} are both negative:

$$\left.\frac{\hat{P}}{\hat{F}}\right|_{\dot{P}\dot{P}} = -\frac{B_{12}}{B_{11}} < 0. \tag{37}$$

The $\dot{F}\dot{F}$ schedule shows the pairs of P and F which are consistent with zero foreign money accumulation. This schedule must also be downward sloping since B_{21} and B_{22} are both negative:

$$\left.\frac{\hat{P}}{\hat{F}}\right|_{\dot{F}\dot{F}} = -\frac{B_{22}}{B_{21}} < 0. \tag{38}$$

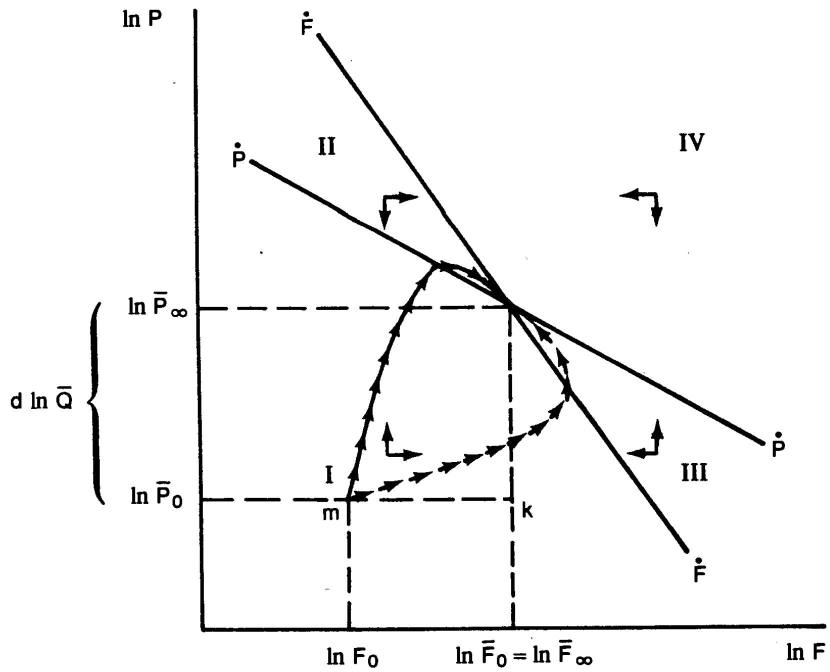


FIGURE 13

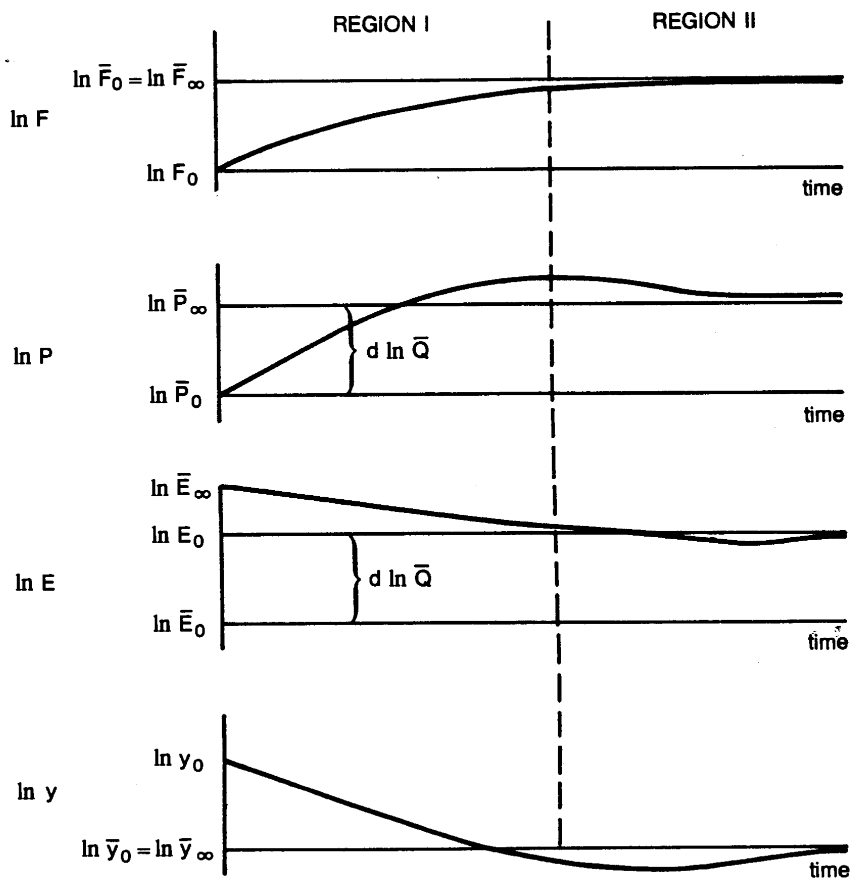


FIGURE 14

The $\dot{\dot{P}}\dot{\dot{P}}$ schedule must be flatter than the $\dot{\dot{F}}\dot{\dot{F}}$ schedule as shown in Figure 13 since $B_{11}B_{22} - B_{12}B_{21}$ is positive:

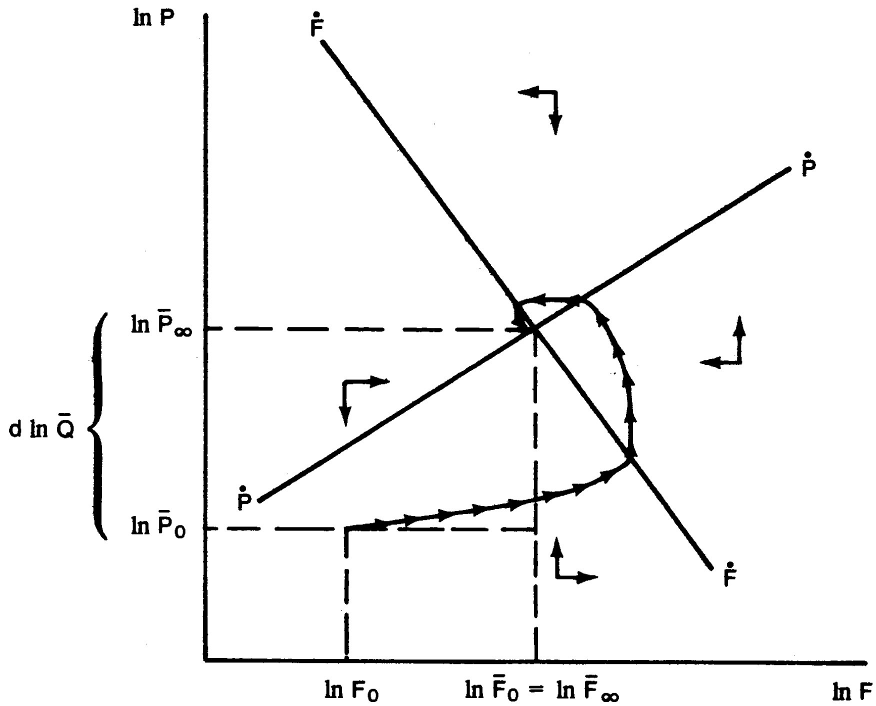
$$\left.\frac{\hat{P}}{\hat{F}}\right|_{\dot{\dot{P}}\dot{\dot{P}}} - \left.\frac{\hat{P}}{\hat{F}}\right|_{\dot{\dot{F}}\dot{\dot{F}}} = \frac{1}{B_{11}B_{21}}(B_{11}B_{22} - B_{12}B_{21}) > 0. \qquad (39)$$

Just before the exchange market intervention the economy is at point k. From the analysis of the stationary equilibrium effects it follows that in the new stationary state F is unchanged ($\bar{F}_0 = \bar{F}_\infty$), and P rises by the same proportion as the increase in $\bar{Q}$. Initially the exchange market intervention moves the economy to point m; F is reduced from $\bar{F}_0$ to F_0, and P remains unchanged at $\bar{P}_0$. Both P and F rise during the early phase of adjustment while the economy is in Region I. Eventually the economy moves into either Region II (solid path) or Region IV (dashed path) in which P and F move in opposite directions and proceeds directly to the new stationary equilibrium. The adjustment paths for P and F for the case in which the economy moves into Region II are shown in Figure 14.

The adjustment paths for E and y must possess two properties in the case in which s_1 is large. First, since in this case increases in P and F reduce both E and y during the adjustment process $(\frac{\hat{E}}{\hat{P}}, \frac{\hat{E}}{\hat{F}}, \frac{\hat{y}}{\hat{P}}, \frac{\hat{y}}{\hat{F}} < 0)$, both E and y fall while the economy is in Region I.[36/] Second, E and y continue to fall for a time after the economy enters Region II or Region IV. These properties are displayed by the adjustment paths for E and y shown in Figure 14 which is constructed on the assumption that the economy moves into Region II.

Some of the other properties of the paths for E and y in Figure 14 are possible but not necessary consequences of the assumption that the economy moves into Region II. In Figure 14 E overshoots, and both E and y first fall below their new stationary equilibrium values and then rise back up to these values. It is also possible when E overshoots that the adjustment of both E and y to their stationary equilibrium values is monotonic. Another possibility is that E may undershoot in which case the paths for E and y have the same general shapes as the paths in Figure 14. It is a necessary consequence of the assumption that the economy moves into Region II that if both E and y increase for a time at the end of the adjustment process, y must begin to increase before E begins to increase.[37/]

Now a case in which the adjustment process is cyclical is considered. If q_2 is large enough, B_{12} is negative, and B_{21} is positive. Under this assumption the adjustment paths for P and F can be analyzed using the phase diagram shown in Figure 15. The $\dot{F}\dot{F}$ schedule is downward-sloping, but the $\dot{P}\dot{P}$ schedule is upward-sloping in this case. When the two schedules have slopes of the opposite sign, the approaches of P and F to stationary equilibrium may be cyclical as in Figure 15. If the paths of P and F are cyclical, there must be cycles in the adjustment paths of both the exchange rate and output.



ln P
$\dot{F}$
$\dot{P}$
ln $\bar{P}_\infty$
d ln $\bar{Q}$
ln $\bar{P}_0$
$\dot{P}$
$\dot{F}$
ln F_0
ln $\bar{F}_0$ = ln $\bar{F}_\infty$
ln F

FIGURE 15

VI. Concluding Remarks

The analysis of the dynamic behavior of open economies under managed floating exchange rates is still in its early stages. This paper is an attempt to consolidate some of the gains that have been made and to build upon them by considering the dynamic effects of one type of intervention policy in three versions of a single model. The three versions of the model are designed to highlight two reasons why the exchange rate may not attain its new long-run equilibrium value immediately after a shock to the economy: wealth effects and slow price adjustment.

It has been shown that robust conclusions can be drawn regarding the impact effects of a purchase of foreign money with home money by the authorities. The home currency depreciates and home nominal income rises. The price of the home good rises if it is flexible and output is always at its full employment level; home output rises if the price of the home good adjusts slowly when the demand for the home good exceeds normal supply.

The exchange rate definitely overshoots its new long-run value in the first version of the model; it may overshoot or undershoot in the second and third versions. What is remarkable is not the ambiguity in the second and third versions but the result that the exchange rate must overshoot in the first version. In early studies of exchange rate dynamics in which overshooting is a necessary result, the exchange rate is the only variable which can move in the short run to remove excess supply in the home money market.[38/] During the adjustment to long-run equilibrium other variables, such as home holdings of foreign money or the home price level, change in a way that raises demand for home money, so the home currency must appreciate as the econnomy adjusts. Here, either the price of the home good or home output is free to increase in the short run. Increases in these variables raise the demand for home money, so the home currency need not depreciate as much as would be necessary if both of these variables were fixed. It remains to be determined whether or not exchange rate overshooting in the very short run in which both prices and output are fixed is a general result which emerges in models which allow for a wider range of financial assets than those of this and earlier studies.

The adjustment process following an exchange market intervention is stable in all three versions of the model.[39/] In the first two versions all of the variables which are free to move in the short run jump initially and then adjust monotonically to their long-run equilibrium values. That the adjustment paths have this simple form is a direct consequence of stability and the fact that there is only one variable which must adjust slowly, home holdings of foreign money or the price of the home good, in each of the first two versions. It is somewhat disappointing, if not too surprising, that it is not possible to reach definite conclusions regarding the adjustment paths of the variables in version three, in which there are two variables which must adjust slowly, without making additional assumptions about the relative sizes of the parameters of the model.

It would be relatively easy to extend the model to allow for interest bearing assets so that the effects of exchange market intervention on the service account could be considered. To begin with it could be assumed that the authorities at home and abroad peg nominal interest rates; then this assumption could be relaxed. As it stands the model could be used to analyze the dynamic effects of other shocks to the economy such as shifts in preferences for home and foreign goods or for home and foreign money, policy actions aimed at the trade account, and conventional fiscal measures.

Footnotes

1/ Girton and Henderson (1977) offer some alternative specifications of intervention policy and analyze the short-run effects of these alternative specifications. Kouri (1976) studies the short-run, medium-run, and long-run effects of the type of intervention policy investigated in this paper.

Most of the analysis of this paper would also apply to the case in which the exchange market intervention consists of a sale of home securities and a purchase of foreign securities by the home authorities so long as it is assumed that the authorities in both countries are pegging nominal interest rates. However, when securities are included in the model, exchange market intervention has service account effects, which, while they may be important, complicate the analysis and obscure other, more important effects.

2/ Kouri's (1976) fundamental contribution to the analysis of exchange rate dynamics puts forward this view. Branson (1976) has also participated in the development of this view.

3/ Dornbusch's (1976a) path-breaking work on exchange rate dynamics is the source of this view.

4/ A description of a general version of this model, a discussion of some of its properties, and references to other applications of the model are provided in Henderson (1977).

5/ Dornbusch (1976b) uses this assumption about expectations formation. He (1976a) also shows that assuming long-run perfect foresight is equivalent to assuming complete perfect foresight under some conditions. Under complete perfect foresight the stationary equilibrium value of the exchange rate is known to consumers and their expectations are correct both in stationary equilibrium and while the system is adjusting to the stationary equilibrium. Kouri (1976) considers three possible assumptions about how exchange rate expectations are formed: static expectations, adaptive expectations, and complete perfect foresight.

6/ The foreign authorities could use balanced budget variations in government spending to accomplish this objective.

7/ By implication consumers' demand for the home good is given by

$$\frac{J}{P_I} = j_1\left(\frac{Py}{P_I} - \frac{S}{P_I}\right) + j_3\frac{E}{P_I} - j_4\frac{P}{P_I}, \qquad 0 < j_1 < 1,\ j_3,\ j_4 > 0,$$

where J is nominal spending on the home good, and

$$m_1 + j_1 = 1,\ m_3 - j_3 = 0,\ m_4 - j_4 = 0.$$

8/ By implication consumers' demand for foreign money is given by

$$\frac{(EF)^d}{P_I} = - f_1\frac{Py}{P_I} + f_2\frac{A}{P_I} + f_5 e - f_6, \qquad f_1,\ f_2,\ f_5,\ f_6 > 0,$$

and

$$q_1 - f_1 = 0,\ q_2 + f_2 = 1,\ q_5 - f_5 = 0,\ q_6 - f_6 = 0.$$

9/ Alternatively it could be assumed that labor supply depends positively on the real wage defined as the ratio of the nominal wage to the price index $(\frac{W}{P_I})$. Salop (1974) analyzes the momentary equilibrium effects of a devaluation under this assumption.

10/ Alternatively it could be assumed that "normal" labor supply depends on the real wage ($\frac{W}{P_I}$) and that consumers attempt to raise the anticipated real wage ($\frac{\dot{W}}{W} - k_1 p - k_2 e$) by raising the nominal wage when labor demand exceeds "normal" supply:

$$\frac{\dot{W}}{W} = u[N^d - \tilde{N}(\frac{W}{P_I})] + k_1 p + k_2 e,$$

where p is the anticipated rate of change in the price of the home good. This wage adjustment equation is one type of expectations augmented Phillips curve. Daniel (1977) analyzes the relationship between inflation and unemployment in a small open economy using a similar expectations augmented Phillips curve.

11/ The technique employed by Dornbusch (1976a) can be used to show that in the first two versions of the model assuming that expectations are formed according to (15) is equivalent to assuming that consumers have complete perfect foresight when ε is chosen properly

If expectations regarding the rate of change of the price of the home good were assumed to affect the rate of change of wages in the manner suggested in footnote 10, it would be natural to assume that consumers correctly calculate the stationary value of P, denoted by $\bar{P}$, and expect that P will adjust toward this stationary state value at a rate which is proportional to the ratio of the gap between its stationary state value and its current value to its stationary state value:

$$p = \pi(1 - \frac{P}{\bar{P}}), \qquad \pi > 0.$$

12/ The version of the model discussed in Section III is similar to the model of Kouri (1976) who analyzes the effects of the type of intervention policy investigated in this paper. The only important difference is that the version of Section III allows for changes in the terms of trade which are ruled out in Kouri's model by his assumption that the home good is a perfect substitute for the foreign good. Flood (1978) analyzes the effects of an increase in the rate of expansion of the home money supply under the assumption that the home good and the foreign good are perfect substitutes. The version of Section III is also similar to the model of Calvo and Rodriguez (1977). Both models allow for changes in a relative price. In this model the variable relative price is the price of the foreign good in terms of the home good; in the Calvo and Rodriguez model the variable relative price is the price of a traded good in terms of a non-traded good. Calvo and Rodriguez analyze the effects of an increase in the rate of expansion of home money rather than those of a one time increase in the home money supply through a purchase of foreign money by the home authorities.

13/ That is, the model exhibits neutrality with respect to a change in the home money supply. An economic model may be said to exhibit neutrality with respect to changes in a particular nominal variable if (1) the model is homogenous of degree zero in all nominal variables and (2) the nominal variable being changed is the only exogenous nominal variable. This way of describing sufficient conditions for neutrality is due to Don Roper (1975).

14/ Solving equations (21) and (22) for $\hat{E}$ subject to $\bar{q}\,\hat{\bar{Q}} + \bar{f}\hat{F} = 0$ yields

$$\hat{E} = -\frac{1}{\Delta_1}[(\bar{Q} + q_5\varepsilon)(g + g_2\bar{A}k_1)]\hat{\bar{Q}} > 0,$$

$$\hat{E} = [1 - \frac{1}{\Delta_1}(gq_2 + q_1\bar{y}k_2g_2)\bar{A}\ \bar{q}]\hat{\bar{Q}} > \hat{\bar{E}} = \hat{\bar{Q}},$$

$$\Delta_1 = -(g + g_2\bar{A}k_1)[(Q - q_1\bar{y} - q_2\bar{A})k_2 + q_2\bar{A}\ \bar{f} + q_5\varepsilon]$$
$$- [g + g_2\bar{A}(\bar{f} - k_2)][(Q - q_1\bar{y} - q_2\bar{A})k_1 + q_1\bar{y}] < 0.$$

Δ_1 is negative because it has been assumed that the sum of the real income and real wealth elasticities of the demand for real balances is less than one $(q_1\bar{y} + q_2\bar{A} < \bar{Q})$ and that a depreciation of the home currency raises excess demand for the home good $[g + g_2\bar{A}(\bar{f} - k_2) > 0]$.

15/ That is, if $q_2 = 0$ and g_2 is positive or if $g_2 = 0$ and q_2 is positive, $\hat{E}$ overshoots. A general analysis of the effects of increases in g_2 and q_2 on the changes in E and P resulting from a given percentage change in $\bar{Q}$ is somewhat more complicated. It can be shown that raising g_2 makes the GG schedule steeper thereby raising $\hat{E}$ and reducing $\hat{P}$. Raising q_2 reduces the responsiveness of the excess demand for money to changes in the price of the home good, so the QQ schedule shifts out farther for a given value of E. Raising q_2 raises (lowers) the responsiveness of the excess demand for money to changes in the exchange rate if $\bar{f} - k_2$ is greater than (less than) zero. Thus, if $\bar{f} - k_2$ is positive so that the QQ schedule shifts up less far for a given value of P, an increase in q_2 raises (lowers) $\hat{E}$ and $\hat{P}$ for slopes of the GG schedule less than (greater than) a critical value which is smaller the larger is $\bar{f} - k_2$. If $\bar{f} - k_2$ is negative so that the QQ schedule shifts up farther for a given value of P, an increase in q_2 raises $\hat{E}$ and $\hat{P}$ for all possible slopes of the GG schedule.

16/ Solving equations (21) and (22) for $\hat{P}$ subject to $\bar{q}\,\hat{Q} + \bar{f}\hat{F} = 0$ yields

$$\hat{P} = -\frac{1}{\Delta_1}\{(\bar{Q} + q_5\varepsilon)[g + g_2\bar{A}(\bar{f} - k_2)]\}\hat{Q} > 0,$$

$$\hat{P} = \left\{1 - \frac{1}{\Delta_1}\{gq_2 - g_2[(Q - q_1\bar{y})k_2 + q_5\varepsilon]\}\bar{A}\bar{q}\right\}\hat{Q} \gtrless \hat{Q}.$$

17/ Solving equations (21) and (22) for $\hat{E}$ subject to $\hat{Q} = 0$ yields

$$\hat{E} = \frac{1}{\Delta_1}[q_2 g + g_2(Qk_1 + q_1\bar{y}k_2)]\bar{A}\,\bar{f}\hat{F} < 0.$$

18/ Solving equations (21) and (22) for $\hat{P}$ subject to $\hat{Q} = 0$ yields

$$\hat{P} = \frac{1}{\Delta_1}\{gq_2 - g_2[(Q - q_1 y)k_2 + q_5\varepsilon]\}\bar{A}\,\bar{f}\hat{F} \gtrless 0.$$

19/ Linearizing equation (18c) in the neighborhood of stationary equilibrium yields

$$\dot{F} = -(t - t_2\bar{A}k_1)\hat{P} + [t - t_2\bar{A}(\bar{f} - k_2)]\hat{E} - t_2\bar{A}\,\bar{f}\hat{F} - t_2\bar{A}\,\bar{q}\hat{Q},$$

$$t = t_1\bar{y}k_2 + t_3k_1 + t_4k_2 > 0.$$

Solving for $\hat{P}$ using equation (21), the total differential of the equilibrium condition for the market for the home good, and substituting the resulting expression into the equation for $\dot{F}$ yields the equation of the $\ddot{F}\ddot{F}$ schedule:

$$\dot{F} = \{[(tg_2 + gt_2)\bar{A}]/(g + g_2\bar{A}k_1)\}(\bar{q}\hat{E} - \bar{f}\hat{F} - \bar{q}\hat{Q}).$$

Strictly, the two propositions in the text are true if and only if it is assumed, as it has been implicitly throughout this Section, that home consumers' initial holdings of foreign money are positive ($\bar{E}_0\bar{F}_0 > 0$).

20/ A comparison of the expressions in footnotes 16 and 18 reveals that if P initially overshoots (undershoots), increases in F cause decreases (increases) in P.

21/ The version of the model discussed in Section IV is similar to the model presented in the Appendix to Dornbusch (1976a). There are three main differences between the assumptions made here and those made by Dornbusch: (1) here home wealth is allocated between home and foreign money, but in Dornbusch's model home wealth is allocated between home money and holdings of a single world security; (2) here there is no rate of return effect in the market for the home good, but in Dornbusch's model increases in the nominal rate of interest reduce demand for the home good; and (3) here a price index is used to deflate nominal income and the money supply, but in

Footnote (continued)

Dornbusch's model the price of the home good is used to deflate these nominal magnitudes. One by-product of the first difference is that the method of increasing the home money supply is different in the two models. Here the home authorities purchase foreign money, but in Dornbusch's model they purchase the single world security. When the policy considered is an increase in the home money supply, the differences in assumptions lead to no important differences in results. For a demonstration that there is only a minor change in the condition for overshooting see footnote 22.

22/ Solving equations (26) and (27) for $\hat{E}$ subject to $\bar{q}\,\hat{\bar{Q}} + \bar{f}\hat{F} = 0$ yields

$$\hat{E} = -\frac{1}{\Delta_2}[g_1\bar{y}(\bar{Q} + q_5\epsilon)]\hat{\bar{Q}} > 0,$$

$$\hat{E} = \{1 - \frac{1}{\Delta_2}[q_1\bar{y}(g_1\bar{y} - g) + g_1 y(\bar{Q} - q_1\bar{y})k_1]\}\hat{\bar{Q}} \gtrless \hat{\bar{E}} = \hat{\bar{Q}},$$

$$\Delta_2 = -g_1\bar{y}[(\bar{Q} - q_1\bar{y})k_2 + q_5\epsilon] - gq_1\bar{y} < 0.$$

Δ_2 is negative because it has been assumed that the real income elasticity of demand for real balances is less than one $(q_1\bar{y} < \bar{Q})$.

The condition under which the exchange rate overshoots in this version of the model is quite similar to the condition under which the exchange rate overshoots in the model presented in the Appendix to Dornbusch (1976a). Here the exchange rate overshoots if

$$q_1\bar{y}(g_1\bar{y} - g) + g_1\bar{y}[(\bar{Q} - q_1\bar{y})k_1] > 0,$$

or equivalently if

$$k_1 + \frac{q_1\bar{y}}{\bar{Q}}k_2 - \frac{1}{g_1\bar{y}}\frac{q_1\bar{y}}{\bar{Q}}g > 0.$$

If $k_1 = 1$ (and $k_2 = 0$) this condition is identical to Dornbusch's since $\frac{1}{g_1\bar{y}}$ is his μ, $\frac{q_1\bar{y}}{\bar{Q}}$ is his $\emptyset$, and g is his δ. The condition here is more stringent because when a price index is employed a depreciation of the home currency has a larger positive effect on the excess demand for money, so the home currency need not depreciate as much to offset a given increase in the home money supply.

23/ Solving equations (26) and (27) for $\hat{y}$ subject to $\bar{q}\hat{\hat{Q}} + \bar{f}\hat{F} = 0$ yields

$$\hat{y} = -\frac{1}{\Delta_2}[(\bar{Q} + q_5\epsilon)g]\hat{\hat{Q}} > 0,$$

$$\hat{y} = \{1 + \frac{1}{\Delta_2}[(g_1\bar{y}k_2 - g)(\bar{Q} - q_1\bar{y}) + (g_1\bar{y} - g)q_5\epsilon]\}\hat{\hat{Q}} \gtrless \hat{\hat{Q}}.$$

24/ Solving equations (26) and (27) for $\hat{E}$ subject to $\hat{\hat{Q}} = 0$ yields

$$\hat{E} = \frac{1}{\Delta_2}[q_1\bar{y}(g_1\bar{y} - g) + g_1\bar{y}(\bar{Q} - q_1\bar{y})k_1]\hat{P} \gtrless 0.$$

25/ Solving equations (26) and (27) for $\hat{y}$ subject to $\hat{\hat{Q}} = 0$ yields

$$\hat{y} = \frac{1}{\Delta_2}[g(Q + q_5\epsilon)]\hat{P} < 0.$$

26/ A comparison of the expressions in footnotes 22 and 24 reveals that if E initially overshoots (undershoots), increases in P cause decreases (increases) in E.

27/ Linearizing equation (23c) in the neighborhood of stationary equilibrium yields

$$\dot{P} = un\bar{y}\hat{y}.$$

Solving for $\hat{y}$ using equation (26), the total differential of the equilibrium condition for the market for the home good, and substituting the resulting expression into the equation for $\dot{P}$ yields the equation of the $\ddot{P}\ddot{P}$ schedule:

$$\dot{P} = [ung/g_1](\hat{E} - \hat{P}).$$

28/ Solving equations (31) and (32) for $\hat{E}$ subject to $\bar{q}\hat{\hat{Q}} + \bar{f}\hat{F} = 0$ yields

$$\hat{E} = -\frac{1}{\Delta_3}[g_1\bar{y}(\bar{Q} + q_5\epsilon)]\hat{\hat{Q}} > 0,$$

$$\hat{E} = \Big\{1 - \frac{1}{\Delta_3}\{q_1\bar{y}[g_1\bar{y} - g - g_2\bar{A}(\bar{f} - k_2)] + g_1\bar{y}[(\bar{Q} - q_1\bar{y})k_1 - q_2\bar{A}(\bar{f} - k_2)]\}\Big\}\hat{\hat{Q}} \gtrless \hat{\bar{E}} = \hat{\hat{Q}},$$

$$\Delta_3 = -g_1\bar{y}[(\bar{Q} - q_1\bar{y} - q_2\bar{A})k_2 + q_2\bar{A}\,\bar{f} + q_5\epsilon] - q_1\bar{y}[g + g_2A(\bar{f} - k_2)] < 0.$$

Δ_3 is negative because it has been assumed that the sum of the real income and real wealth elasticities of demand for real balances is less than one $(q_1\bar{y} + q_2\bar{A} < \bar{Q})$ and that a depreciation of the home currency raises excess demand for the home good $[g + g_2\bar{A}(\bar{f} - k_2) > 0]$.

29/ Solving equations (31) and (32) for $\hat{y}$ subject to $\bar{q}\hat{\bar{Q}} + \bar{f}\hat{F} = 0$ yields

$$\hat{y} = -\frac{1}{\Delta_3}\{[g + g_2\bar{A}(\bar{f} - k_2)](\bar{Q} + q_5\varepsilon)\}\hat{\bar{Q}} > 0,$$

$$\hat{y} = \Big\{1 - \frac{1}{\Delta_3}\{(\bar{Q} - q_1\bar{y} + q_5\varepsilon)[g + g_2\bar{A}(\bar{f} - k_2)] - g_1\bar{y}[(\bar{Q} - q_1\bar{y} - q_2\bar{A})k_2 + q_2\bar{A}\,\bar{f} + q_5\varepsilon]\}\Big\}\hat{\bar{Q}} \gtrless \hat{\bar{Q}}.$$

30/ Note that increases in q_2 can never cause the Q_1Q_1 schedule to cut the dashed line with a slope of positive one to the left of point i under the assumption that the sum of the real income and real wealth elasticities of the demand for real balances is less than (or, in the extreme, equal to) one.

31/ Solving equations (31) and (32) for $\hat{E}$ and $\hat{y}$ subject to $\hat{\bar{Q}} = \hat{F} = 0$ yields

$$\hat{E} = \frac{1}{\Delta_3}\{g_1\bar{y}[(\bar{Q} - q_1\bar{y} - q_2\bar{A})k_1 + q_1\bar{y}] - q_1\bar{y}(g + g_2\bar{A}k_1)\}\hat{P} \gtrless 0,$$

$$\hat{y} = \frac{1}{\Delta_3}\{(g + g_2\bar{A}k_1)[(\bar{Q} - q_1\bar{y} - q_2\bar{A})k_2 + q_2\bar{A}\,\bar{f} + q_5\varepsilon] + [(\bar{Q} - q_1\bar{y} - q_2\bar{A})k_1 + q_1\bar{y}][g + g_2\bar{A}(\bar{f} - k_2)]\}\hat{P} < 0.$$

32/ Solving equations (31) and (32) for $\hat{E}$ and $\hat{y}$ subject to $\hat{\bar{Q}} = \hat{P} = 0$ yields

$$\hat{E} = \frac{1}{\Delta_3}(g_1q_2 + q_1g_2)\bar{A}\,\bar{f}\,\bar{y}\hat{F} < 0,$$

$$\hat{y} = \frac{1}{\Delta_3}\{-g_2\bar{A}\,\bar{f}[(\bar{Q} - q_1\bar{y} - q_2\bar{A})k_2 + q_2\bar{A}\,\bar{f} + q_5\varepsilon] + q_2\bar{A}\,\bar{f}[g + g_2\bar{A}(\bar{f} - k_2)]\}\hat{F} \gtrless 0.$$

33/ These relationships are contained in footnotes 31 and 32.

34/ It is not apparent from the expression for B_{11} that it must be negative. However, $B_{11} = un\bar{y}\,\frac{\hat{Y}}{\hat{P}}$, and, as can be verified by referring to footnote 31, $\frac{\hat{Y}}{\hat{P}}$ is negative under the assumptions of this paper that $q_1\bar{y} + q_2\bar{A} < \bar{Q}$ and that $g + g_2\bar{A}(\bar{f} - k_2) > 0$.

35/ The derivation of (36), which is very tedious, is available from the author on request. It is interesting to note the similarity between (36) and the coefficient of $\hat{F}$ in the $\dot{F}$ equation in the model of Section III which is contained in footnote 19. This similarity becomes more obvious when it is recognized that $s_2C_1 + m_1s_2\bar{y}k_2 = tg_2 + t_2g$.

37/ The adjustment process is also non-cyclical if s_2 is large enough. In this case B_{12} and B_{21} are both positive. With B_{12} and B_{21} both positive $\left.\frac{\hat{P}}{\hat{F}}\right|_{\dot{P}\dot{P}}$ and $\left.\frac{\hat{P}}{\hat{F}}\right|_{\dot{F}\dot{F}}$ are both upward-sloping. It follows from the argument in the text that $\left.\frac{\hat{P}}{\hat{F}}\right|_{\dot{P}\dot{P}}$ is flatter than $\left.\frac{\hat{P}}{\hat{F}}\right|_{\dot{F}\dot{F}}$. Given this relationship between the two schedules the economy must eventually enter a phase in which both P and F rise directly toward the new stationary equilibrium. A description of the adjustment paths for E and y for the case of large s_2 is not attempted here. In this case $\frac{\hat{E}}{\hat{F}}$ and $\frac{\hat{Y}}{\hat{P}}$ are negative, as they are in all cases, but $\frac{\hat{E}}{\hat{P}}$ and $\frac{\hat{Y}}{\hat{F}}$ are positive.

38/ The exchange rate must overshoot in the model of Kouri (1976) and the model in the text of Dornbusch (1976a).

39/ If the expectations augmented Phillips curve of footnote 10 rather than equation (6) described wage adjustment in versions two and three of the model additional assumptions would be required in order to guarantee stability.

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