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11 Exchange Market Intervention Operations: Their Role in Financial Policy and Their Effects

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11.1 Introduction and Conclusions

This paper addresses two unanswered questions regarding exchange market intervention operations that leave money supplies unchanged: (1) what role should such intervention operations play in open economy financial policy, and (2) do they have significant effects on macroeconomic variables.[1] First, several versions of a model in which intervention operations have effects are used to delineate the role of these operations in macroeconomic financial policy.[2] Then, attention is focused on some recent theoretical and empirical studies relevant for assessing the likelihood that intervention operations have significant effects.

According to the view adopted here, the home authorities conduct financial policy using two kinds of financial market operations: (1) intervention operations, exchanges of home (currency) securities for foreign (currency)

Discussions with Matthew Canzoneri, Jo Anna Gray, Peter Isard, Maurice Obstfeld, and Kenneth Rogoff led to improvements in this paper. This paper represents the views of the author and should not be interpreted as representing the views of the Board of Governors of the Federal Reserve System or other members of its staff.

1. Stein (1963), Mundell (1968), and Niehans (1968) were pioneers in the analysis of open economy financial policy. Recent contributions include those of Modigliani and Askari (1973), Hamada (1974), Sweeney (1976), Tower and Willett (1976), Turnovsky (1976, 1983), Fischer (1977), Boyer (1978, 1980), Parkin (1978), Flood (1979), Henderson (1979, 1980, 1982), Kaminow (1979), Bryant (1980), Frenkel (1980), Roper and Turnovsky (1980), Artis and Currie (1981), Mussa (1981), Wallich and Gray (1981), Weber (1981), Argy (1982), Canzoneri (1982), Jones (1982), and Canzoneri and Gray (1983).

2. Only in section 11.10 is there brief mention of the use of intervention policy to counter "disorderly markets" or such features of exchange market dynamics as runs or bandwagons. Shafer (1982) and Wonnacott (1982) address these issues among others.

securities with private agents, and (2) monetary operations, exchanges of home money for home securities with private agents.[3] The intervention operation just described is often referred to as "sterilized intervention" because it leaves both the home money supply and the foreign money supply unchanged.[4]

The role of intervention policy is explored in the context of a discrete-time stochastic model in which agents have rational expectations. The description of this model in section 11.2 reveals that it has two features which are especially important. First, intervention operations affect macroeconomic variables. This feature is an implication of the assumptions that private agents regard home and foreign securities as imperfect substitutes and that private agents do not treat the security holdings of the authorities as being implicitly a part of their own portfolios. Second, contemporaneous financial policy feedback rules can dampen the variance of employment caused by disturbances in the markets for goods and assets even though agents have rational expectations. This feature is a consequence of the assumption that labor market participants set a base nominal wage and, in some versions of the model, an indexing parameter before other markets meet.

Whether one open economy financial policy regime is better than another usually depends on the source of disturbances to the economy. In section 11.3 this observation is illustrated by a comparison of the effects of different kinds of transitory disturbances to a single open economy with no indexing under two alternative pure financial policy regimes. Under an "aggregates constant policy" the money supply is kept unchanged and there is no intervention, so the interest rate and the exchange rate vary when disturbances are experienced. Under a "rates constant policy" monetary operations and intervention operations are employed to keep the interest rate and the exchange rate fixed. It is shown that for disturbances to the market for the home good an aggregates constant policy results in less variation in employment and that for disturbances to financial markets a rates constant policy results in less variation in employment. Then it is argued that similar results can be obtained when the economy is subject to one kind of permanent disturbance as well as to transitory disturbances.

Introducing indexing necessitates qualifications to some of the results for pure financial policy regimes. As explained in section 11.4, for disturbances that directly affect only financial markets, a rates constant policy still results

3. Throughout this paper it is the currency of denomination of a security, and not the country of residence of its issuer or holder, that determines whether that security is a home security or a foreign security.

4. Dooley (1979) provides a thorough discussion of intervention operations. Girton and Henderson (1977) compare the effects of intervention operations and monetary operations in a two-country model of financial markets. Black (1980) describes experience with intervention policy in the years 1973–78.

in less employment variation. However, for disturbances that directly affect the market for the home good, the results are less clear-cut with indexing.

To show that the authorities may be able to reduce the variance of employment below that implied by either pure financial policy regime is the main purpose of section 11.5. The authorities may improve the outcome for currently unobserved employment by adopting a contemporaneous financial policy feedback rule that relates a financial variable chosen as an instrument—say, the exogenous supply of home (currency) assets—to a financial variable chosen as an information variable—say, the exchange rate—because the information variable conveys current though incomplete information about the sources of disturbances. Under general conditions macroeconomic outcomes will be better if the financial authorities in a single open economy facing transitory disturbances neither rigidly fix the exchange rate nor allow it to fluctuate freely. In fact, outcomes may be better if they reinforce the movement of the exchange rate that would occur if there were no intervention by "leaning with the wind."

Section 11.6 is a digression from the topic of intervention policy made in order to consider further how exchange rate movements and interest rate movements can be used together to make inferences about the sources of unobserved disturbances. Not surprisingly, it is found that exchange rate movements provide helpful additional information but that they do not completely resolve the problems faced by the authorities in their attempts to discover the sources of disturbances.

Limited support for the contention that intervention policy can be helpful in dampening "vicious circles" is provided in section 11.7. It is shown that when wage contracts are indexed the trade-off between output variance and price variance can be improved when the exchange rate is fixed.

In section 11.8 attention is turned to the interactions in a two-country world economy that must be considered when choosing financial policies. It is emphasized that the overall stance of intervention policy is the result of the intervention policies of both countries. Then it is shown that for two kinds of transitory disturbances the two countries would agree on what the overall stance of intervention policy should be, while for another kind of transitory disturbance a policy conflict would arise.

The message of section 11.9 is that, strictly speaking, imperfect substitutability among securities denominated in different currencies is neither necessary nor sufficient for intervention operations to have significant effects. As noted in section 11.10, recent rejections of the joint hypothesis that securities denominated in different currencies are perfect substitutes and that expectations are rational are consistent with the effects of intervention operations being significant. However, the results of direct tests for these effects suggest that any such effects are quite weak.

11.2 The Model

This section is a description of a discrete-time stochastic model of a two-country world economy in which agents have rational expectations.[5] Special cases of this model are employed in the next six sections.

First, attention is focused on the real sector of the model. The model contains two goods each of which is produced in only one country but is consumed in both. Home output (Y) must be equal to aggregate demand for the home good, and foreign output ($\overset{*}{Y}$) must be equal to the aggregate demand for the foreign good:

$$Y = y_0 + y_1(Y + \overset{*}{Y}) - y_2 r - y_3 \overset{*}{r} + y_4(e + \overset{*}{p} - p) + y_5 e - y_6 p + \alpha, \tag{1}$$

$$\overset{*}{Y} = \overset{*}{y}_0 + \overset{*}{y}_1(Y + \overset{*}{Y}) - \overset{*}{y}_2 r - \overset{*}{y}_3 \overset{*}{r} - y_4(e + \overset{*}{p} - p) - \overset{*}{y}_5 e - \overset{*}{y}_6 \overset{*}{p} - \alpha. \tag{2}$$

Here and in what follows, all coefficients except intercept terms are positive. Increases in home and foreign output raise income at home and abroad and, therefore, spending on both goods.[6] It is assumed that the marginal propensities to consume the home good (y_1), to consume the foreign good ($\overset{*}{y}_1$), and to save ($s = 1 - y_1 - \overset{*}{y}_1$) are the same in both countries and are all positive.[7] Aggregate demand for each good depends negatively on the expected real interest rate on home securities (r) and on foreign securities ($\overset{*}{r}$) because increases in expected real interest rates raise home and foreign saving.

Aggregate demand for the home good depends positively on the (logarithm of the) relative price of the foreign good ($e + \overset{*}{p} - p$). The variables e, $\overset{*}{p}$, and p are, respectively, the (logarithms of the) exchange rate defined as the home currency price of foreign currency, the foreign currency price of the foreign good, and the home currency price of the home good. Aggregate demand for the foreign good depends negatively on the relative price of the foreign good. An increase in the relative price of the foreign good shifts home and foreign spending toward (away from) the home (foreign) good and raises (lowers) foreign (home) income measured in terms of the

5. This model is a linear approximation to a nonlinear model sketched out in the Appendix. Explicit expressions for the approximation coefficients are presented in the Appendix.

6. It is possible to add Y and $\overset{*}{Y}$ together because units are chosen so that the relative price of the foreign good is one in the equilibrium about which the approximation is made.

7. Home and foreign residents are assumed to have the same tastes so that shifts of wealth between countries through current account surpluses and deficits will have no effects on the variables of the model. Without this assumption a more complicated, dynamic analysis would be required.

home (foreign) good, thereby stimulating (restraining) spending on the home (foreign) good. It is assumed that trade is initially balanced so that the effect of an increase in the relative price of the foreign good on the demand for the foreign good is equal in absolute value to the effect on the demand for the home good.[8]

A depreciation of the home currency—that is, a rise in e—raises (lowers) home and foreign wealth measured in terms of the home (foreign) good, thereby reducing (increasing) world saving measured in terms of the home (foreign) good and raising (lowering) aggregate demand for the home (foreign) good.[9] An increase in the home (foreign) currency price of the home (foreign) good lowers home and foreign wealth measured in terms of the home (foreign) good thereby raising world saving measured in terms of the home (foreign) good and reducing aggregate demand for the home (foreign) good. The effect of a depreciation of the home currency on demand for the home good is smaller in absolute value than the effect of an increase in the home currency price of the home good ($y_5 < y_6$) because a rise in e raises the home good value of only the foreign currency component of home and foreign wealth, but an increase in p lowers the home good value of all components of home and foreign wealth; $\overset{*}{y}_5 < \overset{*}{y}_6$ by an analogous argument.

Positive values of α represent increases in the demand for the home good at the expense of demand for the foreign good. This stochastic variable and those introduced below to represent other disturbances are assumed to have zero means and to be mutually and serially uncorrelated.

The expected real interest rates on home securities and foreign securities are

$$r = i - (\bar{q} - q) = i - (\bar{e} - e) - (\overset{*}{\bar{q}} - \overset{*}{q}), \tag{3}$$

$$\overset{*}{r} = \overset{*}{i} + (\bar{e} - e) - (\bar{q} - q) = \overset{*}{i} - (\overset{*}{\bar{q}} - \overset{*}{q}). \tag{4}$$

The variables i and $\overset{*}{i}$ represent the nominal interest rates on home and foreign securities. The variables q and $\overset{*}{q}$ represent the (logarithms of the) home currency and foreign currency prices of the world consumption bundle:

$$q = hp + (1 - h)(e + \overset{*}{p}), \tag{5}$$

$$\overset{*}{q} = h(p - e) + (1 - h)\overset{*}{p}. \tag{6}$$

The constant h represents the proportion of spending that would be allocated

8. See the Appendix for proof that the assumption of balanced trade has this implication.

9. The assumptions about asset preferences made below imply that the residents of each country have net claims denominated in the currency of the other country, that is, that there are no "negative net foreign asset positions."

to the home good by residents of both countries if all of the disturbance terms were zero. From (5) and (6) it follows that $\bar{q}$ and $\overset{*}{\bar{q}}$ are given by

$$\bar{q} = h\bar{p} + (1 - h)(\bar{e} + \overset{*}{\bar{p}}), \tag{7}$$

$$\overset{*}{\bar{q}} = h(\bar{p} - \bar{e}) + (1 - h)\overset{*}{\bar{p}}, \tag{8}$$

where $\bar{q}$, $\overset{*}{\bar{q}}$, $\bar{p}$, $\bar{e}$, and $\overset{*}{\bar{p}}$ are the constant values of q, $\overset{*}{q}$, p, e, and $\overset{*}{p}$ that all agents expect in any period to prevail in the next period.

According to the production functions for home and foreign output,

$$Y = x_0 + x_1 L + x_2 \beta, \tag{9}$$

$$\overset{*}{Y} = \overset{*}{x}_0 + \overset{*}{x}_1 \overset{*}{L}, \tag{10}$$

home output depends positively on home employment (L), and foreign output depends positively on foreign employment ($\overset{*}{L}$).[10] Positive values of β represent increases in the (marginal) productivity of labor.

Firms and workers in each country enter into a labor contract each period before other markets meet to avoid the costs of ongoing wage negotiations. This contract has two provisions, an employment rule and a nominal wage indexing rule. According to the employment rule, workers must supply whatever amount of labor firms want at the realized real wage. Given this rule, firms in each country employ labor up to the point at which the (logarithms of the) marginal product of labor and the real wage are equal:

$$w - p = l_0 - l_1 L + \beta, \tag{11}$$

$$\overset{*}{w} - \overset{*}{p} = \overset{*}{l}_0 - \overset{*}{l}_1 \overset{*}{L}. \tag{12}$$

The variables w and $\overset{*}{w}$ represent (the logarithms of) home and foreign nominal wages measured in home and foreign currency, respectively. The amount of labor employed in the home (foreign) country may be greater or less than the constant "full employment" amount, L_f ($\overset{*}{L}_f$), that home (foreign) workers would supply in the absence of the labor contract.

The nominal wage indexing rules are

$$w - \bar{w} = \mu(q - \bar{q}), \tag{13}$$

$$\overset{*}{w} - \overset{*}{\bar{w}} = \overset{*}{\mu}(\overset{*}{q} - \overset{*}{\bar{q}}). \tag{14}$$

In each country an indexing parameter (μ or $\overset{*}{\mu}$) determines what fraction of deviations of the price index from its base value ($\bar{q}$ or $\overset{*}{\bar{q}}$) will be reflected in deviations of the same sign in the nominal wage from its base value ($\bar{w}$ or

10. It is shown in the Appendix that the production function of equation (9) is a linear approximation of a nonlinear production function with a multiplicative disturbance.

$\overset{*}{\bar{w}}$). The base values $\bar{w}$ and $\overset{*}{\bar{w}}$ are the values of w and $\overset{*}{w}$ which would be consistent with full employment if all disturbances were zero:

$$\bar{w} - \bar{p} = l_0 - l_1 L_f, \tag{15}$$

$$\overset{*}{\bar{w}} - \overset{*}{\bar{p}} = \overset{*}{l}_0 - \overset{*}{l}_1 \overset{*}{L}_f. \tag{16}$$

As before, $\bar{q}$ and $\overset{*}{\bar{q}}$ are the constant values of q and $\overset{*}{q}$ expected in any period to prevail in the next. In order to calculate $\bar{p}$, $\overset{*}{\bar{p}}$, and $\bar{e}$ so that they can set $\bar{w}$ and $\overset{*}{\bar{w}}$ and $\bar{q}$ and $\overset{*}{\bar{q}}$, labor market participants must know the parameters of the economic model and the values at which the financial authorities' policy instruments would be set if all disturbances were zero.

Now attention is focused on the financial sector of the model, which consists of markets for three assets: home money, foreign money, and home securities.[11] Residents of each country hold the money of their country but not the money of the other country.[12] The supply of home money (M) must equal the demand for home money by home residents, and the supply of foreign money (N) must equal the demand for foreign money by foreign residents:

$$M = m_0 + m_1 p + m_2 Y - m_3 i - m_4(\overset{*}{i} + \bar{e} - e) + \gamma + \delta, \tag{17}$$

$$N = \overset{*}{n}_0 + \overset{*}{n}_1 \overset{*}{p} + \overset{*}{n}_2 \overset{*}{Y} - \overset{*}{n}_3(i - \bar{e} + e) - \overset{*}{n}_4 \overset{*}{i}. \tag{18}$$

Home (foreign) money demand depends positively on the home (foreign) currency price of the home (foreign) good and on home (foreign) output. Increases in both of these variables raise the transactions demands for money balances.[13] In a given country money demand depends negatively on the nominal interest rate on securities denominated in that country's currency and on the expected nominal return on securities denominated in the other country's currency measured in terms of the given country's currency, which is equal to the nominal interest rate on securities denominated in the other country's currency plus the expected rate of depreciation of the given country's currency. Positive values of γ (δ) represent shifts of home resi-

11. The market for the fourth asset, foreign securities, can be omitted by Walras's law; for completeness the equilibrium condition for this market is included in the Appendix.

12. That is, there is no "currency substitution" in this model.

13. The foreign price level does not appear in equation (17), nor does the exchange rate appear as a separate argument. These variables are absent because, as is spelled out in more detail in the Appendix, equation (17) is an approximation of a demand function for nominal balances of the form $PY\lambda(\cdot)$, which has a real income elasticity of unity. If the demand for nominal balances were of the form $[hP + (1 - h)EP]g\{PY/[hP + (1 - h)EP], \cdot\}$ where the real income elasticity was less than one, then $\overset{*}{p}$ and e would appear in equation (17). Assuming that the real income elasticity of the demand for nominal balances is one simplifies the derivation of several results, particularly those for a productivity shock in an economy with no indexing. Under plausible assumptions the qualitative results would be the same if the real income elasticity were less than unity, as is shown in Henderson (1982).

dents' asset preferences toward home money and away from home (foreign) securities.

The supply of home securities (B) must equal the demand for these securities by both home and foreign residents:

$$B = b_0 - b_1 p - b_2 Y + b_3 i - b_4(\overset{*}{i} + \bar{e} - e) + b_5(i - \bar{e} + e) - b_6 \overset{*}{i} + b_7 e - b_8 \overset{*}{p} - b_9 \overset{*}{Y} - \gamma + \epsilon. \tag{19}$$

It is assumed that both home and foreign residents determine the home currency amount that they will hold in securities by subtracting their money demands measured in home currency from the home currency value of their wealth and allocate the same fraction of this amount to home securities.[14] The resulting demand for home securities depends negatively on the prices of the home and foreign goods and on home and foreign output. Increases in prices and outputs raise the transactions demands for money of both home and foreign residents partly at the expense of their demands for home currency securities. It follows that $b_1 < m_1$ and $b_2 < m_2$. It is also assumed that both home and foreign residents regard the three assets they hold as strict gross substitutes. Therefore, the demand for home securities depends positively on the nominal interest rate on home securities and on the expected rate of return on home securities measured in terms of foreign currency, and $b_3 > m_3$. In addition, the demand for home securities depends negatively on the nominal interest rate on foreign securities and on the expected rate of return on foreign securities measured in terms of home currency.[15] The demand for home securities depends positively on the exchange rate because a depreciation of the home currency raises the home currency value of world wealth minus world money demand. The demand for home securities depends negatively (positively) on the disturbance term γ (ϵ). Positive values of γ (ϵ) represent decreases (increases) in the demand for home securities matched by increases (decreases) in the demand for home money (foreign securities).

11.3 Transitory Disturbances and Alternative Pure Financial Policies in a Single Open Economy with No Indexing

In this section a specialized version of the model of section 11.2 is employed to analyze the effects on home employment of some transitory disturbances to macroeconomic equilibrium in the home economy under two

14. The explanation for the assumption that home and foreign residents allocate the same fraction of the home currency value of the difference between their wealth and their money demand to home securities is the same as the explanation in n. 7 for the assumption that these agents have the same tastes for goods.

15. $i - \bar{e} + e$ and $\overset{*}{i}$ are the opportunity costs of holding money rather than the two types of securities in the foreign country.

pure financial policy regimes, an aggregates constant policy and a rates constant policy.[16] The analysis is simplified by the assumption that there is no indexing in the home country ($\mu = 0$).

As a first step the behavior of the home and foreign financial authorities is described. The balance sheet of the financial authorities in the home country has the money supply as a liability and both home and foreign securities as assets. The home authorities' holdings of foreign securities are their only foreign exchange reserves. At a given exchange rate, changes in the three balance sheet items must sum to zero, so values for only two of the three items can be chosen independently. It is assumed that the home authorities do not observe home employment, home output, and the price of the home good in the current period. They can choose as policy instruments and set values for any two of four financial variables: the home money supply (M), private holdings of home securities (B), the interest rate on home securities (i), and the exchange rate (e). The values of the other two variables are determined by the model. The description of the home authorities' balance sheet implies that if the home authorities seek to change B without changing M, they must also change the supply of foreign securities available to private agents through intervention operations. Under an aggregates constant policy M and B are kept unchanged, while under a rates constant policy M and B are allowed to vary to keep i and e constant. Under each policy regime the authorities set and announce the same values for two financial policy instruments before markets meet each period; that is, they either do not observe or, more realistically, elect not to respond to movements in the financial variables for which they do not set values. The announced values of the two policy instruments can be chosen arbitrarily because home country labor market participants set the base nominal wage so that the expected value of L is equal to L_f given these announced values.

Since the objective of this and the next five sections is to focus on financial policymaking in a single open economy, somewhat different assumptions are made about the information available to the foreign authorities and the use they make of this information. It is assumed that the foreign authorities can observe the level of foreign output ($\overset{*}{Y}$) and the price of the foreign good ($\overset{*}{p}$) in the current period and that they act so as to keep these variables as well as the interest rate on foreign securities ($\overset{*}{i}$) fixed.[17]

Given the nature of the disturbances and the behavior of the authorities, it is rational for agents to expect in any period that the values of the price of the home good and the exchange rate in the next period will be equal to

16. The type of analysis used in this section was first employed in the context of a closed economy by Poole (1970) and has been extended by Friedman (1975).

17. The foreign authorities must use monetary operations and two fiscal policy instruments, for example, the level of balanced budget government spending and its allocation between the home good and the foreign good, to achieve these constant values. Flood (1979) makes an interesting alternative set of assumptions about the behavior of the foreign authorities.

the constants $\bar{p}$ and $\bar{e}$, respectively.[18] In addition, it is rational for labor market participants in the home country to set the base nominal wage at the constant value implied by (15) each period before other markets meet.

As a second step the specialized version of the model used in this section is expressed in more compact form. The equilibrium conditions for the markets for the home good, home money, and home securities become[19]

$$0 = -y_L\hat{L} - y_i\hat{i} + y_e\hat{e} + \alpha + y_\beta\beta, \tag{20}$$

$$\hat{M} = m_L\hat{L} - m_i\hat{i} + m_e\hat{e} - m_\beta\beta + \gamma + \delta, \tag{21}$$

$$\hat{B} = -b_L\hat{L} + b_i\hat{i} + b_e\hat{e} + b_\beta\beta - \gamma + \epsilon, \tag{22}$$

where

$$y_L = y_p l_1 + y_Y x_1, \quad m_L = m_p l_1 + m_Y x_1, \quad b_L = b_p l_1 + b_Y x_1,$$

$$y_i = y_2, \quad m_i = m_3, \quad b_i = b_3 + b_5,$$

$$y_e = y_p - y_2 - y_6 + y_5, \quad m_e = m_4, \quad b_e = b_4 + b_5 + b_7,$$

$$y_\beta = y_p - y_Y x_2, \quad m_\beta = m_p - m_Y x_2, \quad b_\beta = b_p - b_Y x_2,$$

and

$$y_p = y_4 + (y_2 + y_3)h + y_6, \quad m_p = m_1, \; b_p = b_1,$$

$$y_Y = s + \overset{*}{y}_1, \quad m_Y = m_2, \; b_Y = b_2.$$

A circumflex over a variable indicates the deviation of that variable from its constant expected value. It is assumed that relative price and wealth effects outweigh possibly "perverse" expected real interest rate effects so that y_e is positive. With employment held constant, an increase in the productivity of labor tends to create excess demand for the home good because it lowers its price but tends to create excess supply of the home good because it increases the amount supplied. It is assumed that the first effect dominates so that y_β is positive. Assumptions embodied in (9), (17), and (19) imply that an in-

18. This statement is strictly true only if it is assumed that there are "no speculative bubbles." Sargent (1973) explains the implications of this assumption in the context of a closed economy. Parkin (1978), Flood (1979), Roper and Turnovsky (1980), Wallich and Gray (1981), and Weber (1981) analyze open economy financial policies under the assumption of rational expectations.

19. Equations (5) and (7) are substituted into (3), and (6) and (8) are substituted into (4). The resulting versions of (3) and (4) are substituted into (1), and (9) is substituted for Y in (1), (17), and (19). Equations (5), (7), and (15) are substituted into (13). The modified version of (13) is used to eliminate w from (11). The modified version of (11) is employed to obtain an expression for p which depends on e when $0 < \mu \leq 1$ but is independent of e when $\mu = 0$. This expression is substituted for p wherever it appears in the modified versions of (1), (17), and (19). The further modified versions of (1), (17), and (19) with the disturbances set equal to zero are subtracted from the same equations with the disturbances free to take on any value to obtain (20), (21), and (22).

crease in labor productivity leaves nominal income unchanged and that with nominal income unchanged the markets for home money and home securities are unaffected, so that $m_\beta = b_\beta = 0$.[20] Under these assumptions a shift in demand from the foreign good to the home good ($\alpha > 0$) and an increase in the productivity of labor can be analyzed together because they both affect only the market for the home good. Foreign variables do not appear in (20), (21), and (22) because they are fixed by the foreign authorities.

Equilibrium schedules for the markets for the home good, home money, and home securities are shown in figure 11.1. The equilibrium schedule for the home good is X_0X_0. An increase in i, which lowers demand, must be accompanied by a decline in L, which raises excess demand. The equilibrium schedule for home money is M_0M_0. A rise in i, which reduces demand, must be offset by a rise in L, which increases demand. The equilibrium schedule for home securities is B_0B_0. An increase i, which raises demand, must be matched by an increase in L, which lowers demand. The assumptions of the model imply that the MM schedule is steeper than the BB schedule. The effect of an increase in L on the demand for home money

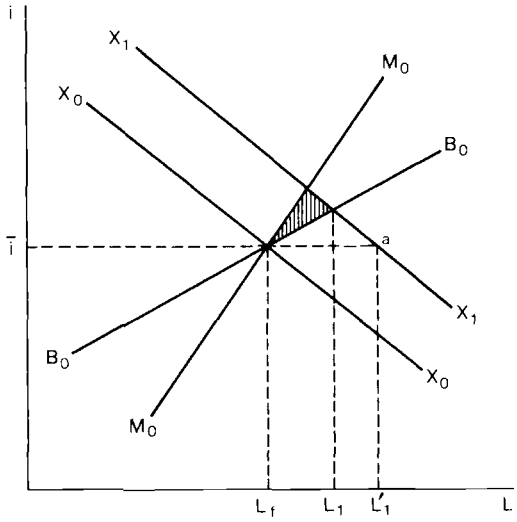

Fig. 11.1 Shift up in excess demand for home goods

20. As stated in n. 13, it is assumed that the demand for home nominal balances has a real income elasticity of unity. Furthermore, it is assumed that p and Y enter the demand for home securities only because home wealth minus home demand for nominal balances is the scale variable for home demand for these securities and that the disturbance term in the production function is multiplicative. These assumptions imply that $m_\beta = b_\beta = 0$ as can be confirmed by reference to the explicit expressions for the relevant approximation coefficients in the Appendix.

is greater than the absolute value of the effect of an increase in L on the demand for home securities: $m_L > b_L$ since $m_1 > b_1$ and $m_2 > b_2$. The absolute value of the effect of an increase in i on the demand for home money is smaller than the effect of an increase in i on the demand for home securities: $m_i = m_3 < b_3 + b_5 = b_i$. Because X_0X_0, M_0M_0, and B_0B_0 are the equilibrium schedules that would result if all disturbances were zero, they intersect at L_f. Changes in the exchange rate or in the balance sheet of the home authorities cause the schedules to shift in a manner described below.

Now consider the employment effects of disturbances to the excess demand for the home good. Such disturbances might result from shifts in the allocation of spending between home and foreign goods either at home or abroad or from a shift up in the productivity of home labor. Suppose an increase in the excess demand for the home good moves the XX schedule from X_0X_0 to X_1X_1 in figure 11.1. If the home authorities pursue an aggregates constant policy, a level of employment between L_f and L_1 results. Employment tends to increase, creating an excess demand for home money and an excess supply of home securities. Those disequilibria can only be removed by a rise in the home interest rate and an appreciation of the home currency. An appreciation of the home currency raises excess supply in the markets for the home good, home money, and home securities. As the home currency appreciates, the X_1X_1, M_0M_0, and B_0B_0 schedules shift toward one another until they intersect at a point in the shaded triangle. Under an aggregates constant policy, disturbances to the home good market induce changes in the interest rate and the exchange rate that dampen the movement in employment.

If instead the authorities pursue a rates constant policy, then following the increase in excess demand for the home good, the equilibrium point is point a, and the level of employment is L_1'. Since there are no dampening changes in the interest rate or the exchange rate, employment raises by the full amount necessary to reequilibrate the market for the home good. The authorities must undertake both monetary operations and intervention operations in order to keep i and e fixed given the change in employment. Expansionary monetary operations, purchases of home securities with home money, shift both the MM and BB schedules to the right. A monetary operation which shifts MM until it passes through point a also shifts BB farther to the right because $m_L > b_L$. Thus, in order to ensure that BB passes through point a, the authorities must undertake an intervention operation, a sale of home securities in exchange for foreign securities. When the only source of disturbances to equilibrium is shifts in the excess demand for the home good, an aggregates constant policy leads to less variation in employment than a rates constant policy.

A different conclusion is reached when disturbances to financial markets are considered. For purposes of illustration, attention is focused on a type

of disturbance for which intervention operations are the appropriate remedy, a shift in asset preferences between home and foreign securities. Suppose a shift in asset preferences away from home securities and toward foreign securities moves the BB schedule from B_0B_0 to B_1B_1 in figure 11.2. Under an aggregates constant policy a level of employment between L_1 and L_2 results. The decrease in demand for home securities leads to an increase in i, which in turn creates an excess supply of home money. In order for equilibrium in financial markets to be reestablished, the home currency must depreciate. The new equilibrium lies in the shaded triangle. Employment may rise, fall, or remain the same since the changes in financial variables have opposite effects on demand for the home good.

If instead the authorities pursue a rates constant policy, they accommodate the shift in asset preferences with an intervention operation. The BB schedule is shifted from B_1B_1 back to B_0B_0, and employment definitely remains unchanged. When the only source of disturbances to equilibrium is shifts in asset preferences between home and foreign securities, a rates constant policy leads to less variation in employment than an aggregates constant policy.

Two other possible sources of stochastic disturbances to equilibrium are (1) shifts in home residents' preferences between home money and foreign securities and (2) shifts in home residents' preferences between home money and home securities. In both these cases, a rates constant policy leads to less variation in employment than an aggregates constant policy. Under a rates constant policy the transmission of financial market disturbances to the market for the home good through interest rate and exchange rate changes is prevented.

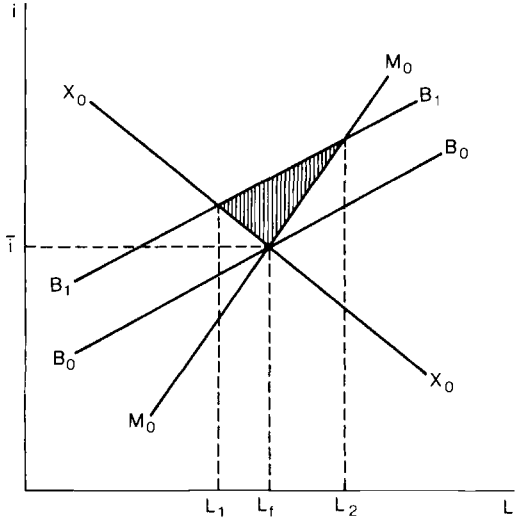

Fig. 11.2 Shift out of home securities into foreign securities

The results just described can be summarized more formally. The variances of home employment (σ_L^2) under rates constant (*RC*) and aggregates constant (*AC*) financial policy regimes are given by

$$\sigma_{L|RC}^2 = (1/y_L)^2(\sigma_\alpha^2 + y_\beta^2\sigma_\beta^2), \tag{23}$$

$$\sigma_{L|AC}^2 = (C_1/\Delta_1)^2(\sigma_\alpha^2 + y_\beta^2\sigma_\beta^2) + [(C_2 + C_3)/\Delta_1]^2\sigma_\gamma^2 + (C_2/\Delta_1)^2\sigma_\delta^2 + (C_3/\Delta_1)^2\sigma_\epsilon^2, \tag{24}$$

$$C_1 = m_i b_e + b_i m_e, \quad C_3 = y_i m_e - m_i y_e,$$

$$C_2 = y_i b_e + b_i y_e, \quad \Delta_1 = y_L C_1 + m_L C_2 + b_L C_3.$$

The two sums $C_2 + C_3$ and $m_L C_2 + b_L C_3$ are clearly positive if $y_e > 0$, since $b_i > m_i$, and $m_L > b_L$. It can be shown that they are positive even if $y_e < 0$.[21] Thus, if $\sigma_\gamma^2 = \sigma_\delta^2 = \sigma_\epsilon^2 = 0$ and either σ_α^2 or $\sigma_\beta^2 > 0$, then $\sigma_{L|AC}^2 < \sigma_{L|RC}^2$. If $\sigma_\alpha^2 = \sigma_\beta^2 = 0$ and σ_γ^2, σ_δ^2, or $\sigma_\epsilon^2 > 0$, then $0 = \sigma_{L|RC}^2 < \sigma_{L|AC}^2$.

Of course, financial authorities operating under the assumptions about the availability and use of information specified above and attempting to choose among alternative financial policies would probably be faced with all the types of transitory disturbances considered above. The analysis above provides only limited assistance. For example, given the coefficients of the model and all the other parameters of the joint distribution of disturbances, there exists a variance of the disturbance terms in the market for the home good large enough to ensure that an aggregates constant policy leads to a lower expected loss than a rates constant policy. Additional conclusions must be based on explicit calculations of expected losses. A special assumption yields a few further conclusions. Suppose that the three equilibrium conditions are normalized on employment and that the variances of the normalized disturbances are equal.[22] An aggregates constant policy may or may not be better than a rates constant policy, whereas under similar conditions in a closed economy a money supply constant policy dominates an interest rate constant policy. An aggregates constant policy is superior (inferior) to a rates constant policy for large values of the degree of substitutability between home and foreign securities (the responsiveness of home good demand to changes in the exchange rate).

The financial authorities would almost certainly have to deal with permanent as well as transitory disturbances.[23] The results regarding the effects of transitory disturbances under alternative pure financial policy regimes carry over with minor modifications to the case in which a permanent disturbance

21. For proof of this assertion, see the Appendix.

22. That is, suppose equations (20), (21), and (22) are divided through by y_L, m_L, and b_L, respectively; that $(\alpha + y_\beta\beta)/y_L = \beta'$, $(\gamma + \delta)/m_L = \delta'$, and $(-\gamma + \epsilon)/b_L = \epsilon'$ are disturbances that may be mutually correlated; and that $\sigma_{\beta'}^2 = \sigma_{\delta'}^2 = \sigma_{\epsilon'}^2$.

23. Meltzer (1978) has emphasized the importance of the distinction between permanent and transitory disturbances.

is also present.[24] As an example of a permanent disturbance, consider a once-and-for-all shift in demand from the foreign good to the home good. Of course, if private agents know that this disturbance has occurred and take it into account when setting the nominal wage, it has no effect on the average levels of output and employment. Now suppose that private agents do not realize immediately that this permanent disturbance has occurred. It seems reasonable to assume that the nominal wage would not be changed, at least for a while. During this time the average real wage would be lower and the average level of employment would be higher than their full employment values under either an aggregates constant or a rates constant financial policy regime. However, the deviation of average employment from its full employment level is smaller under an aggregates constant policy than under a rates constant policy because induced changes in the interest rate and the exchange rate dampen the movement in average employment. After a while private agents would recognize that levels of output above the full employment value were being observed more frequently than would be suggested by what was known about the joint probability distribution of the transitory disturbances. They would conclude that the economic structure had changed and would change the nominal wage. Important research on how private agents would go about trying to separate permanent from transitory disturbances under various sets of conditions is well under way, but it is not reported on here.[25]

11.4 Transitory Disturbances and Alternative Pure Financial Policies in a Single Open Economy with Indexing

Here the analysis of the home employment effects of transitory disturbances under alternative pure financial policy regimes is extended to the case in which there is indexing in the home economy ($0 > \mu \leq 1$). The behavior of the home and foreign financial authorities conforms to the description provided in section 11.3.

Allowing for indexing in the home country necessitates some changes in the compact form of the model of equations (20), (21), and (22). The equilibrium conditions for the markets for the home good, home money, and home securities become[26]

$$0 = -\tilde{y}_L\hat{L} - y_i\hat{i} + \tilde{y}_e\hat{e} + \alpha + \tilde{y}_\beta\beta, \tag{25}$$

$$\hat{M} = \tilde{m}_L\hat{L} - m_i\hat{i} + \tilde{m}_e\hat{e} - \tilde{m}_\beta\beta + \gamma + \delta, \tag{26}$$

24. Suppose there were a succession of permanent shifts in asset preferences away from home securities and toward foreign securities. A rates constant policy would be appropriate but would require a series of sales of foreign securities by the home authorities. A rates constant policy would still be feasible if the authorities exhausted their holdings of foreign securities since the authorities could sell foreign currency forward.

25. See, for example, Brunner, Cukierman, and Meltzer (1980).

26. See n. 19 above.

$$\hat{B} = -\tilde{b}_L\hat{L} + b_i\hat{i} + \tilde{b}_e\hat{e} + \tilde{b}_\beta\beta - \gamma + \epsilon, \tag{27}$$

where

$$\tilde{y}_L = y_p l_1\rho + y_Y x_1, \quad \tilde{m}_L = m_p l_1\rho + m_Y x_1, \quad \tilde{b}_L = b_p l_1\rho + b_Y x_1,$$

$$\tilde{y}_e = y_e - y_p\pi\rho, \quad \tilde{m}_e = m_e + m_p\pi\rho, \quad \tilde{b}_e = b_e - b_p\pi\rho,$$

$$\tilde{y}_\beta = y_p\rho - y_Y x_2, \quad \tilde{m}_\beta = m_p\rho - m_Y x_2, \quad \tilde{b}_\beta = b_p\rho - b_Y x_2,$$

and

$$\pi = \mu(1 - h), \quad \rho = 1/(1 - \mu h).$$

A tilde over a coefficient indicates that the coefficient has a different value with indexing. Though $\tilde{y}_L$, $\tilde{m}_L$, and $\tilde{b}_L$ have the same signs as y_L, m_L, and b_L, respectively, they are larger in magnitude. Each of these coefficients is the sum of the reinforcing effects on the market in question of the output and price rises induced by a rise in L. With indexing a given increase in L must be accompanied by a larger increase in p because a given increase in p leads to a smaller decrease in the real wage. The coefficient $\tilde{m}_e$ has the same sign as the coefficient m_e and is larger; $\tilde{y}_e$ and $\tilde{b}_e$ are smaller than y_e and b_e and may even be negative. The coefficients $\tilde{y}_e$, $\tilde{m}_e$, and $\tilde{b}_e$ are each the sum of the direct effect of a rise in e and the indirect effect through the induced rise in p on the market in question. With indexing, increases in e must be accompanied by increases in p if L is to remain constant. The indirect effects of a rise in e may reinforce the direct effect, as in the case of $\tilde{m}_e$, or counteract it, as in the cases of $\tilde{y}_e$ and $\tilde{b}_e$. Algebraically, $\tilde{y}_\beta$, $\tilde{m}_\beta$, and $\tilde{b}_\beta$ are larger than y_β, m_β, and b_β, respectively. The coefficient on β for each market is the result of subtracting the absolute value of the output effect of a positive β from the absolute value of the price effect. With indexing a given positive β induces a larger decrease in p. Positive β's lower nominal income decreasing the demand for home money ($-\tilde{m}_\beta < 0$) and increasing the demand for home securities ($\tilde{b}_\beta > 0$). Thus, a shift in demand from the foreign good to the home good and an increase in labor productivity can no longer be analyzed together.

The results with indexing can be summarized formally. The variances of home employment ($\tilde{\sigma}_L^2$) under rates constant and aggregates constant financial policy regimes are given by

$$\tilde{\sigma}_{L|RC}^2 = (1/\tilde{y}_L)^2(\sigma_\alpha^2 + \tilde{y}_\beta^2\sigma_\beta^2), \tag{28}$$

$$\begin{aligned}\tilde{\sigma}_{L|AC}^2 = {} & (\tilde{C}_1/\tilde{\Delta}_1)^2\sigma_\alpha^2 + [(\tilde{C}_1\tilde{y}_\beta + \tilde{C}_2\tilde{m}_\beta + \tilde{C}_3\tilde{b}_\beta)/\tilde{\Delta}_1]^2\sigma_\beta^2 \\ & + [(\tilde{C}_2 + \tilde{C}_3)/\tilde{\Delta}_1]^2\sigma_\gamma^2 + (\tilde{C}_2/\tilde{\Delta}_1)^2\sigma_\delta^2 + (\tilde{C}_3/\tilde{\Delta}_1)\sigma_\epsilon^2,\end{aligned} \tag{29}$$

where

$$\tilde{C}_1 = m_i\tilde{b}_e + b_i\tilde{m}_e, \quad \tilde{C}_3 = y_i\tilde{m}_e - m_i\tilde{y}_e,$$
$$\tilde{C}_2 = y_i\tilde{b}_e + b_i\tilde{y}_e, \quad \tilde{\Delta}_1 = \tilde{y}_L\tilde{C}_1 + \tilde{m}_L\tilde{C}_2 + \tilde{b}_L\tilde{C}_3.$$

For what follows, it is useful to note that since $b_i > m_i$ and $m_p > b_p$,

$$\tilde{C}_1 = m_i b_e + b_i m_e + \pi\rho(b_i m_p - m_i b_p) > 0$$

and that since $\tilde{b}_L m_p = \tilde{m}_L b_p$ and $\tilde{m}_L > \tilde{b}_L$,

$$\tilde{m}_L\tilde{C}_2 + \tilde{b}_L\tilde{C}_3 = y_i(\tilde{m}_L b_e + \tilde{b}_L m_e) + \tilde{y}_e(\tilde{m}_L b_i - \tilde{b}_L m_i)$$

can be negative if $\tilde{y}_e$ is negative and the second term on the right-hand side of the equals sign is large enough in absolute value to outweigh the first. Only if $\tilde{\Delta}_1 > 0$ do all the disturbances have their usual comparative static effects. It is assumed that $\tilde{\Delta}_1 > 0$ even if $\tilde{m}_L\tilde{C}_2 + \tilde{b}_L\tilde{C}_3 < 0$.

It is convenient to discuss the results for financial market disturbances first. Indexing does not change the conclusion that when the only sources of disturbances to equilibrium are shifts in asset preferences, a rates constant policy leads to less variation in employment than an aggregates constant policy because it prevents the transmission of financial disturbances to the market for the home good through interest rate and exchange rate changes. If $\sigma_\alpha^2 = \sigma_\beta^2 = 0$ and σ_γ^2, σ_δ^2, or $\sigma_\epsilon^2 > 0$, then $0 = \tilde{\sigma}_{L|RC}^2 < \tilde{\sigma}_{L|AC}^2$. The more difficult question of whether indexing increases or reduces the advantage of a rates constant policy is not addressed here.

Indexing necessitates a minor qualification to the result obtained in section 11.3 for a shift in demand from the foreign good to the home good. For this disturbance an aggregates constant policy still leads to less variation in employment than a rates constant policy unless the effect of a change in wealth on the demand for the home good is too large. The greater the degree of indexing (the larger μ and, therefore, $\pi\rho$), the larger the increase in the price of the domestic good induced by a depreciation of the home currency and the smaller the increase in the relative price of the foreign good ($e - p$). The smaller the increase in the relative price of the foreign good, the lower the algebraic value of the increase in the demand for the home good associated with a depreciation of the home currency:

$$\tilde{y}_e = -y_i + (1 - \pi\rho)[(y_2 + y_3)h + y_4 + y_6] + (y_5 - y_6).$$

What is critical for determining whether a positive μ and the associated lower $\tilde{y}_e$ can lead to a reversal of the result that an aggregates constant policy dominates is the size of the effect of a change in wealth on demand for the home good.[27] If this wealth effect is negligible (y_5, $y_6 \to 0$), then no matter what the degree of indexing ($0 < \mu$, $\pi\rho \leq 1$) an aggregates constant policy continues to dominate since $\tilde{m}_L\tilde{C}_2 + \tilde{b}_L\tilde{C}_3$ remains positive. However, if the

27. For proof of this assertion and the others in the remainder of this section, see the Appendix.

wealth effect is not negligible ($y_6 > y_5 > 0$), then a rates constant policy may dominate since $\tilde{m}_L\tilde{C}_2 + \tilde{b}_L\tilde{C}_3$ may be negative. For example, if indexing is complete, then when there is an intermediate degree of substitutability between home and foreign securities an aggregates constant policy dominates for small enough positive values of y_6 and y_5, but when home and foreign securities are highly substitutable, a rates constant policy is as good as an aggregates constant policy for $y_5 = y_6 = 0$, and a rates constant policy dominates for all $y_6 > y_5 > 0$.

The introduction of indexing complicates the comparison of aggregates constant and rates constant policies in the case of labor productivity disturbances. With indexing these disturbances directly affect all three markets. Thus, for labor productivity disturbances a rates constant policy might be preferred even if an aggregates constant policy would be preferred for disturbances that directly affect only the market for the home good.

11.5 Transitory Disturbances and Contemporaneous Financial Policy Feedback Rules in a Single Open Economy with No Indexing

In this section it is assumed that the financial authorities can observe current movements in financial variables not chosen as policy instruments and respond to them in attempting to dampen the effects of transitory disturbances. Furthermore, it is assumed that the authorities change a financial policy instrument in response to current information while the nominal wage remains fixed at a value set before other markets meet. That the authorities rather than private agents should adjust to current information even if it is available to both sets of agents seems reasonable since the costs associated with changing a financial policy instrument are much smaller than the costs associated with renegotiating the nominal wage.[28] Others have shown that in such an environment contemporaneous financial policy feedback rules usually dominate pure financial policies of the type considered in the last two sections.[29] Here it is demonstrated that a contemporaneous intervention

28. It could be assumed that the nominal wage was "indexed" to the financial variables not chosen as policy instruments and that financial policy instruments were not changed. If such an indexing rule were determined optimally, it would result in the same variation in employment as would the authorities' optimal feedback rule as shown in the context of a closed economy model by Canzoneri, Henderson, and Rogoff (1983). It appears that labor contracts involving indexing to financial variables are not negotiated, and conventional indexing is not a perfect substitute for this type of indexing.

29. The superiority of contemporaneous feedback rules was first demonstrated by Poole (1970). Kareken, Muench, and Wallace (1973) and Friedman (1975) significantly generalize and extend Poole's results. Boyer (1978) derives a contemporaneous feedback rule in a model in which home and foreign securities are perfect substitutes and exchange rate expectations are static. Roper and Turnovsky (1980) show how this rule is affected by the incorporation of a more general hypothesis regarding the formation of exchange rate expectations and an additional type of disturbance. Boyer (1980) considers feedback rules for the authorities in a model which is the same as the one used here in all essential respects except that expectations are static. Fischer's (1977) and Frenkel's (1980) optimal rules are derived in models quite different from the one employed here.

policy feedback rule is usually superior to either fixed or flexible exchange rates. This rule may imply reinforcing rather than dampening the movement in the exchange rate that would occur if there were no intervention.

As before, the financial authorities seek to mitigate the fluctuations in unobserved employment caused by different disturbances. The interest rate and the exogenous supply of home (currency) assets are chosen as policy instruments; the interest rate is kept rigidly fixed at an arbitrary value, and the exogenous supply of home assets is varied through intervention operations in response to the current information conveyed by exchange rate movements. Under these assumptions, the model of equations (20), (21), and (22) can be rewritten as

$$0 = -y_L\hat{L} + y_e\hat{e} + \alpha + y_\beta\beta, \tag{30}$$

$$\hat{B}' = b'_L\hat{L} + b'_e\hat{e} + \delta + \epsilon. \tag{31}$$

Equation (31) is obtained by summing equations (21) and (22). The change in the exogenous supply of all home assets, $\hat{B}' = \hat{B} + \hat{M}$, represents intervention operations since monetary operations leave the exogenous supply of home assets unchanged. Definitions of y_L and y_e are provided above, and

$$b'_L = m_L - b_L, \text{ and } b'_e = m_e + b_e.$$

Equilibrium schedules for the markets for the home good and home assets are shown in figure 11.3. The equilibrium schedule for the home good is X_0X_0. An increase in e, which raises demand, must be accompanied by an increase in L,

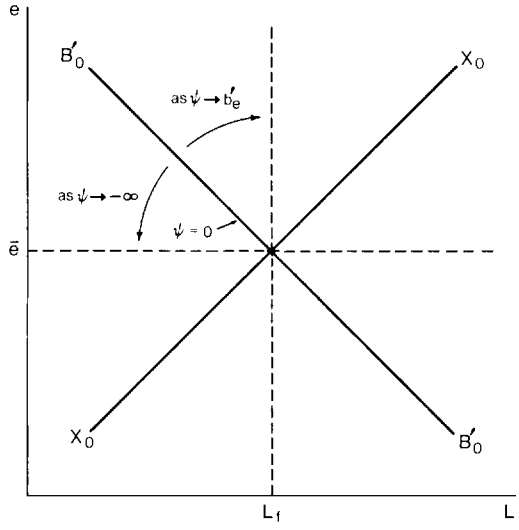

Fig. 11.3 Contemporaneous intervention policy feedback rule: slope of B′B′ schedule depends on reaction parameter.

which lowers excess demand. The equilibrium schedule for home assets is $B_0'B_0'$. A rise in e, which increases demand, must be offset by a fall in L, which reduces demand. The contemporaneous intervention policy feedback rule alters the slope of the $B'B'$ schedule in a manner described below.

Since the authorities observe the movement in the exchange rate, they observe a linear combination of the disturbances. To see this, solve (30) for $\hat{L}$, subsititute the result into (31), and rearrange to obtain

$$\hat{L} = (y_e/y_L)\hat{e} + (1/y_L)(\alpha + y_\beta\beta) = (y_e/y_L)\hat{e} + \theta, \tag{32}$$

$$\hat{B}' - (b_L'y_e/y_L + b_e')\hat{e} = b_L'\theta + \delta + \epsilon = \phi. \tag{33}$$

The authorities can observe the linear combination of disturbances represented by ϕ because they know or can observe everything to the left of the first equals sign in (33).

The authorities minimize the variance of employment by acting so as to make the expectation of the employment deviation conditioned on ϕ, $E(\hat{L}|\phi)$, equal to zero:

$$E(\hat{L}|\phi) = 0 = (y_e/y_L)\hat{e} + E(\theta|\phi), \tag{34}$$

where $E(\theta|\phi)$ is the expectation of θ conditional on ϕ, and [30]

$$\begin{aligned} E(\theta|\phi) &= [\mathrm{cov}(\theta, \phi)/\mathrm{var}(\phi)]\phi, \\ \mathrm{cov}(\theta, \phi) &= b_L'\sigma_\theta^2, \\ \mathrm{var}(\phi) &= b_L'^2\sigma_\theta^2 + \sigma_\delta^2 + \sigma_\epsilon^2, \\ \sigma_\theta^2 &= (1/y_L)^2(\sigma_\alpha^2 + y_\beta^2\sigma_\beta^2). \end{aligned} \tag{35}$$

Setting the conditional expectation of $\hat{L}$ equal to zero implies an intervention rule for the authorities. Substituting the left-hand side of (33) for ϕ in (35), substituting (35) into (34), and solving for $\hat{B}'$ yields this rule:

$$\begin{aligned} B' &= \psi e, \\ \psi &= b_e' - [y_e/(y_L b_L')][(\sigma_\delta^2 + \sigma_\epsilon^2)/\sigma_\theta^2]. \end{aligned} \tag{36}$$

If the authorities follow this rule, the equilibrium condition for the market for home assets (31) becomes

$$0 = b_L'\hat{L} + (b_e' - \psi)\hat{e} + \delta + \epsilon. \tag{37}$$

In general, the authorities should neither fix the exchange rate nor allow it to fluctuate freely. Only if disturbances in the market for home assets predominate $[(\sigma_\delta^2 + \sigma_\epsilon^2)/\sigma_\theta^2 \to \infty]$ should they fix the exchange rate (choose an indefinitely large negative value for ψ so that the $B'B'$ schedule becomes horizontal). By fixing the exchange rate they prevent any transmission of

30. In this section it assumed that the disturbances are normally distributed.

purely financial disturbances to the market for the home good. When disturbances to the market for the home good predominate [$(\sigma_\delta^2 + \sigma_\epsilon^2)/\sigma_\theta^2 \to 0$], the authorities should not simply allow the exchange rate to fluctuate freely (choose a value of zero for ψ so that the $B'B'$ schedule remains unaffected). Rather, they should reinforce any tendency for the home currency to depreciate by selling home assets. By making the market for home assets completely insensitive to exchange rate movements (choosing a value of b_e' for ψ so that the $B'B'$ schedule becomes vertical), thereby amplifying exchange rate movements that would occur in the absence of intervention, the authorities generate exchange rate movements that completely offset disturbances to the market for the home good.

The intervention rule just derived is not the truly optimal contemporaneous financial policy feedback rule except in the extreme cases in which $(\sigma_\delta^2 + \sigma_\epsilon^2)/\sigma_\theta^2$ approaches infinity or zero. The shortcoming of this rule is that it does not reflect the information about θ embodied in the changes in the money supply required to keep the interest rate fixed. The truly optimal intervention policy rule requires intervention to be a linear function of both exchange rate changes and money supply changes. However, few additional qualitative insights can be gained from the considerably more complicated optimal rule.

Even under the optimal financial policy, one policy instrument, the interest rate in the example considered above, can be kept rigidly fixed. It is assumed that the authorities have only a single objective, minimizing the variance of employment, and that the coefficients of the model are known with certainty. Therefore the authorities need vary only one policy instrument, the exogenous supply of home assets, to do as well as they can. If either of these assumptions were relaxed, optimal financial policy would involve variations in both policy instruments as well as in both information variables.[31] Thus, in general, it is optimal for an individual country to opt for managed floating rather than a fixed or freely floating exchange rate whether the exchange rate is chosen as a policy instrument or used as an information variable.

11.6 The Exchange Rate and the Interest Rate as Information Variables

For many years the search for a way to extract information from financial data about the likely realizations of unobserved target variables was a quest

31. Brainard (1967) shows that if the coefficients of the model are stochastic variables which have a joint distribution with the additive disturbances that is known to the authorities, then in general an optimal financial policy requires that all financial variables chosen as policy instruments be set at well-defined values even if the authorities seek to minimize the squared deviations of only a single target variable from its target value. If they operated in this environment, the authorities would have to make inferences about the coefficients of the model as well as about the additive disturbances.

for the best single indicator of the stance of monetary policy. In section 11.5, the current view that more information can be obtained if movements in a number of financial variables are analyzed simultaneously is stated in broad terms. Here there is a more explicit discussion of how the authorities can use exchange rate movements in conjunction with interest rate movements to reduce but not eliminate their uncertainty about the source of disturbances to the economy. It is assumed that the monetary authorities choose the money supply and the supply of home securities as their policy instruments and set them for some interval of time before changing them in response to their inferences about the likely movement in unobserved employment. The tool of analysis is the version of the model used in section 11.3.

Some results have already been obtained. In section 11.3 it was argued that a shift up in excess demand for the home good depicted in figure 11.1 leads to an increase in the interest rate, an appreciation of the home currency, and a rise in unobserved employment. A shift up in excess demand for the home good can be distinguished from a shift in asset preferences away from home securities and toward foreign securities on the basis of movements in financial variables. In the case of a shift in asset preferences represented in figure 11.2, the interest rate rises but the home currency depreciates. As stated above, the effect of this disturbance on unobserved employment is ambiguous in general. However, this effect is likely to be positive. If, as seems probable, the responsiveness of home money demand to the foreign interest rate adjusted for exchange rate expectations (m_4) is small, then with employment held constant a depreciation of the home currency clears the financial markets with little change in the interest rate. The interest rate rises primarily because the employment increase generated by the depreciation raises money demand. Since both of the disturbances probably lead to increases in unobserved employment, the importance of being able to distinguish between them arises because the appropriate responses are different. In the case of a shift up in excess demand for the home good, the authorities would probably want to both reduce the home money supply and intervene to cause an appreciation of the home currency. In the case of a shift in asset preferences away from home securities, the authorities would probably want simply to intervene to prevent the home currency from depreciating.

Now consider a shift up in money demand at the expense of the demand for home securities. As shown in figure 11.4, this disturbance shifts both the MM and BB schedules up, from M_0M_0 to M_1M_1 and B_0B_0 to B_1B_1, respectively; the MM schedule shifts farther up because $m_i < b_i$. If M_1M_1 and B_1B_1 intersect below X_0X_0, as in figure 11.4, then the new equilibrium is in the shaded area. The interest rate rises; the home currency appreciates, and unobserved employment falls. If M_1M_1 and B_1B_1 intersect above X_0X_0, the only difference is that the home currency depreciates. The case in which the home currency appreciates is probably more relevant. The home cur-

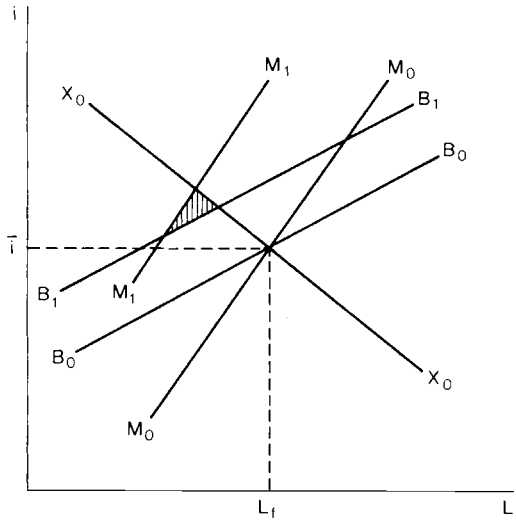

Fig. 11.4 Shift into home money out of home securities

rency is more likely to appreciate the more similar in absolute value are the employment responsivenesses of the demands for home money and home securities, and the better substitutes are home and foreign securities.[32] Thus, exchange rate movements probably make it no easier for the authorities to distinguish between two important sources of disturbances, shifts in excess demand for the home good and shifts in money demand, to which they would want to respond very differently.

There is a presumption that exchange rate movements can help the authorities separate shifts in money demand from changes in expected inflation. Just how to model an increase in expected inflation is not immediately obvious. The experiment conducted here is perhaps the simplest, though clearly not the most realistic. It is assumed that, after nominal wages are set, private agents raise their estimates of next period's price level ($\bar{p}$) and next period's exchange rate ($\bar{e}$) by the same proportion ($\hat{\bar{p}} = \hat{\bar{e}}$) and foresee that the price level and the exchange rate will remain at these new, higher values forever. Such a revision of expectations would be warranted if private agents came to believe that there would be a one-time "helicopter drop" of home money and home securities next period that would increase the stocks of these assets by the same proportion ($\hat{\bar{p}} = \hat{\bar{e}} = \hat{\bar{M}}/\bar{M} = \hat{\bar{B}}/\bar{B}$). As shown in figure 11.5, this kind of increase in expected inflation (with the associated increase in the rate of expected depreciation of the home currency) leads to an increase in the demand for the home good, which shifts the XX schedule from X_0X_0 to X_1X_1, and to decreases in the demands for home money and

32. For proof of this assertion, see the Appendix.

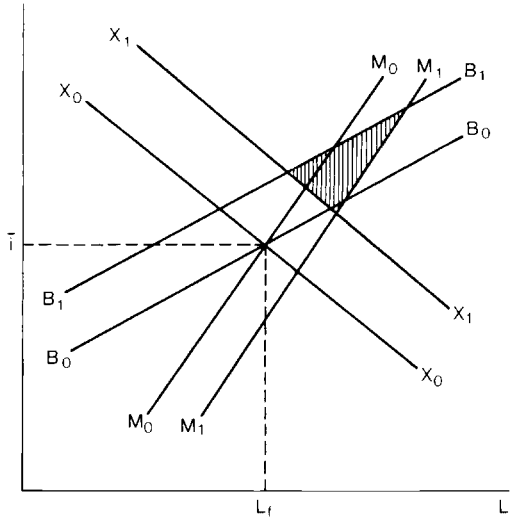

Fig. 11.5 Increase in expected inflation

home securities, which shift the MM schedule from M_0M_0 to M_1M_1 and the BB schedule from B_0B_0 to B_1B_1, respectively. The XX schedule shifts up farther than the BB schedule, and X_1X_1 and B_1B_1 intersect above M_1M_1.[33] If M_1M_1 and X_1X_1 intersect above $\bar{i}$, as in figure 11.5, then the new equilibrium is in the shaded area. The interest rate rises, the home currency depreciates, and unobserved employment rises. If M_1M_1 and X_1X_1 intersect below $\bar{i}$, the only difference is that the interest rate may fall instead of rising. The case in which the interest rate rises is probably more relevant. The interest rate is more likely to rise the smaller the responsiveness of home money demand to the foreign interest rate adjusted for exchange rate expectations (m_4)—that is, the smaller the reduction in money demand resulting from the disturbance—and the better substitutes are home and foreign securities. Thus, the presumption is that shifts in money demand need not be mistaken for revisions in inflation expectations. Disturbances of the two types that have the same implications for the interest rate have different implications for the exchange rate. This presumption may turn out to be particularly helpful in the current policymaking environment. Changes in the financial structure have made pinning down money demand more problematic. At the same time, the authorities have undertaken policies explicitly designed to cause private agents to lower their estimate of expected inflation.

33. Given that $(\hat{\bar{e}} = \hat{\bar{p}})$, $(\hat{i}/\hat{\bar{p}})_{XX} = 1$, $(\hat{i}/\hat{\bar{p}})_{BB} = (b_4 + b_5)/(b_3 + b_5) < 1$ since $b_3 > b_4$. X_1X_1 and B_1B_1 intersect above M_1M_1 since the home currency depreciates. For proof of the assertions in this note and those in the accompanying paragraph in the text, see the Appendix.

11.7 Vicious Circles and Intervention Policy

It is often argued that more flexibility in exchange rates has led to the development of so-called vicious (and virtuous) circles.[34] There is no generally accepted benchmark for use in isolating phenomena which are to be designated as vicious circles. All that is really clear is that those concerned about vicious circles have in mind a positive association between depreciations of a country's currency and increases in measures of that country's price level.

The response has been that increased exchange rate flexibility is not really the root cause of vicious circles. Skeptics point out that a country's monetary authorities can cause both a depreciation of their country's currency and an increase in its price indices by initiating an expansion of their country's money supply. Furthermore, these skeptics argue, exogenous disturbances cannot lead to depreciations and price index increases unless monetary policy is accommodating. Thus, the monetary authorities either directly cause vicious circles or allow them to occur.

There is much to agree with in the skeptical view. However, in some policymaking environments with plausible features, allowing the exchange rate to fluctuate rather than keeping it fixed with intervention operations can change the set of outcomes attainable by the financial authorities in a way that they might legitimately regard as unfavorable. The example of such an environment discussed here has two key features: (1) the nominal wage is partially indexed, and (2) intervention operations can affect the exchange rate.

The objective of the financial authorities is assumed to be the stabilization of employment as before. However, in this section it is assumed that the financial authorities obtain complete information about the disturbances that occur in any period and can respond to this information within the period. Given the types of disturbances included in the model of section 11.2, stabilizing employment implies keeping the change in the real wage measured in terms of home output ($\hat{w} - \hat{p}$) equal to the productivity disturbance (β). Given the objective of the home financial authorities and that the foreign authorities stabilize $\overset{*}{p}$, $\overset{*}{Y}$, and $\overset{*}{i}$, the model of section 11.2 can be rewritten in the following compact form:[35]

$$0 = -y_p\hat{p} - y_i\hat{i} + y_e\hat{e} + \alpha + y_\beta\beta, \tag{38}$$

$$\hat{M} = m_p\hat{p} - m_i\hat{i} + m_e\hat{e} + \gamma + \delta, \tag{39}$$

34. The analysis of this section is based on Henderson (1980) which, in turn, was inspired by Wallich and Gray (1981).

35. The substitutions used to obtain equations (38)–(41) are similar to the ones used to obtain equations (20)–(22) following the procedure of n. 19. However, the expression for p is retained as equation (41) rather than being used to eliminate p from the modified versions of (1), (17), and (19), and L is set equal to zero wherever it appears.

$$\hat{B} = -b_p\hat{p} + b_i\hat{i} + b_e\hat{e} - \gamma + \epsilon, \tag{40}$$

$$0 = -\hat{p} + \pi\rho\hat{e} - \rho\beta. \tag{41}$$

Of course, under both fixed and flexible exchange rates, a shift out of money into home securities ($\gamma < 0$) can be offset with a contractionary open market operation ($\hat{M} = -\hat{B} < 0$) with no change in any other endogenous variable.

Now consider a shift down in the demand for the home good ($\alpha < 0$). Suppose the nominal interest rate is lowered by enough to reequilibrate the market for the home good through an increase in the money supply accomplished by an expansionary open market operation ($\hat{M} = -\hat{B} > 0$). The open market operation which clears the home money market at the new lower nominal interest rate results in an excess supply of home securities since the decline in the nominal interest rate lowers the demand for home securities by more than it raises the demand for home money. The excess supply of home securities gives rise to a tendency for the home currency to depreciate. Under fixed exchange rates, the financial authorities react to the pressure on the exchange rate with an intervention operation, a sale of foreign securities matched by a purchase of home securities ($\hat{B} < 0$, $\hat{M} = 0$), so that the exchange rate, and therefore the price of the home good and the price index, remain unchanged. However, under flexible exchange rates, the financial authorities allow the home currency to depreciate (e to rise). This depreciation leads to an increase in the price index and the partially indexed nominal wage. In order for the real wage to remain constant (as it must since $\beta = 0$), the price of home output must rise, but the increase in p is less than the rise in e because indexation is only partial. Since both the price of the home good (p) the relative price of the foreign good ($e - p$) rise, the nominal interest rate decline needed to reequilibrate the market for the home good may be larger or smaller under floating exchange rates.[36]

36. If indexing were complete ($\mu = 1$), the relative price of the foreign good would remain unchanged and i would definitely decline by more under flexible exchange rates. In this case, the real wage measured in terms of the consumption basket as well as the real wage measured in terms of home output would remain unchanged. The direct effect of a decline in i on the demand for home output is to raise this demand. However, there are also some induced effects. If i falls, e rises, p increases, and $\hat{M} = -\hat{B}$ increases. These changes must take place in order to satisfy (39), (40), and (41). The rise in e raises the demand for home output, but the increase in p lowers this demand. Throughout this section, it is assumed that the net result of the direct and induced effects of a decline in i on the demand for home output is an increase in this demand. More formally, it is assumed that

$$y_i > -\tilde{y}_e[(b_i - m_i)/(\tilde{m}_e + \tilde{b}_e)],$$

where $\tilde{y}_e$, $\tilde{m}_e$, and $\tilde{b}_e$ are defined below equation (27). This condition is always met if $\tilde{y}_e \geq -y_i$, since it can be shown that the expression in square brackets is positive and less than one. In section 11.4 it is shown that $\tilde{y}_e \geq -y_i$ for all y_5, $y_6 > 0$ if the indexing parameter is small ($\mu \to 0$) and that $\tilde{y}_e \geq -y_i$ for all $0 < \mu \leq 1$ if the effect of wealth on aggregate demand is negligible (y_5, $y_6 \to 0$).

Next consider a shift down in the productivity of labor ($\beta < 0$). It is useful to begin the analysis of this disturbance by noting that if the exchange rate were fixed, p would have to rise in order to lower the real wage by enough to match the drop in β. Suppose this rise in p occurs. It adds to the excess supply of the home good caused by the direct effect of the decline in β on the market for the home good. Further, suppose that the nominal interest rate is lowered by enough to reequilibrate the market for the home good. To accommodate the rise in p and the decline in i hypothesized above, the authorities must increase the money supply with an expansionary open market operation. The open market operation which clears the home money market at the higher p and lower i may result in either an excess supply or excess demand for home securities. The decline in i lowers the demand for home securities by more than it raises the demand for home money, but the rise in p lowers the demand for home securities by less than it raises the demand for home money. Thus, under fixed exchange rates, the authorities may be required either to purchase or to sell home securities in exchange for foreign securities to stabilize the exchange rate, thereby preventing any further movement in p and the price index. It follows that under flexible exchange rates the home currency may either depreciate or appreciate and the initial increase in p and q may be amplified or dampened according to the logic employed above in the analysis of a shift in demand for the home good.

A similar line of argument can be used to establish that for a shift out of home money into foreign securities ($\delta < 0$) or a shift out of home securities into foreign securities ($\epsilon < 0$), stabilizing employment leads to no change in e, p, q, or i under fixed exchange rates. Under flexible exchange rates, both disturbances lead to a depreciation of the home currency and increases in p and q. Whether i increases or decreases depends on whether the increases in p and $e - p$ which satisfy the condition that the real wage must remain constant, equation (41), lead to an excess demand for, or supply of, the home good.

These results have implications for the trade-off between output variability and price level (home good price and price index) variability under the two alternative exchange rate regimes. In order to achieve the same amount of output variability under both exchange rate regimes, the authorities will have to accept more price variability under floating exchange rates, except perhaps in the case of disturbances in labor productivity. This change in the authorities' trade-off between output and price variability might legitimately be regarded as unfavorable and is suggestive of the concerns of those who emphasize the importance of vicious circles. However, further analysis is necessary before firm conclusions can be drawn about the importance of the results derived above. It is important to establish a basis for the authorities' concern about price level variability and to study the effects of possible

responsiveness of the indexing parameter to changes in exchange rate regime.[37]

11.8 Transitory Disturbances and the Scope for Agreement on Intervention Policy in a Two-Country World Economy with No Indexing

In this section it is assumed that neither the home authorities nor the foreign authorities observe the current values of their country's output, employment, or the price of their country's good. As a result, transitory disturbances such as those considered above affect employment in both countries of the two-country world economy. For simplicity, it is also assumed that the authorities in each country use monetary operations to fix the interest rate on securities denominated in the currency of their country. The overall stance of intervention policy is the net result of the intervention operations of the two sets of authorities. Taken together, they can choose as a policy instrument and set a value for either the exogenous supply of home assets (and, by implication, the exogenous supply of foreign assets) or the exchange rate. In this environment it is interesting to consider whether the authorities in the two countries could agree on a fixed or a freely fluctuating exchange rate.[38]

Under the assumptions of this section the relevant version of the model of section 11.2 written in compact form is[39]

$$0 = -y_L\hat{L} + y_e\hat{e} + y_L^*\hat{\overset{*}{L}} + \alpha + y_\beta\beta, \tag{42}$$

$$\hat{B}' = b_L'\hat{L} + b_e'\hat{e} - b_L'\hat{\overset{*}{L}} + \delta + \epsilon, \tag{43}$$

$$0 = \overset{*}{y}_L\hat{L} - \overset{*}{y}_e\hat{e} - \overset{*}{y}_L\hat{\overset{*}{L}} - \alpha. \tag{44}$$

Definitions of y_L, y_e, $\hat{B}'$, b_L', and b_e' are provided above, and

37. Flood and Marion (1982) assume that agents choose the indexing parameter in order to maximize expected utility and find that the optimal indexing parameter is different under alternative exchange rate regimes.

38. Sweeney (1976) and Canzoneri (1982) analyze open economy financial policy using two-country models.

39. Equations (5) and (7) are substituted into (3), and (6) and (8) are substituted into (4). The resulting versions of (3) and (4) are substituted into (1) and (2). Equations (9) and (10) are substituted for Y and $\overset{*}{Y}$ in (1), (2), (17), and (19). Equations (5), (7), and (15) are substituted into (13), and equations (6), (8), and (16) are substituted into (14). The modified versions of (13) and (14) are used to eliminate w and $\overset{*}{w}$ from (11) and (12). The modified versions of (11) and (12) are employed to obtain expressions for p and $\overset{*}{p}$ which are independent of e under the assumption that $\mu = \overset{*}{\mu} = 0$. These expressions are substituted for p and $\overset{*}{p}$ wherever they appear in (1), (2), (17), and (19). The modified versions of (1) and (2) and the sum of (17) and (19) with the disturbances set equal to zero are subtracted from the same equations with the distrurbances free to take on any value to obtain (42), (43), and (44).

$$y_L^* = y_p^* \overset{*}{l}_1 + y_Y^* \overset{*}{x}_1, \qquad \overset{*}{y}_L = \overset{*}{y}_p l_1 + \overset{*}{y}_Y x_1,$$
$$b_L^{\prime *} = b_L^* = b_p^* \overset{*}{l}_1 + b_Y^* \overset{*}{x}_1, \qquad \overset{*}{y}_e = \overset{*}{y}_p^* - \overset{*}{y}_3 - \overset{*}{y}_6 + \overset{*}{y}_5,$$
$$\overset{*}{y}_L^* = \overset{*}{y}_p^* \overset{*}{l}_1 + \overset{*}{y}_Y^* \overset{*}{x}_1,$$

and

$$y_p^* = y_4 - (y_2 + y_3)(1 - h), \qquad y_Y^* = y_1, \qquad b_p^* = b_8,$$
$$\overset{*}{y}_p = y_4 - (\overset{*}{y}_2 + \overset{*}{y}_3)h, \qquad \overset{*}{y}_Y = \overset{*}{y}_1, \qquad b_Y^* = b_9,$$
$$\overset{*}{y}_p^* = y_4 + (\overset{*}{y}_2 + \overset{*}{y}_3)(1 - h) + \overset{*}{y}_6, \qquad \overset{*}{y}_Y^* = s + y_1.$$

It is assumed that income, relative price, and wealth effects outweigh possibly perverse expected real interest rate effects so that y_L^*, $\overset{*}{y}_e$, and $\overset{*}{y}_L$ are all positive. In order to simplify the analysis further, it is assumed that the two countries are "symmetric" in the sense that $y_L = \overset{*}{y}_L^*$, $\overset{*}{y}_L = y_L^*$, $b_L^{\prime} = b_L^{\prime *}$, and $y_e = \overset{*}{y}_e$.[40]

Equilibrium schedules for the markets for the home good, the foreign good, and home assets are shown in figure 11.6. The equilibrium schedule for the home good is X_0X_0. An increase in L, which reduces excess demand, must be matched by a rise in $\overset{*}{L}$, which increases demand. The equilibrium schedule for the foreign good is $\overset{*}{X}_0\overset{*}{X}_0$. An increase in L, which raises

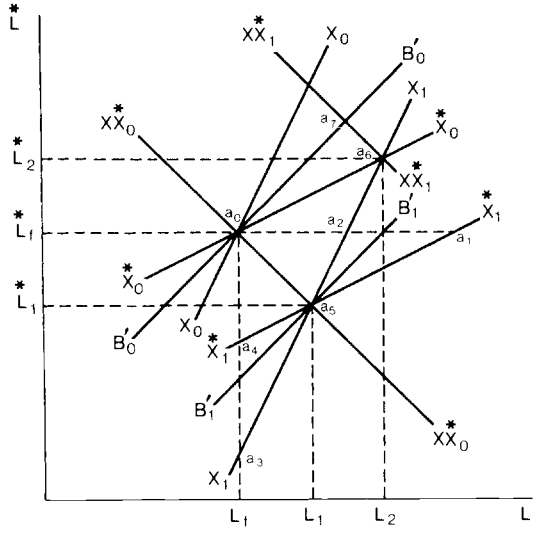

Fig. 11.6 Disturbances in a two-country world economy

40. In Henderson (1982) all these assumptions except the one that $y_e = \overset{*}{y}_e$ are relaxed. Although the analysis is more complicated, the results are basically the same.

demand, must be matched by a rise in $\overset{*}{L}$, which reduces excess demand. Under the symmetry assumption the slope of the XX schedule is greater than positive one, and the slope of the XX schedule is the reciprocal of the slope of the $\overset{**}{XX}$ schedule:

$$(\hat{L}/\hat{L})_{XX} = 1/(\overset{*}{\hat{L}}/\hat{L})^{**}_{XX} = y_L/y^*_L > 1.$$

The restrictions on the parameters of equations (42), (43), and (44) imply that $y_L > \overset{*}{y}_L$; the absolute value of the reduction in excess demand for the home good caused by a rise in L which increases home saving as well as home imports exceeds the increase in excess demand for the foreign good caused by a rise in L which increases not only foreign exports (home imports) but also foreign saving. The symmetry assumption implies that $\overset{*}{y}_L = y^*_L$. The equilibrium schedule for the market for home assets is $B'_0B'_0$. An increase in L, which raises the demand for home money plus home securities, must be offset by a rise in $\overset{*}{L}$, which raises the demand for foreign money partly at the expense of the demand for home securities. Under the symmetry assumption, the slope of the $B'B'$ schedule is $+1$. Therefore, the $B'B'$ schedule is steeper than the $\overset{**}{XX}$ schedule.

It is useful to consider first the effects of a shift up in the demand for the home good matched by a shift down in the demand for the foreign good which is equal in absolute value ($\alpha > 0$). Such a shift can be represented by movements in the XX and $\overset{**}{XX}$ schedules from X_0X_0 to X_1X_1 and from $\overset{*}{X}_0\overset{*}{X}_0$ to $\overset{*}{X}_1\overset{*}{X}_1$, respectively. At a constant value of $\overset{*}{L}$, $\overset{**}{XX}$ shifts farther to the right than XX ($a_0a_1 > a_0a_2$) since $y_L > \overset{*}{y}_L$ as argued above. Similarly, at a constant value of L, XX shifts down farther than $\overset{**}{XX}$ ($a_0a_3 > a_0a_4$) since $\overset{*}{y}^*_L > y^*_L$ from the symmetry assumption. A series of demand shifts of the type under consideration would trace out the $\overset{*}{X}X_0\overset{*}{X}X_0$ schedule in figure 11.6.

As an intermediate step, consider the effect of a depreciation of the home currency. Under the symmetry assumption this depreciation raises demand for the home good and lowers demand for the foreign good by amounts that are equal in absolute value. Thus depreciations (appreciations) move the XX and $\overset{**}{XX}$ schedules down (up) so that they continue to intersect on the $\overset{*}{X}X_0\overset{*}{X}X_0$ schedule.

Now the analysis of a shift in demand to the home good from the foreign good can be completed. The shifted XX and $\overset{**}{XX}$ schedules are X_1X_1 and $\overset{*}{X}_1\overset{*}{X}_1$. Under fixed rates the equilibrium is at point a_5. The shift in preferences for goods causes home employment to rise and foreign employment to fall. Both of these movements tend to raise demand for home currency assets, so the home currency tends to appreciate. However, the authorities undertake intervention operations, sales of home securities for foreign securities which shift the $B'B'$ schedule down. The new $B'B'$ schedule labeled

$B_1'B_1'$ passes through a_5. Under flexible exchange rates the home currency appreciates, dampening the rise in home employment and the fall in foreign employment. The $B'B'$ schedule shifts down and the XX and $\overset{**}{XX}$ schedules shift up along $\overset{*}{XX}_0\overset{*}{XX}_0$ until an equilibrium is reached somewhere on the line segment a_0a_5 above a_5. Thus, for shifts in demand between home and foreign goods there is less variation in both home and foreign output under floating exchange rates, and there is no policy conflict.

Next, consider a shift in asset preferences toward home assets and away from foreign assets. For convenience, suppose that the initial equilibrium is at a_5. The change in asset preferences shifts the $B'B'$ schedule from $B_1'B_1'$ to $B_0'B_0'$. Under fixed exchange rates the new equilibrium is at a_5, which is also the initial equilibrium. The shift in asset preferences puts pressure on the home currency to appreciate. Under fixed exchange rates this pressure is met by intervention operations, sales of home securities in exchange for foreign securities, which shift the $B'B'$ schedule from $B_0'B_0'$ back to $B_1'B_1'$. Under flexible exchange rates the home currency appreciates, lowering home employment and raising foreign employment. The $B'B'$ schedule shifts down and XX and $\overset{**}{XX}$ shift up along $\overset{*}{XX}_0\overset{*}{XX}_0$ until a new equilibrium is reached along the line segment a_0a_5 above a_5. Thus, for shifts in asset preferences between home and foreign assets there is less variation in both home and foreign employment under fixed exchange rates, and once again there is no policy conflict.

Finally, consider an increase in the productivity of labor in the home country. Suppose the original equilibrium is at a_0. This disturbance initially affects only the XX schedule, which is shifted from X_0X_0 to X_1X_1. Under fixed exchange rates the new equilibrium is at a_6. Home employment rises and, as a result of induced home demand for foreign goods, foreign employment rises. Since the $B'B'$ schedule is steeper than the $\overset{**}{XX}$ schedule, there is pressure on the home currency to appreciate. Under fixed exchange rates this pressure is countered with intervention operations which cause the $B'B'$ schedule to shift down from $B_0'B_0'$ until it passes through a_6. Under flexible exchange rates the home currency appreciates, dampening the rise in home employment but amplifying the rise in foreign employment. The $B'B'$ schedule shifts down, and the XX and $\overset{**}{XX}$ schedules shift up along the new $\overset{*}{XX}\overset{*}{XX}$ schedule $\overset{*}{XX}_1\overset{*}{XX}_1$ until a new equilibrium is reached on the line segment a_7a_6 above a_6. Thus, for shifts in home labor productivity there is more variation in home employment under fixed exchange rates and more variation in foreign employment under flexible exchange rates, and there is a definite policy conflict.

The results just described can be summarized more formally. The variances of home employment (σ_L^2) and foreign employment ($\sigma_{\overset{*}{L}}^2$) under fixed ($FI$) and flexible ($FL$) exchange rates given the symmetry assumption are

$$\sigma_{L|FI}^2 = [(y_L - \overset{*}{y}_L)/D_1]^2\sigma_\alpha^2 + (y_L/D_1)^2y_\beta^2\sigma_\beta^2, \tag{45}$$

$$\sigma^2_{L|FI} = [(\overset{*}{y}_L - y_L)/D_1]^2\sigma^2_\alpha + (\overset{*}{y}_L/D_1)^2 y^2_\beta \sigma^2_\beta, \tag{46}$$

$$\sigma^2_{L|FL} = [b'_e(y_L - \overset{*}{y}_L)/\Delta_2]^2\sigma^2_\alpha + (D_3/\Delta_2)^2 y^2_\beta \sigma^2_\beta + [y_e(\overset{*}{y}_L - y_L)/\Delta_2]^2(\sigma^2_\delta + \sigma^2_\epsilon), \tag{47}$$

$$\sigma^2_{L|FL} = [b'_e(\overset{*}{y}_L - y_L)/\Delta_2]^2\sigma^2_\alpha + (D_4/\Delta_2)^2 y^2_\beta \sigma^2_\beta + [y_e(y_L - \overset{*}{y}_L)/\Delta_2]^2(\sigma^2_\delta + \sigma^2_\epsilon). \tag{48}$$

$$D_1 = y^2_L - \overset{*}{y}^2_L, \qquad D_3 = y_e b'_L + b'_e y_L,$$

$$D_2 = b'_L(y_L - \overset{*}{y}_L), \quad D_4 = y_e b'_L + b'_e \overset{*}{y}_L,$$

$$\Delta_2 = b'_e D_1 + y_e D_2.$$

The expressions D_1, D_2, D_3, D_4, and Δ_2 are all positive. Thus if $\sigma^2_\beta = \sigma^2_\delta = \sigma^2_\epsilon = 0$ and $\sigma^2_\alpha > 0$, then $\sigma^2_{L|FL} < \sigma^2_{L|FI}$ and $\sigma^2_{L|FL} < \sigma^2_{L|FI}$. If $\sigma^2_\alpha = \sigma^2_\beta = 0$ and either σ^2_δ or $\sigma^2_\epsilon > 0$, then $0 = \sigma^2_{L|FI} < \sigma^2_{L|FL}$ and $0 = \sigma^2_{L|FI} < \sigma^2_{L|FL}$. By manipulating the coefficients in (45), (46), (47), and (48) it can be shown that if $\sigma^2_\alpha = \sigma^2_\delta = \sigma^2_\epsilon = 0$ and $\sigma^2_\beta > 0$, then $\sigma^2_{L|FL} < \sigma^2_{L|FI}$ but $\sigma^2_{L|FI} < \sigma^2_{L|FL}$.

11.9 The Effects of Intervention Operations: The Theoretical Underpinning

According to the theory of international financial markets developed and elaborated during the 1970s a necessary and sufficient condition for sterilized intervention policy to have effects on the exchange rate and interest rate is that securities denominated in different currencies be imperfect substitutes. Recently this proposition has been challenged: it has been argued that securities being imperfect substitutes is neither a necessary nor a sufficient condition for intervention policy to have effects.[41] That is, proponents of this view argue that resolving the debate about whether securities denominated in different currencies are imperfect substitutes in private portfolios would not settle the issue of whether sterilized intervention has effects.

The argument that intervention policy can alter the exchange rate even if securities are perfect substitutes is considered first. According to this argument, sterilized intervention would not affect the exchange rate if it did not alter expectations about the future values of other variables, perhaps most importantly monetary policy instruments. However, it can have effects if it does alter expectations.[42] Some may regard this argument as a useful extension of previous theory. Others may regard it as simply a precise restatement of an argument often used to justify intervention under the adjustable peg

41. Stockman (1979) provides a clear statement of both parts of this argument. Obstfeld (1980, 1982*a*) develops the second part.

42. Stockman (1979) has explicitly modeled the possible effects of intervention on expectations.

Bretton Woods system. In any case, the argument is not just a trivial special case of the proposition that any policy action might alter expectations. Intervention policy and monetary policy are often, if not always, in the hands of the same authorities. Furthermore, losses on foreign exchange positions can lead to significant political problems for the authorities. Thus, if the authorities undertake an intervention policy which would generate foreign exchange losses if their pronouncements about future monetary policy were not put into effect, there might be more reason for private agents to take these pronouncements seriously. However, private agents do have a number of past episodes on which to base an evaluation of such policy packages, some of which would tend to make them wary.

The argument that intervention policy may not alter the exchange rate when securities are imperfect substitutes represents a more fundamental challenge to previous theory. It has long been recognized that the answers to certain basic questions, such as whether open market operations are neutral and whether replacing tax financing of government expenditure with bond financing is neutral, depend on whether government bonds are net wealth, that is, on whether private agents regard the claims and obligations of the government as their own. For the most part, closed economy models have been used to chart this territory. Recent contributions make clear that whether sterilized intervention can affect the exchange rate when securities are imperfect substitutes also depends on whether private agents "see through" government transactions. The basic insight is that if private agents regard the authorities' holdings of home and foreign securities as their own, then when the authorities decide to alter their holdings through intervention operations, private agents will simply alter their direct holdings in an offsetting way leaving the exchange rate unchanged. This proposition is valid whether or not private agents regard home and foreign securities as imperfect substitutes because of exchange risk. However, it does depend, just as the more familiar closed economy neutrality results do, on the absence of contemporaneous distribution effects and the presence of consumers who either live as long as the (perhaps infinitely lived) government or make bequests that represent the first step along the "time-consistent" path that maximizes the utility of enough (perhaps all) future generations of their offspring.

The discovery that intervention operations do not affect the exchange rate under some fairly strong but nonetheless interesting assumptions is significant in and of itself. More important, it adds urgency to the investigation already under way of the theoretical basis for asset demand functions in open economies and suggests that this investigation may need to focus somewhat more on contemporaneous and intertemporal distribution effects.[43] Some of the results of this investigation are consistent with the type

43. Participants in this investigation include Kouri (1977), Frankel (1979), and Dornbusch (1980).

of asset demand functions used earlier in this paper; the one discussed here obviously is not.

11.10 The Effects of Intervention Operations: The Empirical Evidence

A brief discussion of empirical evidence that bears on the question of whether intervention operations affect the exchange rate is in order. Attention is focused on two classes of empirical work: (1) tests of the joint hypothesis that securities denominated in different currencies are perfect substitutes because agents are risk neutral and that expectations are rational and (2) what are called direct tests for effects of intervention.[44]

Under the joint hypothesis the "ex post excess return," defined either as the difference between interest differentials and actual exchange rate changes or equivalently as the difference between forward rates on maturing contracts and realized spot rates, should be white noise. Although some early studies did not reject the joint hypothesis, it has been rejected in most recent studies, some of which incorporate refinements in the testing procedure.[45]

At first, rejections of the joint hypothesis were viewed as evidence against rational expectations. More recently, they have been regarded as refuting the hypothesis of perfect substitutability and providing evidence in favor of the existence of a "time-varying risk premium." Of course, neither of these interpretations is strictly correct. The rejections cast doubt on both components of the joint hypothesis. They are certainly consistent with intervention operations affecting exchange rates. However, even if they are interpreted as evidence in favor of a variable risk premium and, therefore, imperfect substitutability, they do not necessarily imply that the authorities can alter the risk premium and, thus, affect exchange rates with intervention operations.

The ambiguous implications of efficiency tests whet the appetite for more direct tests for effects of intervention. Such tests have been performed by Dooley and Isard (1982), Frankel (1982*a*, 1982*b*), and Obstfeld (1983). All these studies focus on the dollar–deutsche mark exchange rate.[46] Although they differ significantly in details, the Dooley and Isard and Frankel studies

44. Genberg (1981) and Obstfeld (1982*b*) survey empirical work relevant for assessing the likelihood that intervention policy has significant effects. Dooley (1982) points out that since 1973 the intervention policies of several major industrial countries have generated only minor changes in the relative supplies of bonds denominated in those countries' currencies. However, the smaller industrial countries and the developing countries have denominated an increasing share of their total net debt in the currencies of the major countries and have generated relatively large changes in the relative supplies of bonds denominated in the currencies of the major industrial countries.

45. Recent studies include Hansen and Hodrick (1980), Meese and Singleton (1980), and Cumby and Obstfeld (1981).

46. Hooper and Morton (1982) have performed similar tests for the weighted average dollar. Their results are consistent with those reported below.

use the same general approach. Estimating equations are obtained by solving asset demand functions for the risk premium and then imposing rational expectations. The ex post excess return is regressed on an asset stock (and in the first Frankel study on some other variables). In the Dooley and Isard study the coefficient on the asset stock is of the correct sign and in the best regression nearly twice its standard error. However, the authors conclude that their particular representation of the portfolio balance model explains only a small part of the variation in the ex post excess return. Among the many regressions run in the first Frankel study there are no significant coefficients on asset stocks (or any other variable) and coefficients are often of the wrong sign. In his second study Frankel imposes restrictions implied by mean variance optimizing and manages to obtain an asset stock coefficient of the correct sign, but that coefficient is not significant. The results of these studies are consistent with the view that dollar and deutsche mark securities are very good substitutes since changes in asset stocks cause little or no change in expected return. According to this view intervention operations of reasonable size do not have very much effect on the exchange rate.

The results of the Obstfeld study are quite similar. Obstfeld estimates structural equations for German sight deposit demand, German sight deposit supply, German demand for deutsche mark securities, and foreign supply of deutsche mark securities as well as a reduced-form equation for German consumer price index inflation. The differential between Euro–deutsche mark and Eurodollar interest rates is used as a proxy for the expected rate of deprecation of the deutsche mark. Obstfeld finds evidence of lagged adjustment of actual quantities to long-run desired quantities in three of his four structural equations. He simulates two transitory intervention operations under the assumption that market participants have perfect foresight. Each operation is reversed after 9 months. The first operation is a nonsterilized intervention operation that reduces the German monetary base by 10% of its January 1979 level. This operation causes an immediate 3% appreciation of the deutsche mark. Then the deutsche mark begins to depreciate because market participants know that the operation will be reversed. The second operation is a sterilized intervention operation of equal magnitude. This operation causes an immediate appreciation of only 0.04%. These results suggest that sterilized exchange market intervention operations have virtually no effect on the exchange rate.

Appendix

The model of the text is a linear approximation to the one sketched out here at a zero disturbance, balanced trade equilibrium where endogenous variables take on their constant expected values represented by the variables with

bars over them. In a linear approximation, output coefficients in aggregate demand equations are familiar marginal propensities to spend, and balance sheet constraints imply straightforward relationships among coefficients of asset demands. Units are defined so that $\bar{E} = \overset{*}{\bar{P}} = \bar{P} = \overset{*}{\bar{Q}} = \bar{Q} = \overset{*}{\bar{W}} = \bar{W} = 1$; thus the differentials of E, $\overset{*}{P}$, P, $\overset{*}{Q}$, Q, $\overset{*}{W}$, and W are equal to the differentials of their logarithms. Symbols are defined at the end of the Appendix. Coefficients displayed below or beside an equation are the coefficients of the approximation to that equation.

The aggregate demand equations for the home and foreign goods are given by

(A1)
$$PY = h(E\overset{*}{P}/P)\{PY + E\overset{**}{P}Y - c[a(r, \overset{*}{r})(PY + E\overset{**}{P}Y) - (A + \overset{*}{A})]\} + P\alpha,$$

$$y_1 = h(1 - ca), \quad y_4 = h'(Y + \overset{*}{Y}) + h(1 - ca)\overset{*}{Y},$$
$$y_2 = ca_r Y, \quad y_5 = hc(N + F),$$
$$y_3 = ca_r^* Y, \quad y_6 = hc(A + \overset{*}{A}),$$

(A2)
$$E\overset{**}{P}Y = [1 - h(E\overset{*}{P}/P)]\{PY + E\overset{**}{P}Y - c[a(r, \overset{*}{r})(PY + E\overset{**}{P}Y) - (A + \overset{*}{A})]\} - E\overset{*}{P}\alpha,$$

$$\overset{*}{y}_1 = (1 - h)(1 - ca), \quad y_4 = h'(Y + \overset{*}{Y}) + h(1 - ca)\overset{*}{Y},$$
$$\overset{*}{y}_2 = ca_r\overset{*}{Y}, \quad \overset{*}{y}_5 = (1 - h)c(M + B),$$
$$\overset{*}{y}_3 = ca_r^*\overset{*}{Y}, \quad \overset{*}{y}_6 = (1 - h)c(A + \overset{*}{A}).$$

In equations (A1) and (A2), $h(\cdot)$ represents a function with $h'(\cdot) > 0$; in the expressions for y_j and $\overset{*}{y}_j$, $j = 1, 4, 5$, and 6, and everywhere else in the paper h represents the value of $h(\cdot)$ at the zero disturbance, balanced trade equilibrium. It is assumed that $0 < h$, $ca < 1$, and that a_r, a_r^*, and $h' > 0$, so all the approximation coefficients are positive, and $0 < y_1, \overset{*}{y}_1 < 1$. In deriving y_2, y_3, $\overset{*}{y}_2$, $\overset{*}{y}_3$, and y_4, use is made of the facts that in equilibrium $h(Y + \overset{*}{Y}) = Y$, and $(1 - h)(Y + \overset{*}{Y}) = \overset{*}{Y}$, and that with balanced trade $h\overset{*}{Y} = (1 - h)Y$. The product ca is represented by s in the text.

Expressions for $A + \overset{*}{A}$, r, and $\overset{*}{r}$ are

(A3)
$$A + \overset{*}{A} = M + B + E(N + F),$$

(A4)
$$r = i - (\bar{Q} - Q)/Q = i - (\bar{E} - E)/E - (\overset{*}{\bar{Q}} - \overset{*}{Q})/\overset{*}{Q},$$

(A5)
$$\overset{*}{r} = \overset{*}{i} + (\bar{E} - E)/E - (\bar{Q} - Q)/Q = \overset{*}{i} - (\overset{*}{\bar{Q}} - \overset{*}{Q})/\overset{*}{Q},$$

where

$$Q = hP + (1 - h)E\overset{*}{P}, \tag{A6}$$

$$\overset{*}{Q} = hP/E + (1 - h)\overset{*}{P}, \tag{A7}$$

and $\overline{Q}$ and $\overline{\overset{*}{Q}}$ are obtained by replacing P, E, and $\overset{*}{P}$ with $\overline{P}$, $\overline{E}$, and $\overline{\overset{*}{P}}$. The production functions for home and foreign output are given by

$$Y = e^{\beta}X_0L^{X_1}, \quad x_1 = e^{\beta}X_0X_1L^{X_1-1}, \quad x_2 = Y, \tag{A8}$$

$$\overset{*}{Y} = \overset{*}{X}_0\overset{*}{L}^{\overset{*}{X}_1}, \quad \overset{*}{x}_1 = \overset{*}{X}_0\overset{*}{X}_1\overset{*}{L}^{\overset{*}{X}_1-1}, \tag{A9}$$

and the marginal productivity conditions for home and foreign firms are given by

$$W/P = e^{\beta}X_0X_1L^{X_1-1}, \quad l_1 = e^{\beta}X_0X_1(1-X_1)L^{X_1-2}, \tag{A10}$$

$$\overset{*}{W}/\overset{*}{P} = \overset{*}{X}_0\overset{*}{X}_1\overset{*}{L}^{\overset{*}{X}_1-1}, \quad \overset{*}{l}_1 = \overset{*}{X}_0\overset{*}{X}_1(1 - \overset{*}{X}_1)\overset{*}{L}^{\overset{*}{X}_1-2}. \tag{A11}$$

Replacing P and L with $\overline{P}$ and L_f yields $\overline{W}$; replacing $\overset{*}{P}$ and $\overset{*}{L}$ with $\overline{\overset{*}{P}}$ and $\overset{*}{L}_f$ yields $\overline{\overset{*}{W}}$. It is assumed that $0 < X_1, \overset{*}{X}_1 < 1$, so x_1, $\overset{*}{x}_1$, l_1, and $\overset{*}{l}_1$ are positive.

The nominal wage indexing rules are given by

$$(W - \overline{W})/\overline{W} = \mu(Q - \overline{Q})/\overline{Q}, \tag{A12}$$

$$(\overset{*}{W} - \overline{\overset{*}{W}})/\overline{\overset{*}{W}} = \overset{*}{\mu}(\overset{*}{Q} - \overline{\overset{*}{Q}})/\overline{\overset{*}{Q}}. \tag{A13}$$

The asset market equilibrium conditions are given by

$$M = PY\lambda[i, \overset{*}{i} + (\overline{E} - E)/E] + P(\gamma + \delta), \tag{A14}$$

$$m_1 = Y\lambda, \; m_2 = \lambda, \; m_3 = -Y\lambda_1, \; m_4 = -Y\lambda_2,$$

$$EN = E\overset{***}{P}\overset{**}{Y}\nu[i - (\overline{E} - E)/E, \overset{*}{i}], \tag{A15}$$

$$n_1 = \overset{**}{Y}\nu, \; n_2 = \overset{*}{\nu}, \; n_3 = -\overset{**}{Y}\nu_1, \; n_4 = -\overset{**}{Y}\nu_2,$$

$$B = k[i - \overset{*}{i} - (\overline{E} - E)/E][A + \overset{*}{A} - PY\lambda(\cdot) - E\overset{***}{P}\overset{**}{Y}\nu(\cdot)] - P(\gamma - \epsilon), \tag{A16}$$

$$b_1 = km_1, \qquad b_6 = k'(\overset{*}{A} - N) - kn_4,$$

$$b_2 = km_2, \qquad b_7 = kF,$$

$$b_3 = k'(A - M) + km_3, \qquad b_8 = kn_1,$$

$$b_4 = k'(A - M) - km_4, \qquad b_9 = kn_2,$$

$$b_5 = k'(\overset{*}{A} - N) + kn_3,$$

$$EF = \{1 - k[i - \overset{*}{i} - (\bar{E} - E)/E]\}[A + \overset{*}{A} - PY\lambda(\cdot) - \overset{***}{EPY}\nu(\cdot)] - \overset{*}{EP}(\delta + \epsilon). \tag{A17}$$

It is assumed that $0 < k < 1$; that λ, $\overset{*}{\nu}$, k', $(A - M)$, and $(\overset{*}{A} - N) > 0$; and that λ_1, λ_2, $\overset{*}{\nu}_1$, and $\overset{*}{\nu}_2 < 0$. These assumptions imply that all the asset market approximation coefficients except b_4 and b_6 are positive. The assumption that wealth holders in both countries regard the three assets they hold as strict gross substitutes implies that b_4 and b_6 are positive, that is, that the positive effect of the increase in the ratio of wealth minus money demand that home (foreign) wealth holders want to hold in home securities exceeds the negative effect of the increase in home (foreign) money demand. In the equilibrium at which the approximation is made (1) an increase in productivity leaves the demands for home money and home securities unchanged since $m_1 = m_2x_2$ and $b_1 = b_2x_2$ and (2) actual wealth equals desired wealth in both countries, that is, $A = aY$ and $\overset{*}{A} = a\overset{*}{Y}$. Adding (A14), (A15), (A16), and (A17) yields the identity (A3), so only three of the four asset market equilibrium conditions are independent. In this paper the equilibrium condition for foreign currency securities, (A17), is not used.

An assertion made in section 11.3 requires proof. No matter what the size of y_e, $C_2 + C_3$ and $m_LC_2 + b_LC_3$ are positive:

$$C_2 + C_3 = [(y_2 + y_3)h + y_4 + y_5](b_i - m_i) + y_2[b_7 + (1 - k)(m_3 + m_4)] > 0,$$

$$m_LC_2 + b_LC_3 = [(y_2 + y_3)h + y_4 + y_5](m_Lb_i - b_Lm_i) + y_2m_Lb_7 > 0.$$

Some assertions made in section 11.4 require proof. It follows from the definitions of y_5 and y_6 under equation (A1) that y_5, $y_6 \to 0$ as $c \to 0$ and that $y_6 > y_5$ for all $c > 0$. If indexing is complete ($\mu = 1$), then

$$\tilde{m}_L\tilde{C}_2 + \tilde{b}_L\tilde{C}_3 = y_i\tilde{m}_Lb_7 + (y_5 - y_6)(\tilde{m}_Lb_i - \tilde{b}_Lm_i).$$

If y_5, $y_6 \to 0$ or if b_i is finite and $y_6 > y_5 > 0$ are small enough, then $\tilde{m}_L\tilde{C}_2 + \tilde{b}_L\tilde{C}_3$ is positive. However, as $b_i \to \infty$, then, for all $y_6 > y_5 > 0$, $\tilde{m}_L\tilde{C}_2 + \tilde{b}_L\tilde{C}_3 < 0$.

Some assertions made in section 11.5 require proof. The effect on the exchange rate of a shift in asset preferences toward home money and away from home securities ($\gamma > 0$) is given by

$$\hat{e}/\gamma = (1/\Delta_1)[y_L(m_3 - b - km) + y_2m_L(1 - k)],$$

$$\Delta_1 = (y_Lm + m_Ly)b + (y_Lm_3 + m_Ly_2)b_7 + km_Lm_4y + y_Lm_4km > 0.$$

The effects on the interest rate, the exchange rate, and employment of an expected helicopter drop in the next period of home money and home securities that would change stocks of both of these assets and the expected price of the home good and the expected exchange rate by the same propor-

tion ($\hat{\overline{M}}/\overline{M} = \hat{\overline{B}}/\overline{B} = \hat{\bar{p}} = \hat{\bar{e}}$) are given by

$$\hat{i}/\hat{\bar{p}} = (1/\Delta_1)[m_L yb + km_L m_4 y + (y_2 m_L - m_4 y_L)b_7],$$

$$\hat{e}/\hat{\bar{p}} = (1/\Delta_1)(y_L mb + y_L m_4 km),$$

$$\hat{L}/\hat{\bar{p}} = (1/\Delta_1)(ymb + y_2 mb_7 + m_4 ykm).$$

In deriving the expressions reported above, use has been made of the definitions of the approximation coefficients supplied earlier in the Appendix. The definitions of b, m, and y are the following: $b = b_4 + b_5$, $m = m_3 + m_4$, and $y = y_2 + y_e$. Account has been taken of two implied relationships: $b_L = km_L$ and $b_3 = b_4 + km$. By the gross substitutes assumption, $m_3 - b - km = m_3 - b_i$ is negative, so $\hat{e}/\gamma$ is negative if $0 < k < 1$ is close enough to one (that is, if the employment responsiveness of the demand for money and the demand for home securities are similar enough in absolute value). If b is large enough (that is, if home currency and foreign currency securities are close enough substitutes), $\hat{e}/\gamma$ is definitely negative. If m_4 is small enough (that is, if the demand for home money is insensitive enough to the foreign interest rate adjusted for exchange rate expectations) or if b is large enough, $\hat{i}/\hat{\bar{p}}$ is positive. Both $\hat{e}/\hat{\bar{p}}$ and $\hat{L}/\hat{\bar{p}}$ are definitely positive.

The symbols are defined as follows:

P = home currency price of home good.

$\overset{*}{P}$ = foreign currency price of foreign good.

E = home currency price of foreign currency.

Y = aggregate demand for and aggregate supply of home good.

$\overset{*}{Y}$ = aggregate demand for and aggregate supply of foreign good.

A = home residents' wealth measured in home currency.

$\overset{*}{A}$ = foreign residents' wealth measured in home currency.

$h(\cdot)$ = proportion of spending allocated by home and foreign residents to home good.

c = speed of adjustment of actual to desired wealth by home and foreign residents.

$a(\cdot)$ = desired ratio of wealth to income for home and foreign residents.

r = expected real interest rate on home securities.

$\overset{*}{r}$ = expected real interest rate on foreign securities.

i = nominal interest rate on home securities.

$\overset{*}{i}$ = nominal interest rate on foreign securities.

Q = home currency price of world consumption bundle.

$\overset{*}{Q}$ = foreign currency price of world consumption bundle.

W = home currency money wage of home residents.

$\overset{*}{W}$ = foreign currency money wage of foreign residents.

L = employment in home country.

$\overset{*}{L}$ = employment in foreign country.

M = supply of home money measured in home currency.

B = supply of home securities measured in home currency.

N = supply of foreign money measured in foreign currency.

F = supply of foreign securities measured in foreign currency.

$\lambda(\cdot)$ = inverse of velocity in home country.

$\overset{*}{v}(\cdot)$ = inverse of velocity in foreign country.

$k(\cdot)$ = proportion of wealth minus money demand held in home securities by home and foreign residents.

Comment

Rudiger Dornbusch

Henderson's paper is a comprehensive and definitive assessment of what can be said about intervention. It offers little encouragement to anyone who had hoped that intervention, following easily identified rules, might do away with volatility and unnecessary swings in foreign exchange markets. On the contrary, it concludes that there are few instances where intervention is decidedly called for.

The Approach

Henderson analyzes foreign exchange market intervention in terms of a simple general equilibrium model. Its virtue is that asset markets are modeled with great care and are rightly identified as central to the issue of intervention. Henderson distinguishes between sterilized and nonsterilized intervention: In each a purchase of foreign exchange by the authorities is associated with a change in the relative supply of assets in the hands of the world public. However, in the case of nonsterilized intervention there is an increase in money relative to outside debt, and in the sterilized case outside debt rises relative to money. Sterilized intervention thus becomes a change in the currency composition of the world stock of outside debt whereas non-

sterilized intervention changes the currency composition of the world money supply.

It is generally accepted that changes in the currency composition of the world money stock should exert effects: money is the medium of transactions and thus there is no foreign demand for home money. Even in models of currency substitution—the theoretical basis of which has never been established—changes in the composition of world money exert effects because of imperfect substitution. In Henderson's paper there is no external money demand and therefore the role of imperfect asset substitution is reserved, rightly, for interest-bearing assets. It serves as the channel through which intervention, by way of sterilization, can affect relative asset supplies and thus equilibrium asset yields, aggregate demand, output, and prices.

Henderson's model is cast in macroeconomic terms in that it establishes a link between money and bond markets and provides for transmission channels between assets and goods markets. But cutting through these details the central point of the finance-theoretic approach remains a link between the depreciation-adjusted interest rate differential and the risk premium on home securities:

$$(1) \qquad i - i^* - \dot{e}/e = \theta(B/e\overline{W}, \ldots); \theta' \geq 0.$$

The risk premium, θ, will be an increasing function of the supply of domestic currency assets relative to world wealth, $B/e\overline{W}$. This equation is central to intervention in that it shows the relative supply of assets as one of the determinants in the interest rate–exchange rate relation. Suppose, for example, that domestic interest rates were increased but the exchange rate and depreciation rate were to remain unchanged. Equation (1) suggests that a change in the relative supply of domestic currency assets will do the trick by generating a matching increase in the risk premium. Sterilized intervention then is nothing but management of the risk premium.

The Key Results

Two results come clearly out of Henderson's analysis: first, nonsterilized intervention is effective. If in the face of exchange depreciation the central bank sells foreign exchange and reduces the home money stock, then such intervention cannot fail to dampen the exchange depreciation. Second, sterilized intervention is *the* appropriate policy initiative whenever the disturbance is a portfolio shift between home and foreign currency debt. Sterilized intervention in this case avoids the spreading of purely financial disturbances to interest rates, prices, and exchange rates.

The case for sterilized intervention, when disturbances are primarily portfolio shifts, is parallel to the standard Poole argument that rates should be pegged and supplies endogenized whenever asset demands are random. It is here applied, not to the interest-bearing versus non-interest-bearing govern-

ment debt, but rather to the currency denomination of debt. Thus, whenever there is a shift out of United States dollar T-bills into French franc bonds, the United States government, or the government of France, would retire dollar debt and issue French franc–denominated debt. Henderson rightly emphasizes that it is rarely the case that we can identify disturbances as being clearly financial as opposed to real. Therefore the accommodation rule retains its interest primarily for those cases where portfolio shifts predominate relative to real disturbances.

In the general case where disturbances can be either real or financial and can originate on the demand or supply side, not much can be said. Henderson considers two policy settings: constant aggregates (money and bonds) and constant rates (exchange rate and interest rate) and asks which setting provides more stability in output and prices. The comparison can be readily made in terms of figure 11.C.1, where AD_r is the aggregate demand schedule along which the interest rate and the exchange rate are held constant, and AD_a is the schedule along which aggregates (money and debt) are constant. The latter is flatter (assuming that certain elasticity conditions are satisfied) since a decline in the price level raises real balances and brings about a fall in interest rates and a depreciation, both of which increase aggregate demand. By contrast, along AD_r the aggregate demand schedule slopes downward only because a decline in prices enhances external competitiveness.

It is immediately apparent from the diagram that an adverse supply shock shifting AS to AS' will bring about a larger increase in prices and smaller decline in output when rates are held constant as opposed to aggregates. When rates are held constant money is accommodating and the supply shock finds its way into prices, not interest rates. Figure 11.C.2 shows the impact of a fiscal expansion or an increase in net exports under the two policy settings. Under a rates constant policy the income expansion is accommo-

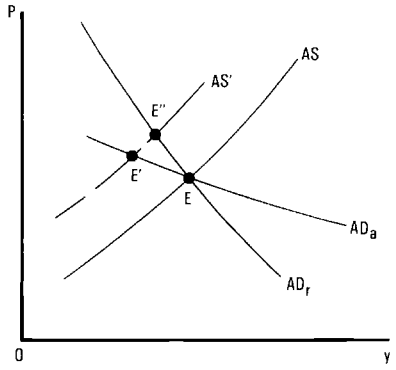

Fig. 11.C.1

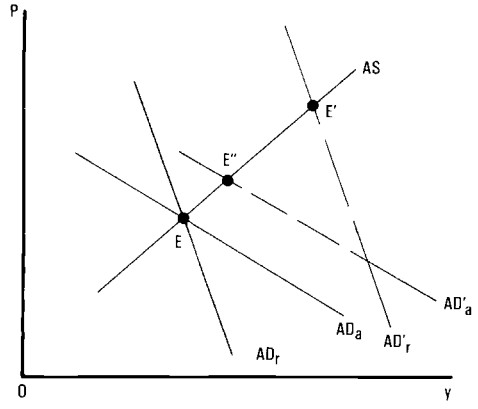

Fig. 11.C.2

dated through an increase in money. With less crowding out, the shift of the aggregate demand schedule is larger than that of AD_a. Thus with a rates constant policy demand disturbances exert larger impacts on output *and* on prices than is the case with constant aggregates. Which policy setting is more conducive to stability then depends on the relative preference for output and price stability and the relative prevalence of demand and supply disturbances. But the answer does not stop here. In a realistic model there would be exchange rate effects on the aggregate supply side—through wage indexing or materials prices—and once that occurs the apparent sharpness of the analysis in figures 11.C.1 and 11.C.2 goes away altogether. Henderson's paper is valuable in showing so strongly that pure portfolio shifts apart there is no case whatsoever for sterilized intervention as a generally good idea.

The Intervention Problem

Henderson's analysis is carefully placed in a macroeconomic, stochastic model. Policymakers face uncertainty about the disturbances that hit the economy and are offered alternative policy menus to select so as to minimize the asymptotic variances of output and prices. The analysis could, and indeed should, also take into account other policy objectives such as real interest rates, which surely matter for the medium-term question of growth. Needless to say, introduction of further trade-offs only weakens the chances that one rigid setting—sterilized intervention—should be optimal. Indeed, we would move further in the direction of Henderson's conclusion that a managed float would be appropriate.

The intervention issue arises in practice in two possible settings. First, should the authorities intervene to reduce "noise" in the foreign exchange

market? Here we are concerned with day-to-day fluctuations and for the sake of the argument we might assume that there is no uncertainty about the trend. I can see neither harm nor great advantages to such intervention. One argument is that if the spot exchange rate moves a lot, under these idealized circumstances, it is presumably because it matters very little. Alternatively, noise may be a reflection of the fact that there is insufficient private speculation, which would be the case if there were uncertainty about exchange rate trends. Thus intervention in the case of noise strikes me as sensible only if the central bank can confidently announce financial stability and take bets on it with risk-averse and doubtful speculators.

The more serious intervention problem is the one we face today. Exchange rates have gone far out of line. The real exchange rate of the dollar stands more than 10% above its average of the 1971–81 period and more than 15% above the average of the last 5 years. The exchange rate swings have exerted a major impact on growth and on international inflation differentials. Most important, the overvaluation is the consequence, not of changes in portfolio preferences, but rather of policy decisions to control inflation in the United States. Henderson does not address this critical issue: When one country goes on a disinflation course, is it possible to use intervention and is it advisable to do so? This strikes me as the most important instance where the intervention issue arises, because it is in this case that real exchange rates move so very far from their long-run averages. Henderson's comparative static analysis cannot answer that question, since it is concerned with alternative scenarios of inflation stabilization, credibility, and expectations formation. This is regrettable because the case of intervention response to dyssynchronized inflation stabilization is one of the most serious international financial issues.

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