MODULE 10

Small Open Economy Equilibrium III:

Monetary Policy Under Fixed Exchange Rates

This module continues the analysis of the previous module, focusing on the equilibrium of the small open economy and the operation of monetary policy under fixed exchange rates. It begins with an overview of the conditions of equilibrium. The process of money creation is then explored in detail, followed by separate analyses of the less-than-full-employment and full-employment cases. The same *IS-LM-ZZ* and *XX-MM-ZZ* tools used in the previous model are used again here. Finally, the nature and causes of balance of payments disequilibria are considered. The basic result that emerges is that domestic output and prices are determined by the condition of flow equilibrium and the world interest rate when the exchange rate is fixed—this equilibrium is given by the intersection of the *IS* (or *XX*) and *ZZ* curves. The domestic money supply then adjusts through changes in the official stock of foreign exchange reserves in response to domestic residents' attempts to maintain portfolio equilibrium at these levels of output and prices. This adjustment drives the LM (or MM) curve through the IS-ZZ (or XX-ZZ) intersection. The money supply will thus be independent of the actions of the authorities although they can control the stock of foreign exchange reserves by using open market operations in domestic bonds to force home residents to adjust their portfolios by purchasing and selling assets abroad.

1. Equilibrium Under Fixed Exchange Rates

Under fixed exchange rates equilibrium is determined by the world interest rate and the condition of goods market equilibrium, with the money supply adjusting endogenously to maintain asset equilibrium. The money supply becomes independent of the actions of the monetary authorities and monetary policy becomes impotent.

Begin with the previously developed equations of stock and flow equilibrium:

$$\frac{M}{P} = \theta + \epsilon Y - \Omega\,(r^* + \tau^e) \tag{1}$$

$$\begin{aligned} Y = {} & [\frac{1}{s+m}][Z_{BT} + \alpha + \delta] + [\frac{m^*}{s+m}]\,Y^* - [\frac{\mu}{s+m}]\,r^* \\ & -[\frac{\sigma}{s+m}]\,q + [\frac{1}{s+m}]\,DSB \end{aligned} \tag{2}$$

Consider first the less-than-full-employment case. The domestic price level is fixed by construction and the price level in the rest of the world is independent of what happens in the domestic economy. Fixing of the nominal exchange rate thus implies a fixed level of the real exchange rate q. There is only one level of Y consistent with flow or goods market equilibrium in equation (2), given that r^* and Y^* are determined in the rest of the world. When we plug this equilibrium level of Y into the asset equilibrium equation (1) there is only one level of the nominal money stock consistent with asset equilibrium, given the fixed price level and the world-determined real interest rate.

In the full-employment case output is fixed and the price level responds to market conditions. Replacing Y in (2) with Y_F leaves only one level of q consistent with flow equilibrium.[1]

$$q = \frac{1}{\sigma}\,[Z_{BT} + \alpha + \delta] + \frac{m^*}{\sigma}\,Y^* - \frac{\mu}{\sigma} r^* - \frac{s+m}{\sigma}\,Y_F + \frac{1}{\sigma}\,DSB \tag{5}$$

When we fix the exchange rate and take into account that the price level in the rest of the world is fixed by conditions abroad, this equilibrium level of q implies an equilibrium level of P.

[1] A number of equations in the module presentation are skipped here because, being repeats of earlier equations, they are redundant to a bare-bones exposition of what the module contains.

Thus, under fixed exchange rates with full employment the domestic price level is determined by the condition of domestic commodity market equilibrium combined with the real interest rate (and output and price level) determined in the rest of the world. Given this price level, and the world real interest rate and domestic full-employment level of income, there is only one level of the domestic nominal money stock consistent with domestic asset equilibrium. This can be seen from equation (1).

Regardless of whether or not there is full employment, once the authorities fix the exchange rate they lose control over the domestic money supply.

2. Money Creation: The Basics

To fully develop an analysis of small open economy equilibrium under fixed exchange rates we must first examine the process by which money is created. Money exists in order to facilitate the making of transactions—it saves the labour and capital resources that would have to be used if barter were the only method of exchange and avoids the costs of checking the creditworthiness of transactors required for basing transactions on credit. Here we define the money supply simply as cash-in-hand plus bank deposits.

In modern economies money is put in circulation by the central bank. Every time the central bank buys assets from (sells assets to) the private sector or to another branch of government (that adjusts its expenditure accordingly) it puts money in (takes money out of) circulation. The treasury branch of government finances the government's expenditures by either collecting taxes from the public or borrowing. Its actions do not affect the money supply unless it finances expenditures by borrowing from the central bank. Central bank purchases and sales of assets in the open market, called *open market operations*, are the main avenue through which it changes the money supply.

Changes in bank deposits as a result of commercial bank actions will also change the money supply. Commercial banks make their profits by borrowing funds from depositors and lending them out to households and businesses at rates of interest above the rates paid on deposits.

The balance sheet of a typical bank is given in Figure 2.1. Some portion of funds on deposit must be kept as cash reserves to meet demands of depositors to withdraw cash. These reserves consist of cash-on-hand plus deposits with the central bank that can be immediately converted into cash. Banks will also normally hold some government bonds and other interest earning assets in addition to their commercial loans.

Figure 2.1:

First City Bank

Assets	(thousands of $)		Liabilities
Cash Reserves	3,000	Deposits	30,000
Government Bonds	10,000		
Loans	22,000		Net Worth
		Equity	5,000
Total	35,000	Total	35,000

Figure 2.2:

First City Bank

Assets	(thousands of $)		Liabilities
Cash Reserves	3,100 ←	Deposits	30,100 ←
Government Bonds	10,000		
Loans	22,000		Net Worth
		Equity	5,000
Total	35,100	Total	35,100

Suppose that the central bank buys \$100 of bonds from someone in the private sector who deposits the cash in the commercial bank depicted in Figure 2.1. The bank's deposits and reserves both increase by \$100, as shown in Figure 2.2. Since the bank only needs, say, \$10 of reserves to back the additional \$100 of deposits, it loans out \$90. The resulting balance sheet is shown in Figure 2.3.

Figure 2.3:

First City Bank

Assets	(thousands of $)		Liabilities
Cash Reserves	3,010 ←	Deposits	30,100 ←
Government Bonds	10,000		
Loans	22,090 ←		
			Net Worth
		Equity	5,000
Total	35,100	Total	35,100

Figure 2.4:

Second City Bank

Assets	(thousands of $)		Liabilities
Cash Reserves	2,000	Deposits	20,000
Government Bonds	5,000		
Loans	17,000		
			Net Worth
		Equity	4,000
Total	24,000	Total	24,000

The person who took out the loan spends the funds and they are thus redeposited in some other bank in the system, shown in Figure 2.4. That bank's reserves and deposits will increase by \$90, as shown in Figure 2.5. That second bank only needs to hold, say, \$9 in reserves to back the additional deposit of \$90, so it will loan out \$81, which will be deposited in a third bank. The money supply is then higher by \$100 + \$90 + \$81 = \$271 as a result of the central bank's open market operation. The third bank, in turn, will loan out a portion of these \$81 and keep only a fraction as reserves. This loan will be deposited again, and so on.

Figure 2.5:

Second City Bank

Assets	(thousands of $)		Liabilities
Cash Reserves	2,090 ←	Deposits	20,090 ←
Government Bonds	5,000		
Loans	17,000		
			Net Worth
		Equity	4,000
Total	24,090	Total	24,090

So the ultimate effect of a \$100 open market purchase of bonds by the central bank will be an expansion in the money supply of some multiple of that amount. A decision on the part of the public to hold \$100 less cash and \$100 more deposits will have exactly the same effect. Deposits and reserves will initially rise by \$100 followed by a multiplier effect as the excess reserves are repeatedly loaned out and redeposited.

We now introduce the distinction between *base money* or *high-powered money* and the money supply itself. High-powered money is the cash or reserve base upon which the banking system can create deposits. It equals the reserves of the banking system, upon which deposits can be directly created, plus the public's cash-in-hand, which can potentially be deposited in banks to augment the reserves on which deposit expansion can be based.

Base money thus equals

$$H = CP + BR \tag{1}$$

and the money supply is

$$M = CP + DP \tag{2}$$

where H and M are the stocks of base money and money respectively and CP is the public's cash holdings, DP is its deposit holdings and BR is the reserve holdings of the commercial banking system. The ratio of the money supply to base or high powered money then equals

$$mm = \frac{M}{H} = \frac{CP + DP}{CP + BR}. \tag{3}$$

Dividing both the numerator and denominator of this expression by DP we obtain

$$mm = \frac{c+1}{c+f} \tag{4}$$

where $c = CP/DP$ is the public's desired ratio of cash-in-hand to deposit holdings and $f = BR/DP$ is the commercial banking system's desired ratio of reserves to deposits. If the banking system's desired reserve ratio or the public's desired cash to deposit ratio falls the money supply associated with any given stock of base money will increase.

The central bank can control the stock of base money by its open market operations but private sector decisions determine how big the stock of money associated with this stock of base money will be. To control the money supply, the central bank must continually adjust H to offset the effects of changes in c and f on mm and M.

3. Domestic and Foreign Source Components of the Stock of Base Money

The central bank's control over the money supply is also affected by government operations in the foreign exchange market designed to influence or maintain fixed the country's foreign exchange rate. When the central bank, acting on behalf of the government, changes the country's stock of official reserves of foreign exchange it buys and sells short-term securities denominated in foreign currency in return for domestic currency. This puts base money in and out of circulation in the same way as when the bank buys or sells domestic government bonds, and the resulting changes in base money have the usual multiplier effects on the domestic money supply.

The stock of domestic high-powered money can thus be divided into two parts—the part that arose from the purchase of domestic-currency denominated assets (D) and the part that arose from the purchase of official reserves of foreign exchange (R):[2]

$$H = R + D \tag{2}$$

D and R are called, respectively, the *domestic* and *foreign source components* of the money supply. An increase in either of these components, holding the

[2]Equation (1) in the module presentation is omitted here because it is a repeat of the material at the end of the previous topic.

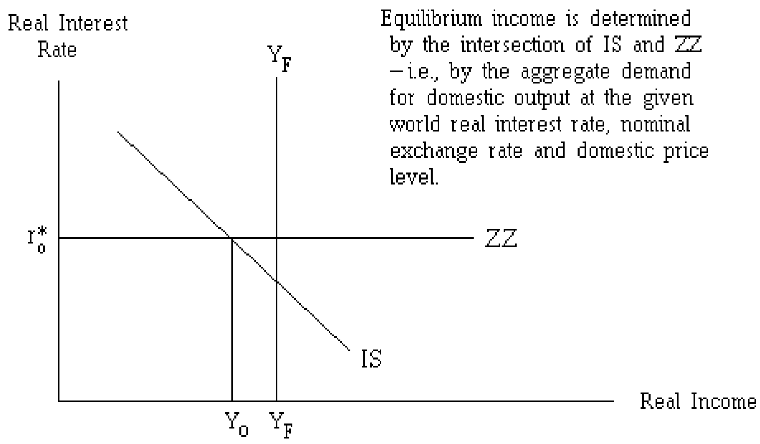
other constant, will increase the stock of domestic base money. The central bank may increase the stock of official reserves and hold base money constant by selling an equal amount of domestic securities at the same time. In this case it is said to be *sterilizing* the effects of the increase in foreign exchange reserves on the money supply.

The central bank can use methods other than open market purchases and sales of domestic securities and foreign exchange to affect the domestic money supply. It can change the stock of base money by shifting the treasury's deposits, which it manages on behalf of the government, between deposit accounts with the commercial banks and deposit accounts with itself. The latter deposit accounts are not part of the stock of high-powered money because the commercial banks can not use them as a base for loan and deposit expansion. In terms of the terminology above, this counts as a change in D. The central bank could also engineer a change in the money supply by persuading the government to force the commercial banks to hold a specific minimum ratio of reserves to their deposit liabilities—this would lead to a change in mm.

4. Equilibrium Under Fixed Exchange Rates: Less Than Full Employment

Consider now the process by which the small open economy gets into equilibrium under less-than-full-employment conditions. The condition of flow equilibrium developed previously appears as the downward sloping curve IS in Figure 4.1. The vertical line Y_F specifies the full-employment level of output and the horizontal line ZZ specifies the real interest rate determined in the world market.

Figure 4.1:



When the government fixes the nominal exchange rate at the level Π_0 and the price level is fixed by less-than-full-employment conditions at P_0, this condition of real goods market equilibrium, after substituting the definition of the real exchange rate, $q = P/\Pi P^*$, becomes

$$\begin{aligned} Y &= [\frac{1}{s+m}][Z_{BT} + \alpha + \delta] + [\frac{m^*}{s+m}]\,Y^* - [\frac{\mu}{s+m}]\,r^* \\ &\quad -[\frac{\sigma}{s+m}]\,[\frac{P_0}{\Pi_0 P_0^*}] + [\frac{1}{s+m}]\,DSB \end{aligned} \tag{1}$$

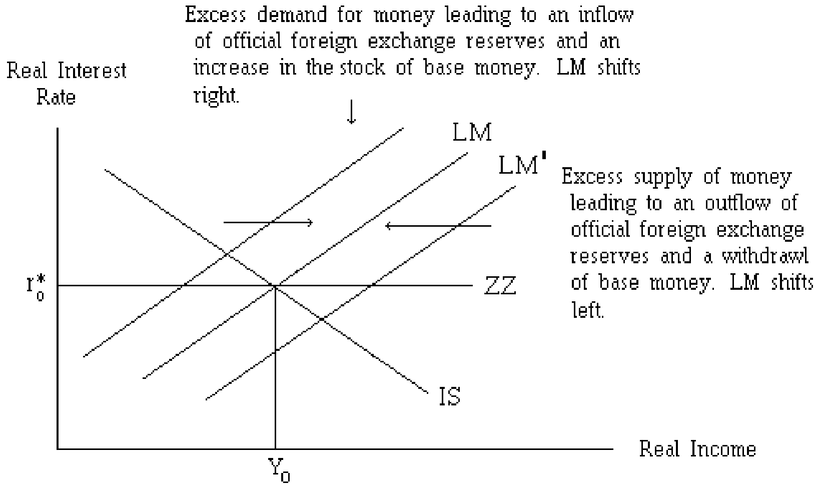
Everything on the right-hand side is predetermined, so the equation gives us the equilibrium level of Y without mention of asset equilibrium. Equilibrium is determined by the intersection of the *IS* curve and the *ZZ* line in Figure 4.1 at the output level Y_0.

For asset equilibrium to hold, the *LM* curve must cross the *ZZ* line at the same place that the *IS* curve crosses it. Given the world real interest rate and level of income determined by flow equilibrium and the fixed level of P, there is only one level of the nominal money supply M in the asset equation,

$$\frac{M}{P} = \theta + \epsilon Y - \Omega\,(r^* + \tau^e), \tag{2}$$

consistent with stock, asset, or portfolio equilibrium. Deviations of domestic residents' stock of money from its desired level cause them to reestablish portfolio equilibrium by exchanging domestic currency and foreign assets, leading to adjustments of the money stock as portrayed in Figure 4.2.

Figure 4.2:



To examine these portfolio or asset adjustments in more detail, multiply both sides of the asset equation by P to yield

$$M = P\,[\theta - \Omega\, r^* - \Omega\, \tau^e + \epsilon Y]. \tag{3}$$

Now express the nominal money stock as a multiple mm of the stock of high-powered money and then express the latter as the sum of its domestic and foreign source components:

$$M = mm\,H = mm\,[R + D] \tag{4}$$

The asset equilibrium equation then becomes

$$H = R + D = \frac{P}{mm}\,[\theta - \Omega\, r^* - \Omega\, \tau^e + \epsilon Y] \tag{5}$$

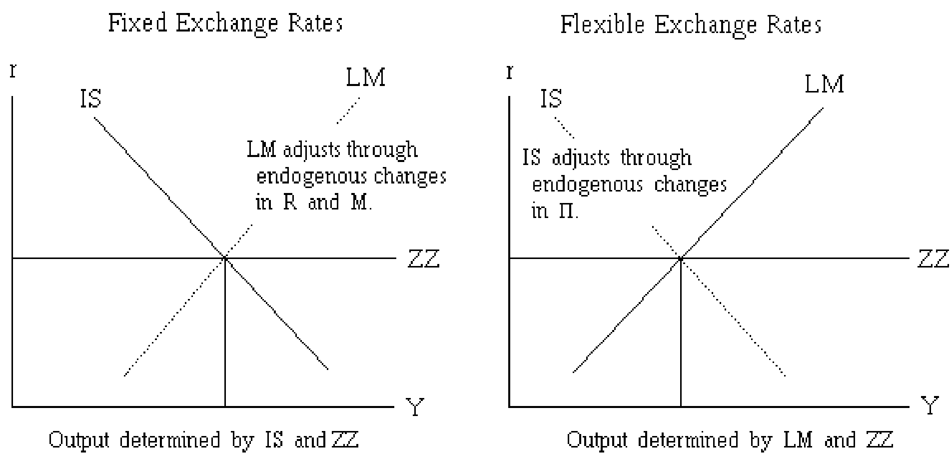
which can be further rearranged to yield

$$R = \frac{P}{mm}\,[\theta - \Omega\, r^* - \Omega\, \tau^e + \epsilon Y] - D. \tag{6}$$

A change in the public's demand for nominal money balances (given by the expression in the square brackets [...] in equation (6)) will result, in the absence of changes in the domestic source component, in an equilibrating change in the stock of official reserves. An open market purchases or sales of bonds by the domestic central bank—that is, a change in D—will result in an equal and opposite change in the stock of official reserves R. If the government does not supply the public with its desired money holdings by open market operations in domestic bonds, it will be forced to do so by purchasing and selling foreign exchange reserves—otherwise, the exchange rate will move away from its official parity. Monetary policy is impotent under fixed exchange rates.

This contrasts with the situation under flexible exchange rates, shown in the right panel of Figure 4.3, where equilibrium is determined by asset or stock equilibrium at the world real interest rate and the nominal exchange rate then adjusts to ensure that the *IS* curve passes through this *LM*-*ZZ* intersection.

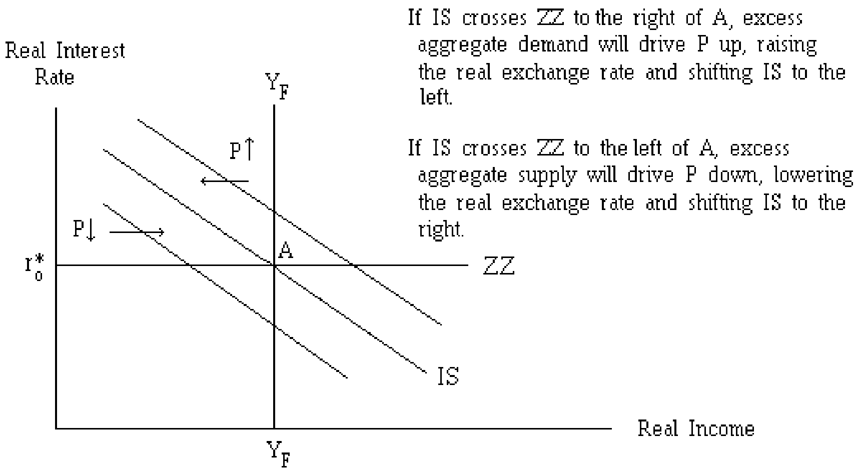
Figure 4.3:



5. Equilibrium Under Fixed Exchange Rates: Full Employment

When output and income are fixed at their full-employment levels the domestic price level is determined by the conditions of commodity market equilibrium at the fixed world interest rate, independently of domestic monetary conditions. As in the less-than-full-employment case the government, by fixing the exchange rate, loses control over the stock of money.

Figure 5.1:



Under full-employment conditions where Y equals Y_F there is only one value of P that will bring about equilibrium. That level of P can be found by rearranging the commodity market equilibrium equation to put q on the right-hand side,

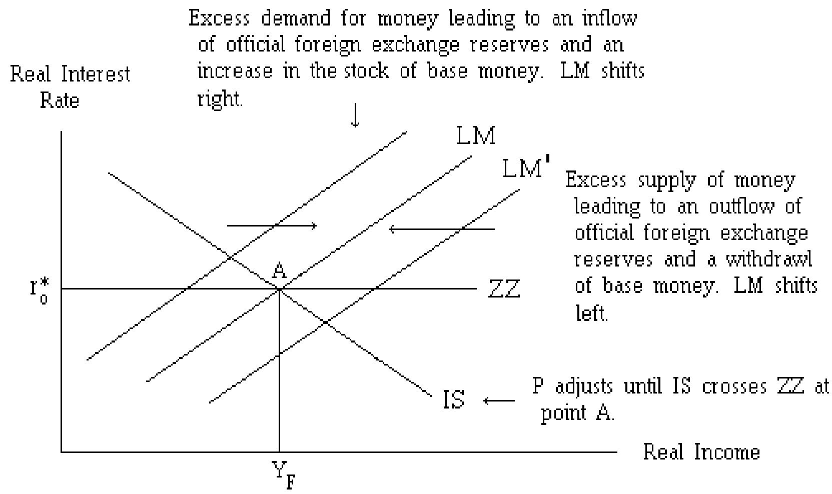
$$q = \frac{1}{\sigma}\left[Z_{BT} + \alpha + \delta\right] + \frac{m^*}{\sigma} Y^* - \frac{\mu}{\sigma} r^* - \frac{s+m}{\sigma} Y_F + \frac{1}{\sigma} DSB \tag{1}$$

and substituting into it the definition of the real exchange rate:

$$\begin{aligned} P \;\; = \;\; & [Z_\pi][Z_{BT} + \alpha + \delta] - [Z_\pi(s+m)]\, Y + [Z_\pi m^*]\, Y^* \\ & -[Z_\pi \mu]\, r^* + Z_\pi\, DSB \end{aligned} \tag{2}$$

where $Z_\pi = (\Pi_0 P^*)/\sigma$. The price level and the real exchange rate must adjust to ensure that the *IS* curve in Figure 5.1 crosses the *ZZ* line at the full-employment level of output given by the vertical line Y_F.

Figure 5.2:

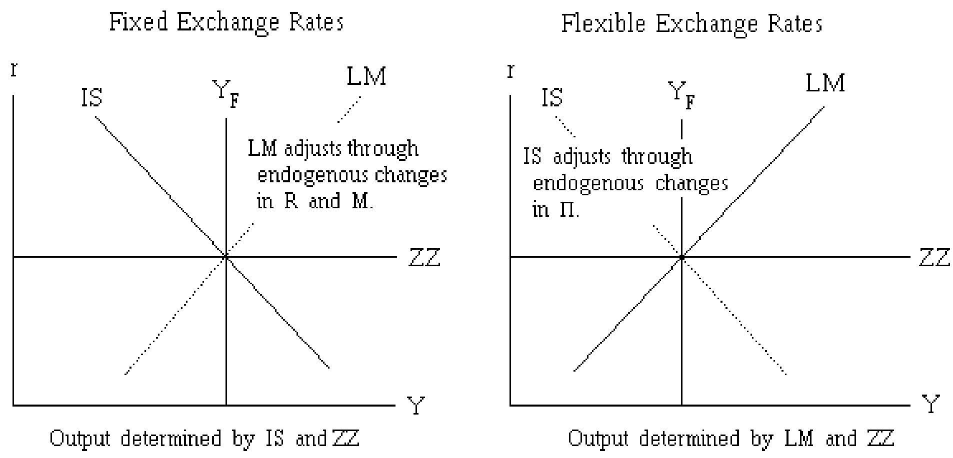


For asset equilibrium to hold, the *LM* curve must cross the *ZZ* line at the same place that the *IS* curve crosses it. The asset equilibrium equation is

$$\frac{M}{P} = \theta - \Omega\, r^* - \Omega\, \tau^e + \epsilon\, Y. \tag{3}$$

Given the world real interest rate and the levels of income and prices determined by flow equilibrium above, the only variable that can adjust to preserve asset equilibrium is M. If *LM* crosses *ZZ* to the right of *IS*, as indicated by *LM′* in Figure 5.2, domestic residents have more money than they want to hold. They will reestablish portfolio equilibrium by purchasing assets from foreign residents, creating an excess supply of domestic currency and demand for foreign currency on the foreign exchange market. To maintain the fixed exchange rate, the government must sell official foreign exchange reserves in return for domestic currency. This will reduce the money supply, shifting *LM* to the left until it passes through the *IS*–*ZZ* intersection. By a similar argument the authorities will be forced to accumulate official reserves whenever there is an excess demand for money and *LM* crosses *ZZ* to the left of *IS*—the money supply will increase, driving *LM* to the right.

Figure 5.3:



We can again express the nominal stock of money as a multiple mm of the stock of high-powered money and then express the latter as the sum of its domestic and foreign source components.

$$M = mm\,H = mm\,[R + D] \tag{4}$$

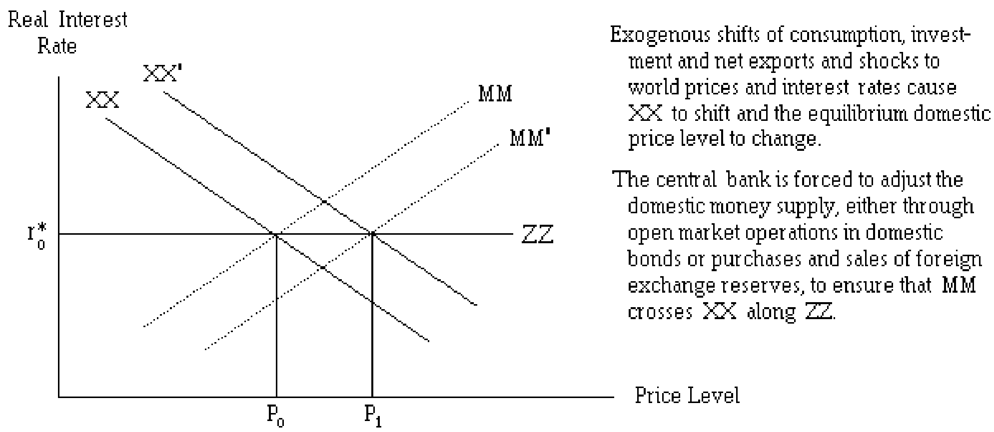
where R is the stock of official foreign exchange reserves and D is the domestic source component. The asset equilibrium equation then becomes

$$R = \frac{P}{mm}\,[\theta - \Omega\,r^* - \Omega\,\tau^e + \epsilon Y] - D. \tag{5}$$

A change in the public's demand for nominal money balances (given by the expression in the square brackets [...] in equation (5)) will result, in the absence of changes in the domestic source component, in an equilibrating change in the stock of official reserves in the same fashion as in the less-than-full-employment case. An open market purchases or sales of bonds by the domestic central bank will again result in an equal and opposite change in the stock of official reserves. If the government does not supply the public with its desired money holdings by open market operations in domestic bonds, it will be forced to do so by purchasing and selling foreign exchange reserves. By fixing the exchange rate the government is tying the domestic price level to the price level abroad and thereby giving up the option of determining that price level by varying the domestic supply of money. Figure 5.3 compares the fixed and flexible exchange rate cases.

An alternative graphical presentation of these results puts the price level on the horizontal axis instead of income as in Figure 4. The XX and MM curves behave exactly as do the IS and LM curves in the less-than-full-employment case—the only difference is that P is on the horizontal axis instead of Y.

Figure 5.4:



6. Balance of Payments Equilibrium

Balance of payments equilibrium occurs when induced transactions—those engineered by the government to influence the nominal exchange rate—are zero. It requires that the stock of foreign exchange reserves be constant. Only by chance will autonomous receipts and payments balance when the exchange rate is fixed—induced transactions by the authorities must make up the difference. The government may also engage in foreign exchange transactions to manipulate the exchange rate when it is flexible—these induced transactions also represent balance of payments disequilibria.

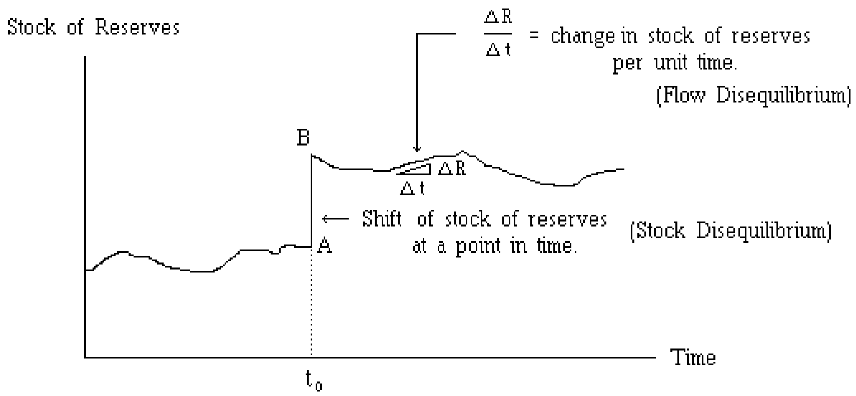
The equilibrium stock of foreign exchange reserve holdings is given by equation (5) of the previous topic, relabelled here as (3):[3]

$$R = \frac{P}{mm}\left[\theta - \Omega\, r^* - \Omega\, \tau^e + \epsilon Y\right] - D. \tag{3}$$

[3]The equation numbers in this guide follow the corresponding numbers in the module—the numbers of the equations not shown in the study guide are skipped.

The authorities are forced to maintain a stock of reserves that will provide domestic residents with their desired money holdings, given the domestic source component. This implies that the banks and the public will have their desired stock of base money. It also means that the authorities can effectively control the stock of official foreign exchange reserves by manipulating the domestic source component, but cannot control either the stock of base money or the money supply.

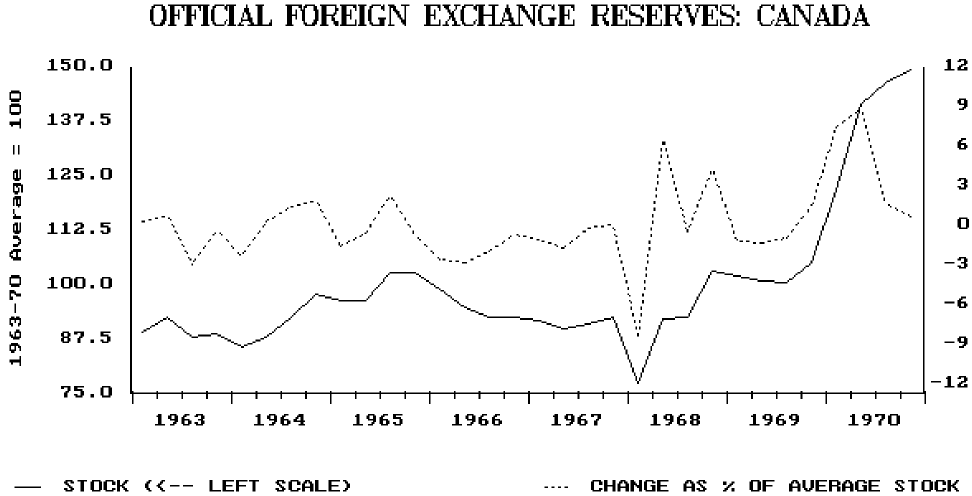
Figure 6.1:



We must distinguish here between stock and flow balance of payments disequilibria. A one-shot adjustment of the domestic source component or shift in the demand for base money holdings at a moment in time will lead to a shift in the stock of official reserves at that moment in time. This is shown as a movement from point A to point B in Figure 6.1. Also, the stock of official reserves will typically be growing or declining at some rate through time, as shown by the slope of the time-path of reserves at points other than A and B in Figure 6.1.

The stock of official reserves in Canada during the fixed exchange rate period 1963-70 together with quarter-to-quarter changes in the stock is given in Figure 6.2.

Figure 6.2:



Official reserve holdings change through time because the levels of income, prices, world interest rates, and the domestic source component change through time. Denoting changes per unit time by the symbol Δ , equation (3) can be reworked to produce

$$\Delta R = \Delta\Big(\frac{P}{mm}\,[\theta - \Omega\, r^* - \Omega\,\tau^e + \epsilon Y]\Big) - \Delta D. \qquad (4)$$

The government can control the time-path of foreign exchange reserves by controlling the time-path of D. But shocks to the demand for money are unpredictable and the main adjustment to these shocks will necessarily be the day-to-day purchases and sales of foreign exchange reserves in return for domestic currency necessary to keep the exchange rate at its fixed parity. Changes in the domestic source component perform the role of providing for long-run growth in the money supply to match the growth in demand as income and the volume of transactions rise with time. Without growth in the domestic source component, the stock of foreign exchange reserves would grow without limit as the country's income and demand for money grows. This growth of reserves must be controlled because short-term foreign government securities, the main assets held as official reserves, are not a particularly good form for a country to hold a large fraction of its wealth.

Occasionally the ability of a country to maintain a fixed exchange rate parity comes into question, usually because the government is under political pressure to finance some of its expenditures, or improve its popularity, by printing money. Such monetary expansion is inconsistent with maintaining the nominal exchange rate fixed and makes it reasonable to expect that the country's currency will devalue in the future. This creates potential gains from shifting portfolios out of domestic assets—if the domestic currency in fact devalues there are enormous gains to having one's assets denominated in foreign currencies while if devaluation does not occur little is lost by holding these currencies. To maintain the fixed exchange rate in the face of speculation against the domestic currency, the authorities must sell large quantities of foreign exchange reserves. This puts them in danger of eventually running out of reserves, in which case devaluation becomes inevitable.

Speculative pressures on the exchange rate sometimes also arise under flexible exchange rates. When investors think that a currency will depreciate in the future, they will shift funds out of assets denominated in that currency. This means that the prices of those assets will fall and interest rates on them will rise to reflect a forward discount on the currency expected to depreciate. The currency will depreciate now. Central banks often "lean against" movements in the external value of their currencies by purchasing and selling foreign exchange reserves. In this case balance of payments disequilibria, usually of a minor sort, will arise even when the exchange rate is flexible.

Under flexible exchange rates it is difficult to guess which way the rate is likely to move in the future. When speculative pressures arise under fixed exchange rates it is usually quite clear in which direction the exchange rate will move.

It should be obvious that sterilization of the effects of changes in official holdings of foreign exchange reserves on the money supply is impossible under fixed exchange rates when assets can be freely bought and sold across international boundaries. Any attempt of the authorities to offset a fall in R by an increase in D will lead to a further fall in R equal to that increase in D. Sterilization is impossible because the authorities cannot control the nominal money supply.

Study Questions

1. As a matter of accounting, the net outflow of official reserves equals the sum of the current account balance and the balance of autonomous capital account transactions in the balance of payments accounts. Does this mean that a government action that increases imports will lead to an outflow of official reserves under a fixed exchange rate regime?

2. When the authorities fix the exchange rate they are forced to continually create the public's desired stock of high-powered money by either buying bonds from the public or buying foreign exchange reserves from foreign residents. Does it matter which they do? Why should countries ever be in danger of running out of reserves and, if they did, why would a devaluation be inevitable? Why do currency crises occur when governments can replenish official reserve stocks easily by reducing the domestic source component of the money supply?

References

William J. Baumol, Alan S. Blinder and William M. Scarth, *Economics*, 4th Canadian edition, Harcourt Brace and Co., 1991, Chapter 25, 819-845, and Chapter 26, 847-854.

N. Gregory Mankiw, *Macroeconomics*, 3rd Edition, Worth Press, 1997, Chapters 7 and 11. (Alternatively, students can read the same chapters in any edition of Mankiw's book.)

Michael Parkin and Robin Bade, *Economics*, Addison-Wesley, 1991, 717-736, 746-758.